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CATIE

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Programa de Cultivos Anuales

A FARMING SYSTEM RESEARCH APPROACH FOR SMALL FARMS OF CENTRAL AMERICA

Turrialba, Costa Rica

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This paper was prepared by Raúl A. Moreno and Joseph L. Saunders. The authors are responsible for opinions expressed.

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A FARMING SYSTEM RESEARCH APPROACH FOR SMALL FARMS OF CENTRAL AMERICA

Population increase in Central America remains above 3% per year, in spite of public effort to regulate population growth. An estimated total of more than 35 million people will have to be fed by the year 2000 (Table 1). In Central America, the majority of the locally consumed foods are produced on small farms. In spite of recent developments in new technology, small farm crop yields remain considerably lower than those of the larger ones (Table 2). Consequently increase in farm production has no more than kept up with the increase in population.

Low average income and the small size of their farm units are among the main constraints that limit the Central American small farmer's ability to take full advantage of technology that farmers with greater land and capital resources have so successfully utilized to improve the productivity of their holdings (Table 3).

More appropriate technologies that consider the main constraints faced by small farmers have to be developed if their living conditions are to be improved within reasonable limits of time. The development of these new technologies should consider the farm as a reference point and should be based on a profound understanding of the small farm systems that are operating under different ecological and socio-economic conditions throughout Central America.

A farm system is a complexly interdependent association of plants, animals, soils, labor tools and other inputs; all influenced by the ecological and socio-economic environment and predominantly dependent on the farmers knowledge, ambition and abilities to convert these inputs

into outputs. In the process of adapting cropping patterns, livestock combinations and farming practices to the condition of each location in Central America, small farmers have developed several more or less distinct types of farm systems. Within these farm systems most of the crop and animal activities are closely related to each other by the common employment of labor, land and capital resources. Change in any one practice usually requires a reappraisal of all of the others, since the system has been imbalanced by such change.

Farming systems in Central America vary along gradients of environmental conditions ranging from perennial crops - tropical roots - grazing systems in the lowlands tropics to the maize-beans-small animals systems in the wet and dry tropics and the maize-sorghum holding of the semi-arid interior region. The 'milpa'[1/]-potato-field crops holdings are common in the Central American 'altiplano'[2/]. While the multiple cropping systems which characterize the small farm of Central America have their basis in the practices of the Maya indians, a wide variety of European crops and domestic animals have been incorporated into this basic scheme. This results in farming systems of incredible complexity.

Ecologically, small farmers are operating under very complex and poorly understood tropical ecosystems where they have developed specific agroecosystems by replacing natural populations with populations of a agronomic value. Unlike temperate regions, in the tropics the inter-

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1/ milpa = maize field, often with other crops interplanted
2/ altiplano = high plateau

actions among the natural communities and the agroecosystems and among the tropical agroecosystems' components are not well understood, mainly due to the lack of sufficient basic biological information.

From the socio-economic point of view, Central American small farmers are also facing a very complex environment characterized by instability of prices, inadequate inputs and outputs marketing, infrastructure, politically rather than technically oriented land reform programs and others.

CATIE, with the national institutions of the Central American Isthmus, is working to improve the standard of living of small farmers by increasing agricultural and forest production through rational use of natural resources. Considering this objective and in response to the above described situation, CATIE has adopted a Farming System approach to study the small farmers and their environment in Central America. A description of the objectives of this Farming System approach follows:

General

- To generate reliable, persistent and flexible alternative technologies through a conservative management of limited natural resources that will improve the productivity of the resources of the small farm system, thereby contributing to the socio-economic well being of the small farmer and benefiting society as a whole.

Specific

- To analize the farming systems operated by small farmers in different ecological and socio-economical environments in Central America; considering land, capital and labor distribution in time and space among the farm subsystems.
- To develop a methodology to design, test and evaluate (within the framework of a small farm) alternative technologies more suitable to the small farm.
- To provide training, technical cooperation and information services concerned with small farm system improvements which will strengthen the capacity of national institutions to carry on adequate programs of technical assistance for small farmers.
- To provide information to national and regional organizations for the design and implementation of integrated programs for agricultural development which include land reform, credit extension and other complementary efforts.
- To serve as a link between the findings of crop or animal oriented research institutions and national organizations mainly concerned with a regional approach for agricultural development.
- To improve the problem identification process and select target research problems in farming system practices to be studied by national, regional and international research organizations.

Three integrated Research Projects (Small Farmers Cropping Systems, Milk and Beef Production Systems and Agroforestry Systems) are presently being implemented to accomplish the above described general and specific objectives of this Farming System Research Approach for Central American Small Farms.

A. THE CROPPING SYSTEMS RESEARCH PROJECT

Technology is a social product that reflects the unique characteristics of the agricultural system that originated it. The successful transfer of technological information between two given points requires a profound knowledge of both the characteristics of the place of origin and the place of destiny of this technology.

