CATIE
CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Annual Crops Program

CATIE's SMALL FARMERS ORIENTED AGRICULTURAL RESEARCH EFFORT IN THE CENTRAL AMERICAN ISTHMUS

Luis A. Navarro

Document to be presented at the FAO "Consultation Meeting on Natural Resources Management for Food and Agricultural Production through Farming Systems Adapted to Ecological and Socio Economic Conditions of Small Farmers in the Caribbean Region", Kingston, Jamaica, July 1980.

Turrialba, Costa Rica
June, 1980

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

FOREWORD

The "Centro Agronómico Tropical de Investigación y Enseñanza" (CATIE) is the Tropical Agricultural Research and Training Center located in Turrialba, Costa Rica, Central America. (Address: CATIE, Turrialba, Costa Rica).

CATIE is an autonomous non profit institution of scientific and educational character. It was founded in 1973 and is an association within the Interamerican Institute of Agricultural Cooperation, belonging to the Organization of American States, and the governments of the various countries in the Central American Isthmus.

The Turrialba headquarters houses the oldest Graduate School and one of the principal libraries in agriculture for Latin America. At present CATIE is a transformation of the old Training and Research Center (CEI) which gave place to the then Interamerican Institute of Agricultural Sciences (IICA). IICA moved its headquarters to San José, Costa Rica, leaving, at Turrialba, the Tropical Center of Training and Research (CTEI) which later gave place to CATIE.

Another contribution from Turrialba has been the TURRIALBA journal. This was founded in 1951 in Turrialba; today it is edited at IICA's headquarters in San José and publishes scientific articles in Spanish and English.

CATIE's DEVELOPMENT ORIENTED AGRICULTURAL RESEARCH EFFORT IN THE CENTRAL AMERICAN ISTHMUS

Luis A. Navarro*

INTRODUCTION

This document responds to an invitation by FAO to participate in the "Consultation Meeting on Natural Resources Management for Food and Agricultural Production through Farming Systems adapted to Ecological and Socioeconomic Conditions of Small Farmers in the Caribbean Region". It attempts to present CATIE as an institution, its objectives, philosophy, and work methodology.

To do this, the presentation starts by reviewing CATIE's mandate and the general framework for its actions. In what follows, it concentrates on a specific project through which CATIE has been outreaching part of its mandate geographical area. Within this project, special attention will be given to its methodology, and how a systems approach and multidisciplinary action have been incorporated; some findings and results are also reported. Finally, a partial reference is made to other CATIE programs, projects and their research results. This is not an official presentation for CATIE. Opinions are the author's responsibility.

CATIE's MANDATE AND GENERAL ACTION FRAMEWORK

The Tropical Agricultural Research and Training Center was created as a regional institution of support to the agricultural development efforts in the different countries of the Central American Isthmus and the Caribbean Region. Up to the present, CATIE has concentrated its action in the Isthmus. Its main tools would be the actual effecting, promotion and stimulation of agricultural research, and different levels of training. Its main thrust would be in selected aspects of agriculture, forestry, animal production and related fields. Its presence in every country should respond to an explicit requirement by them.

CATIE would not act alone. It should work through and cooperate mainly with the national Agricultural Research and Extension institutions.

---

* Ph.D., Agricultural Economist, CATIE.

This interaction should contribute to strengthen those institutions by stimulating a better use of existing capabilities and the exchange of knowledge and expertise among countries.

To define its present lines of action, CATIE asked for guidance and identification of priorities from the national agricultural research and development authorities in the Isthmus. Based on this consultation, the goal would be to contribute to the improvement of the low income farmer's well-being and to the rational use of natural resources in the region.

Rural population in the Isthmus accounts for two thirds of the total population. Small farmers' families account for an absolute majority of that rural population. They also produce most of the food directly consumed within the region but their income and resource endowment is the poorest in quantity and/or quality.

To attempt an approach toward the stated goals, CATIE has oriented its basic research actions toward the development of technologies in the fields of agriculture, forestry, animal husbandry and combinations which are: a) an improvement in relation to those currently used in areas of small farmer concentration; b) appropriate to the ecological and socio-economic conditions in which they would be used and c) attractive and adoptable by their potential users; that is congruent with their resources, knowledge and goals. This orientation was based on the realization that there is a lack of adequate "modern" technology for the small producers in the tropics.