In Central America, agricultural research has primarily been dedicated to the generation and adaptation of technology for industrial or large market oriented crops; i.e. coffee, bananas, cacao, sugarcane, cotton and rice: crops that constitute the sole components of monocrop production systems. This type of agricultural technology (invariably involving the use of machinery, fertilizer, pesticides and other high cost inputs for monoculture) was available, relevant and consequently successfully adapted to increase productivity of these colonial crops, regardless of the ecological implications of its use. Conversely basic food crops such as maize, beans, cassava, plantains, sorghum and others that constituted the plant component of complex traditional multiple cropping systems deeply rooted in the culture of the small farmers were not given, until recently, deserved attention.

Despite the introduction of new varieties of food crops and discoveries derived from the developmental type of research from temperate countries, small farmers were not fully incorporating this new technology into their traditional cropping systems. It became evident that knowledge of the process of integration of new component technologies into existing farming systems was lacking, particularly at the level of the small tropical farmer.

Traditional cropping systems can be appreciated as an expression of the dynamic equilibrium that exists between man's needs and abilities and nature's resources and restraints. Given the ecological and socio-economic conditions, these traditional cropping systems operate very close to the optimum. However most traditional cropping systems are in a constant state of evolution by gradually incorporating fragments of "outside" technology in their operations. The selection by the small farmer of technological components to be included within existing cropping systems is based on the criteria of maintaining a maximum degree of control on the whole production system once this innovation is functioning within the system. Traditional cropping systems are usually highly efficient in the use of energy. Recent price increases of fossil-based agricultural inputs have further increased the relative advantage of traditional agriculture, compared with energy intensive agriculture.

Given the high degree of adaptation of traditional cropping systems to their environment, an acceleration of natural evolution instead of a revolution seems more likely the approach to follow in the process of generating persistent, reliable and flexible technological alternatives to improve the productivity of these traditional cropping systems.

These technological alternatives must be designed within the conceptual framework of a small farm, tested within the physical framework of a small farm including farmer management and finally evaluated both in terms of productivity and fitness to the existing system.

Considering the lack of an adequate technology for the small farmer, in 1973 the former Department of Tropical Crops and Soils of CATIE, decided to devote a major share of its budget and professional attention to the study of cropping systems for small farmers in the tropics. As a means of self orientation to the interdisciplinary approaches required in cropping systems investigations, a multidisciplinary team of researchers was organized to develop methodology for cropping system field research. An experiment designed with 24 different cropping systems that include maize, beans, cassava and sweet potato was implemented and is still under test to study the persistence of these cropping patterns.

In July 1975, the outreach phase of this project was initiated in Central America. This phase has been financed largely by the Regional Office for Central American Programs (ROCAP) of the USAID.

The general objective of this outreach project is to develop improved cropping systems for use by low income farmers and create a capability in the Central American region and its countries to continue to develop such cropping systems.

More specific objectives of this outreach project are:

- To study the cropping systems now in use by low income farmers

from the stand point of production per unit of limiting resource, income, nutritional value and employment opportunities.

- To design, test and evaluate cropping systems which will increase small farmers' economic benefits, general well being, production and employment opportunities per unit area of land at various levels of technical inputs, ecological conditions and socio-economic situations throughout Central America.
- To assist national institutions of the five Central American countries in the creation of a capability to conduct research in cropping systems for small farmers.
- To provide training needed to qualify Central American researchers to collect pertinent base line data, to conduct field test of technological alternatives with small farmers and to evaluate these alternatives.
- To conduct a continuing research program at Turrialba, Costa Rica to develop improved methods for conducting of field trials.

The general strategy of the project is:

- As a regional organization, CATIE arranges with the Ministries of Agriculture of the Central American countries for cooperative work at specific sites that represent important ecological zones where concentrations of small farmers exist (Fig. 1). Local collaboration of appropriate national institutions is essential and has been obtained.
- A resident agronomist from CATIE works with the national institutions in each of the countries outside of Costa Rica. An

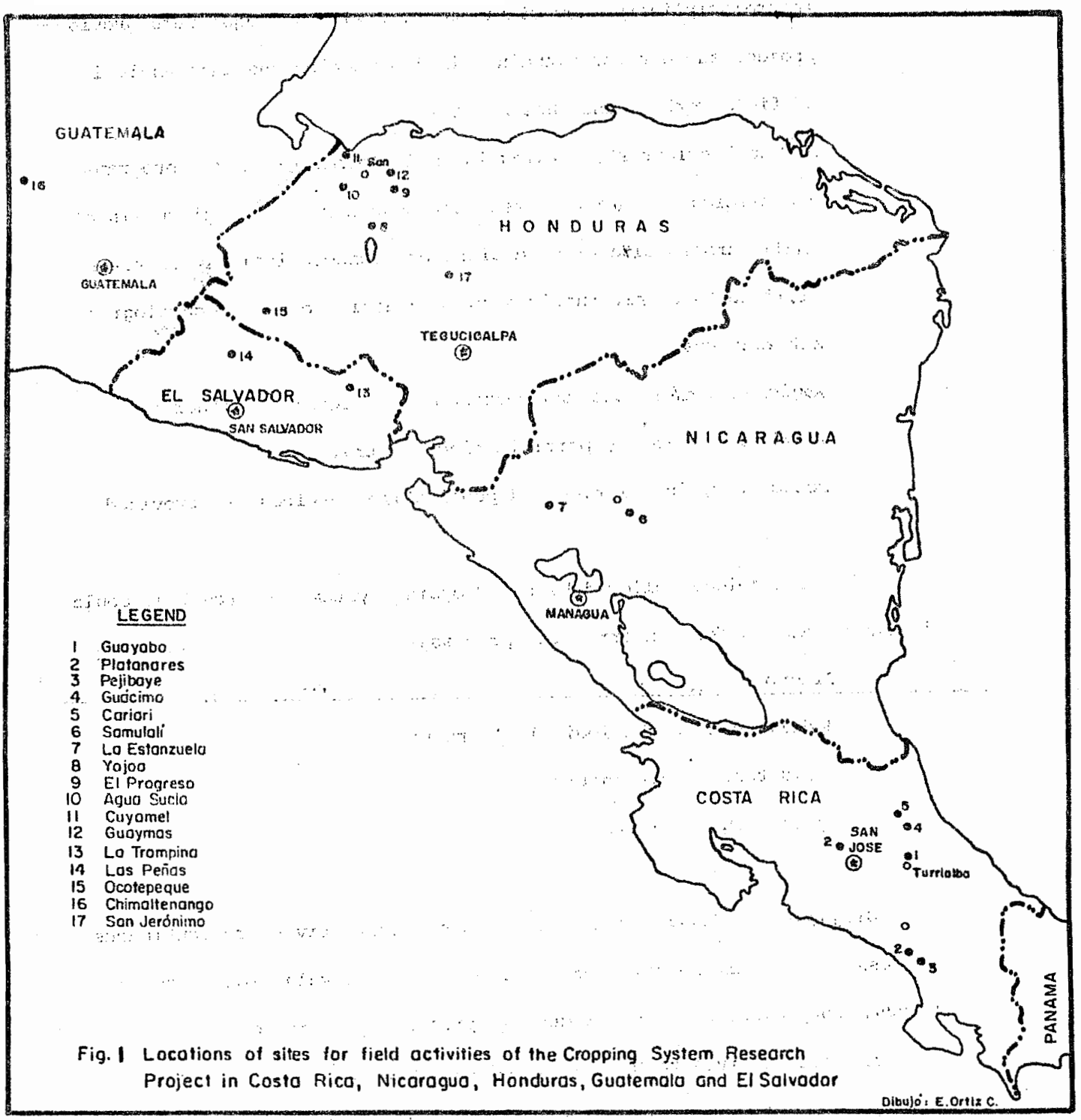


Fig. 1 Locations of sites for field activities of the Cropping System Research Project in Costa Rica, Nicaragua, Honduras, Guatemala and El Salvador

interdisciplinary team stationed at CATIE's headquarters provide project support for planning, implementation and data analysis of field work at the chosen sites.

- National scientists working in small farmers research programs are offered a seminar course that concentrates on: diagnosis of small farmers situation; designs of technological alternatives; field tests of alternatives and evaluation of the technological alternatives.
- Regional conferences and workshops are organized either at Turrialba or in any participating country.
- Documentary information and publication services are provided.

The methodology followed by the Cropping System Research Team could be summarized as four interrelated processes:

Diagnosis

Modelling of technological alternatives

Field test of alternatives

Evaluation of alternatives

Diagnosis, modelling and evaluation of alternatives are continuous processes. New alternatives are designed and the evaluation criteria becomes more precise as the diagnostic process is improved.

The alternatives to be tested and the evaluations necessary to verify these alternatives usually goes beyond the capability of current research teams. A rigorous selection based on the farmer's main needs must be made.

The diagnostic process is done at 4 levels:

- Macro-Diagnosis

  This level involves an analysis and synthesis of secondary information about the country such as relative economic development, agricultural sector policies, economic organization, infrastructure, and others. This is done for each region and group of farms within the region where the team has been assigned to work.

- Area Diagnosis

  Here the region becomes the focus of the study. Both secondary and primary sources (surveys, field visits, case studies, etc.) of data are used. Geographers, anthropologists, ecologists, and other specialists are usually involved at this level of diagnosis. Relationships between farms and the relationship of the farm groups with the external environment are analyzed and discussed by the study team.

- Farming Systems Diagnosis

  Primary source information is needed since accurate secondary information is lacking in Central America. The structure (subsystems or components) of the unit of production is identified and studied to determine the intensity of the dynamic interactions among the different activities in terms of their demand on farm resources and their contribution to farm income. The amount of resources needed for each subsystem activity is analyzed over time for the agronomic year.

- Cropping System Diagnosis.

  At this level, the cropping pattern and management used by the farmer are analyzed to determine: what, how, when and why are crops cultivated.

  One or two of the cropping systems are then selected. Criteria such as the number of people dependent upon the system, the nutritional benefits of the system, use of hand labor, etc. form the basis for making the selection.

After the diagnosis process, the expected outputs are:

- Definition of the system (limits, components, interactions, input-output ratios, etc.).
- Definition of the objectives of the system (farmer, community, government).
- How the system reacts to the environment.
- How the environmental variables interact.

Design of Technological Alternatives

If the system and its objectives are known and its reactions to the environment and the relations between environmental variables are understood, the main constraints of the system can be identified. The design of technological alternatives is a conceptual phase in which models are designed to overcome the identified constraints and satisfy the farmer objectives. Within this process alternatives are considered in which one or several of the following possibilities are studied: a) inputs are changed; b) alternative components are tried; c) arrangement of

components are modified; d) inputs and components are changed; e) components and arrangement of components are modified; f) inputs and arrangement of components are changed; g) inputs, components and arrangements of components are changed.

The main product of this process is a set of models to be submitted to selection by the farmers, extension agents and researchers to determine which will be tested in the field.

According to the degree of knowledge of the area and farms and of complexity of the information obtained in the diagnostic process, the selection is conducted under the general criterion that increasing levels of understanding of a particular system are required to operate it, to modify it, to improve it or to replace the existing for a new one.

Field Testing of Alternatives

The experimental design of the technological alternatives to be tested in the field and the distribution of replications throughout the area constitute the most important aspects of this research process. Repetitions of the same experiment distributed among several farms permit a wider frame of reference to analyze the effects of different environmental variables that modify the field results as well as the effects of different types of management when the plots are either partly or entirely under farmer management. Criteria for selecting farmers (and farms) are mainly based on how well they represent different points in a gradient of a variable which is one of the main determinants of the

cropping system performance in that particular area. Precipitation, topography, soil reaction, size of the farm, available hand labor and other possibly determinant variables are considered singly or in combination, to select the experimental farms.

The product of this research process is a set of experimental results. If these research findings solve some of the constraints identified in the diagnostic process, the improved or new cropping systems will be evaluated with more farmers to ascertain how well the question "what does the farmer want from the system?" is answered.

Evaluation of Alternatives

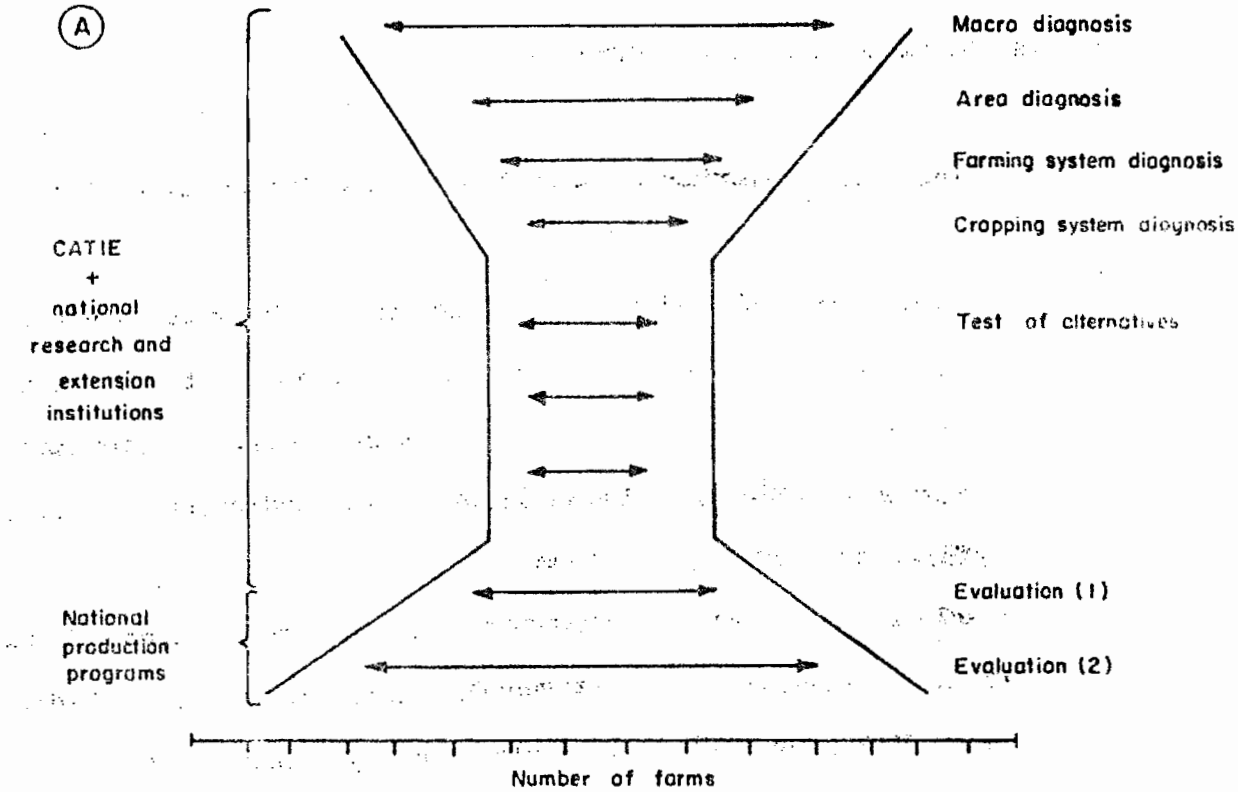
The evaluation process is greatly simplified if the model of the technological alternatives was selected with the participation of the farmer before field implementation and if the farmer and the researcher shared on equal basis the responsibilities of the field work. The process of evaluation begins early in the research effort, however, its emphasis is at the later part of the research cycle when more farmers are participating in the field tests. Evaluation is a complex and continuous process. The farmer's ability to integrate isolated components or subsystems into his production system is also a dynamic process highly dependent on the socio-economic environment. Long term evaluation efforts are needed before a definite judgement about a particular set of technological alternatives and its acceptability by farmers can be made. Evaluation criteria include adaptability of technology to ecological and socio-economic environmental changes, simplicity of management, congruency of improved technology with existing farming

systems, profitability, etc. (Figure 2).

Some Cropping System Experiments in Implementation Throughout Central America

- In some semi arid regions of El Salvador and Nicaragua several water and soil conservation practices are being tested in farmer's fields with the traditional maize-sorghum cropping system and some new cropping systems including cowpea and/or pigeon pea in addition to maize and sorghum.

  Double rows of sorghum alternated with four rows of common beans (cash crop in this case) prevent the desiccating effect of wind on common beans. This particular cropping system is in the evaluation process.
- Velvet bean (*Stizolobium deeringgianum*) is used as a cover crop under maize to prevent weed growth and also serve as a green manure in some areas of Central American lowlands. Experiments are conducted to determine the feasibility of partly replacing velvet beans with different varieties of cowpea to provide an extra food source for the farmer and serve as cover crop.
- Different associations of rice and maize using traditional and improved maize and rice varieties are being tested under different levels of management in areas of erratic precipitation. The objective is to diminish the risk of excess or lack of precipitation.
- No tillage, minimum tillage and conventional mechanized land preparation methods are compared in experiments conducted at CATIE's headquarters to evaluate the effect of soil preparation



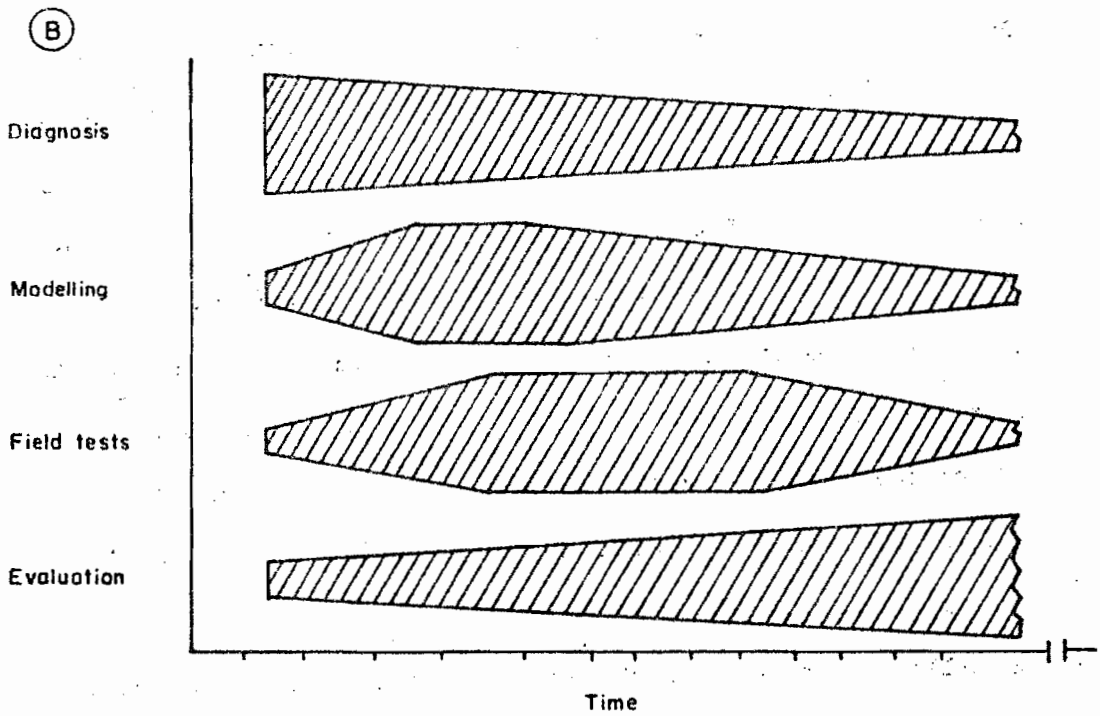


Fig. 2 A.- Number of farms considered for diagnosis, field tests and evaluation processes
B.- Intensity on time of different process in CATIE's methodology.

on the severity of diseases, insect attack, soil microbiology, and rate of residue mineralization in a traditional maize and beans cropping system.

- Perennial plants such as coffee and cacao are combined with valuable timber trees and semi perennial species such as sugarcane and plantain to study different systems of establishing a perennial crops plantation system as limited areas of these perennial crops are often grown by small farmers. Hand labor distribution, capital requirementes and land use efficiency are considered.

- Different spatial arrangements of a maize-common bean traditional rotation are being tested with Nicaraguan farmers to find the optimal distribution of beans plants around the maize stalks that will better utilize the residual fertilizer used in maize production.
- Since weeds are a major problem for food crop cultivation in the lowland tropics, different experiments in which hand labor, non-specific herbicides, minimum tillage, no-tillage and different traditional weed control practices are compared. Effect on soil fertility, hand labor demand, cost and productivity of traditional cropping systems based on maize are considered.

B. A MILK AND BEEF PRODUCTION SYSTEM USING CROP DERIVATIVES RESEARCH PROJECT

Past animal production research has primarily focused on improving methods of specialized milk and beef production. This purely livestock approach to research resulted in discipline-oriented knowledge and methodologies that could be used for the improvement of very specialized livestock farm systems. However due to the various management and resource requirements of these improved methods, the small farmers have not been able to capitalize on the benefits of this technology, thereby confining themselves to a diverse combination of agricultural and livestock activities.

Considering the lack of an appropriate technology for improvement of small farmers' mixed farming systems, a holistic approach is being undertaken by the research team of this Project to conduct multidisciplinary system oriented research in order to generate technological alternatives for crop-cattle production systems. Such systems are to be based on the efficient use of farm crop by-products, serving either as a substitute or complement depending on the seasonal availability of pasture.

The general objective of the Project is to develop an integrated crop-cattle production system based on crop by-products appropriate for small farm ecological and socio-economical conditions.

The more specific objectives are:

- To generally characterize the predominant mixed farm cattle production systems.
- To identify the critical factors which determine the productivity levels of these production systems.
- To create a sound knowledge base to guide bio-economic experimentation and to provide the basis for a subsequent technology transfer phase.
- To generate information concerning the nutritional value of crop by-products.
- To develop storage and conservation methods for crop by-products potentially useful as animal feed.

The strategy followed by the Project is:

- Research is conducted at four different ecological areas of Costa Rica. Milk production systems research is emphasized in three areas and beef production systemas are studied in one area.
- Technicians located in each of the four regions gather data on general structure of the farm subsystems, their interactions and the relationship of the farm system with its ecological and socio-economic environment.
- Farm level research consists of a static and a dynamic diagnosis process and simple experiments to corroborate the diagnostic findings. At the experiment station level, agronomic characteristics and nutritional value of crop derivatives resulting from the diagnosis process are researched.

- Production demonstration units are being established within CATIE's Experimental Farm for self orientation and training in the interdisciplinary approaches required in mixed farm production systems.
- Training at the M.S. level is provided for Latin-american graduate students.

The methodology followed by the Cattle Feeding System Research Project could be summarized in 3 main processes:

Diagnosis

Experimentation

Evaluation

The diagnosis has been divided in two sequential stages: a static part involving the survey of numerous (230) representative farmers in the four regions of Costa Rica and a dynamic part involving the temporal observations of fewer (40) farms during approximately one year. The purpose of the dynamic stage is to acquire a solid understanding of the farmer's decision-making process and an in depth analysis of the criteria they use to discriminate among managerial decisions.

The diagnosis process will define:

The systems (components, limits, input-output ratios, etc.)

The objectives of the systems

Reaction of the systems to the environment

The main constraints of the system

The experimental phase of the Project consists of three steps:

- The study of qualitative and quantitative agronomic variables of plant species and varieties to assess the cattle production potential of crop residues on farms managed for mixed purposes.
- The study of different crop residues and by-products in terms of their chemical composition, dry matter, digestibility, intake, possible content of toxic substances and others. Different storage and conservation methods for crop by-products are also studied because the availability of substantial quantities of crop residues will usually coincide with periods of high pasture availability. Consequently, adequate conservation methods must be developed.
- Once the limitations and advantages of a given by-product are known, the animal performance as a response to the use of such a derivative is evaluated. This by-product may be used either as a basal diet component or as a supplement to grazing animals or in combination with other supplements rich in energy and/or protein.

The evaluation process uses the same criteria as those previously described for the cropping system project. Basically the integration of the information obtained in the field experimentation phase is considered both horizontally (at the animal production subsystem level) and vertically (at the farming system level).

Cattle Feeding Experiments Using Crop-Derivatives

- Maize-bean is a classical association of crops widely practiced by small farmers in the wet and dry tropics throughout Central America. Intake, chemical composition and *in vitro* digestibility of bean straw and chopped maize stalks are being evaluated through a series of experiments that also include the addition of different levels of molasses.
- Sweet potatoes, because of their potential for biomass production in the humid tropics, are being studied as a cattle feed source. Since harvest of sweet potato is concentrated in a very short period and since it has a high moisture content, different levels of additives to silages of the aerial part of the sweet potato are under test. Non-commercial sweet potato tubers are also included in the diet.
- Several experimental trials are conducted within the production demonstration unit. These include tests of different species of legume trees for nitrogen fixation, production of poles to be used as dead or live fences and production of forage. The effect of bending vs. cutting maize tops on grain production and the effect of adding different amounts of poultry litter to silage made from maize tops is also being tested. Two species of trees (*Erithrina poeppigiana* and *Gliricidia sepium*) are being compared for use as living fences.

C. AGROFORESTRY RESEARCH PROJECT

Throughout the humid tropics local people have developed interesting technologies to manage stable production systems that combine agricultural crops, tree crops, forest plants and/or animals simultaneously or sequentially. However as a result of population increase and the need to produce more food, production technologies from drier tropics and/or temperate countries have been transferred to these stable lowlands production systems to enhance their productivity. The end result of this transfer of technology has been the unbalance of these production systems. This unbalance is typified by the disappearance of natural vegetation witnessed in various tropical humid environments. In recent years, increased export beef production has induced large scale deforestation followed by the introduction of pastures, mostly alien agressive African grasses, with dubious value concerning the establishment of stable grazing systems.

Most of these changes represent a net and often far reaching environment loss, particularly regarding the potential productivity of the soil and the disappearance or deterioration of natural environmental protective devices. This loss also involves scientific and educational material and even considerable cultural values, all sacrificed for a substantial short-term economic benefit for a few.

To counteract the present destructive trend, it is necessary to design production systems (involving agricultural crops, tree crops, forest plants and/or animals) that constitute technological alternatives for land use in the Central American lowlands tropics. The empirical knowledge of such alternatives already exists in many areas throughout

the humid tropics. This knowledge is often linked with the so called "primitive" conditions and technologies, but under scrutiny they often prove to be elaborated and sophisticated.

Considering the above described situation the general objective of the Agroforestry Research Project is to improve the productivity of agro ecosystems that combine agricultural crops, tree crops, forest plants and/or animals through a conservative management of inherently limited natural resources.

More specific objectives are:

- To analyze throughout Central America, the existing stable systems involving a mixture of trees, climbers, annuals and animals that produce goods and services for local populations. This study encompasses the nature of the components, interactions among components and their environments, input-output ratios, etc.
- To study the introduction of tree crops that have successfully been integrated as components of farming systems, be it for economic or social reasons or as a way of safeguarding the productivity of the land.
- To assess the potential of forage trees as components in grazing subsystems and interactions with the rest of the small farm agro ecosystem.
- To study the use of live fence post and hedge trees in small farm production systems in terms of their contribution for the

production of goods and services.

- To study rotations of species that include food crops and trees from the stand point of present modalities and possible improvements.

The general strategy followed by the Project could be summarized as follows:

- Since Agroforestry is a relatively new concept in rural development efforts, several international and national organizations have been contacted to analyze their approaches in agroforestry research.
- Available information on agroforestry has been analyzed and organized for retrieval at the CATIE's Natural Renewable Resources Program.
- Seminars and workshops dealing with Agroforestry have been organized at CATIE headquarters for Central American researchers.
- CATIE past experience in fast growing forest trees species such as *Pinus caribaea* var. Hondurensis and *Eucalyptus deglupta* is being analyzed to ascertain the feasibility of incorporating these two species into small farm systems on land not used for crops or pastures.
- Several experiments at the Experimental Station combined food crops with forest species in different combinations. Several of these experiments are conducted by students from the CATIE graduate school.

Some field experiments in implementation by the Agroforestry Project:

- Simultaneous planting of trees with annual crops (Taungya system) is being investigated as a method of reforestation. Maize and common beans are intercropped between rows of newly planted native laurel (*Cordia alliodora*).
- Maize and common beans are also interplanted between rows of two fast growing tree species, *Gmelina arborea* and *Eucalyptus deglupta*. Agronomic and economic variables affecting these planting systems are under analysis.
- The use of native laurel (*Cordia alliodora*) as a high canopy in plantings of coffee and cacao in the humid Atlantic region of Costa Rica is being studied. In this study laurel stands above the normal coffee shade tree (*Erythrina poeppigiana*). Interactions among components, input-output ratios, cycling of nutriments, etc. are considered.

INTEGRATION OF RESEARCH PROJECTS AND EXTRAPOLATION OF RESULTS

The multidisciplinary nature of farming system research requires extensive understanding of the wide range of interactions found in complex production systems. CATIE's four programs - Annual Crops, Perennial Plants, Natural Renewable Resources and Cattle and Small Animals - provide technical inputs for specific projects to study and

improve farming systems in Central America.

At the conceptual level the design, modelling and evaluation of technological alternatives of every project is conducted through a co-ordinated effort of researchers from the four Programs.

At the field level, experiments in which annual crops are interacting with timber trees are conducted both by field crops specialists and foresters in coordination. In the same way the agronomic part of animal feeding using crops by-products is designed and conducted both by agronomists and animal science specialists.

Experimental design and computer facilities are shared by the four Programs and their projects.

Since farming systems vary along specific transects of changing environmental conditions, it has become widely accepted that farming system research is site specific. Due to this apparent specificity, the extrapolation of research findings should be approached conservatively. The understanding of how environmental conditions modify the locations and the intensity of farming systems operations provides useful information to design methodologies for adequate transfer of information between two given areas.

Classification of physical environments is a useful tool for the design of such methodologies. CATIE, through a Central American Project on Soil Fertility, is conducting research to identify soil analogs based on several soil characteristics. At the present time approximately 30.000 Km^2 of the coastal parts of El Salvador, Nicaragua and Honduras have been studied and several soil types of similar characteristics have been identified. Bioclimatic as well as physiographic and topographic parameters have been used in this study.

Models and the concept of gradients are also under consideration by researchers in different projects.

Table 1 Population and rate of population increase in Central America[1/]

	Population (x 1000)		Rate of population increase		
Country	1970	2000 (projected)	1970-80	1980-90	1990-2000
Costa Rica	1,872	3,695	2,80	2,57	2,24
El Salvador	3,549	8,803	3,38	3,15	2,89
Guatemala	5,679	11,582	2,76	2,72	2,40
Honduras	2,897	6,881	3,40	3,29	3,20
Nicaragua	1,878	4,812	3,80	3,19	2,70

1/ Source: General Studies Division, Dept. Econ. and Soc. Dev., Interamerican Development Bank. Report on demographic trends and projections for Central America. Washington, D.C. 1977.

Table 2a. Total farm area and distribution in strata, 1970

Country	Total Farm area 1/	Farm area Distribution less than 4 ha	4-35 ha	more than 35 ha
Guatemala	3,752	463	803	2,486
El Salvador	1,646	223	362	1,061
Honduras	2,462	154	824	1,484
Nicaragua	3,939	65	514	3,360
Costa Rica	2,743	48	429	2,252
Central America	42,311	953	2,932	10,657

Table 2b. Extend and yield of crops in farms of different sizes

Crops	Total area 1/	FARM SIZE less than 4 ha		4-35 ha		more than 35 ha	
		Area	Av.Yield 2/	Area	Av.Yield	Area	Av.Yield
Maize	1,526	397	720	815	1,070	314	1,670
sorghum	259	78	680	138	1,320	42	1,960
rice	134	74	1,360	45	1,840	14	2,340
wheat	30	0.9	1,440	18	1,180	10	910
beans	306	13	550	167	710	65	720
cassava	15	3	3,660	8	5,470	3	5,840
potato	10	2	2,000	6	5,920	2	9,470

1/ = thousands of ha; 2/ = kg/ha

Source: SIECA. Perspectivas para el desarrollo y la integración de la agricultura en Centro América. Two volumes, Guatemala 1974.

Table 3 Rural population and total agricultural income by socio-economic strata (1970)

	Size of the farm					
	less than 4 ha		4 - 35 ha		more than 35 ha	
Country	N°people (x 1000)	Total Income (million$)	N°people (x 1000)	Total Income (million$)	N°people (x 1000)	Total Income (million$)
Guatemala	3,044	107	515	67	96	134
El Salvador	1,844	61	235	75	57	120
Honduras	1,219	49	555	73	93	87
Nicaragua	697	70	305	42	211	53
Costa Rica	836	84	225	58	130	165
Central America	7,764	371	1,835	315	587	559

Source: SIECA. Perspectivas para el desarrollo y la integración de la agricultura en Centro América. Two volumes, Guatemala 1974.

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