CATIE has defined technology development as its main research area, recognizing that in such a process, the technology should be studied and evaluated throughout the whole process beginning with its generation and ending with its adoption by farmers.

The main focus is still on the technical aspects of technology but their direct implication for rural development and, in particular, for the small farmer's well-being is carefully evaluated.

The approach also allows CATIE and collaborating entities, to better identify the responsibilities and possibilities for the Research and Extension institutions within all institutions dealing with agricultural and national economic development. Without doubt their actions will be much more effective when they are complemented or they complement the actions of those other institutions. For this to happen, a proper and effective coordination, or at least communication, between institutions should exist both within the agricultural sector as well as within institutions in other basic development sectors. At present, this coordination is not well defined in the Central American Isthmus.

CATIE has found that at the field operational level a consciousness about the need for such inter-institutional coordination is getting stronger.

However, for it to happen, decisions and actions will be needed at the directive level of legislation and national planning.

A PROJECT OF RESEARCH IN CROPPING SYSTEMS FOR SMALL FARMERS

Congruent with CATIE's mandate and national development priorities, a project of research in cropping systems for small farmers was initiated in 1975. This project, financed by AID/ROCAP*, provided the initial outreach means for CATIE's work to all the countries of the Central American Isthmus. It has also been a leader in the definition of CATIE's current working philosophy and methodology.

The project's objectives can be summarized as follows:

a) To develop, in interaction with national research institutions of the different countries, methodologies or strategies for cropping system research implemented at small farms level.

b) These methodologies or strategies should enable a research team to develop appropriate alternatives for improving the present cropping systems used by small farmers of specific areas, and in terms of income, production, use of labor and nutrition.

The specific outputs include a certain number of better technical alternatives for selected cropping systems in specific areas and the training of a number of national personnel for the type of work being done.

The project began its second phase during the past year (1979). This phase will also include research on animal production systems and mixed crops and animal production systems, as steps toward a general farming system research. The specific outputs have also been expanded to include the development of methodologies for extrapolating the results between areas and the study of proper ways to transfer those results to the farmers.

The basic working philosophy in the project requires direct interaction both with the farmers as well as with the Extension agents in the working areas. This requires the acquisition of adequate knowledge of the farming conditions as well as doing field experimental work in small farms. Experimental stations, laboratories and greenhouses would be used for support research which requires better environmental control.

The work characteristics require the participation and interaction of several disciplines in a team. This also requires the use of a proper tool

---

* ROCAP, AID's "Regional Office for Central America and Panama".

for allowing that interaction. Such a tool has been the basic principles of the "Systems Approach". The team has included agronomists, phytopathologists, entomologists, weed management specialists, ecological systems specialists as well as agricultural economists, statisticians, anthropologists and communication experts.

The approach has also shown it necessary to keep up to date with the present and projected actions of other agricultural and rural development institutions present in the working areas and the possibilities of interacting with them.

The project presently operates by locating one agronomist, as part of the national institutions, to coordinate the work in each country. Several scientistis have headquarters at Turrialba from where they continously travel to the different work areas throughout the Isthmus. Every country provides the counterpart personnel to form national teams. Working site locations are shown in Fig. 1.

THE "METHODOLOGY" AND ITS BACKGROUND

The working methodology which has emerged as part of CATIE's cropping system research project, is identified as a variant of the general Farming Systems Research Approach (19).

Foundations for the Methodology

To attempt an improvement of present cropping systems, or crop production systems, it is first necessary to know those cropping systems as well as the existing conditions to guide the work. Those conditions are the farmer's current resource endowment (quantity and quality), his goals and purposes, as well as his knowledge and management capabilities (what they are doing, how they are doing it and why they are doing it).

Existing conditions at the small farms level, which determine most of their cropping systems characteristics, are consequences of the ecological as well as socio-economic environment in which small farmers work.

The local ecological environment determines most of the physical and biotic characteristics of the resources handled by farmers. These characteristics force certain technological adjustments in the cropping systems as well as adjustments and priority changes in farmers' goals. For example, in areas of erratic rainfall (i.e. the North of El Salvador), small farmers have developed cropping systems based mainly on corn and sorghum, mostly as association or relay crops. In case of insufficient rain for corn, (the prefered crop), they will at least harvest sorghum, diminishing the implied risks for their subsistence. In areas where there are possibilities of excessive rain, they prefer associations based on rice and corn.

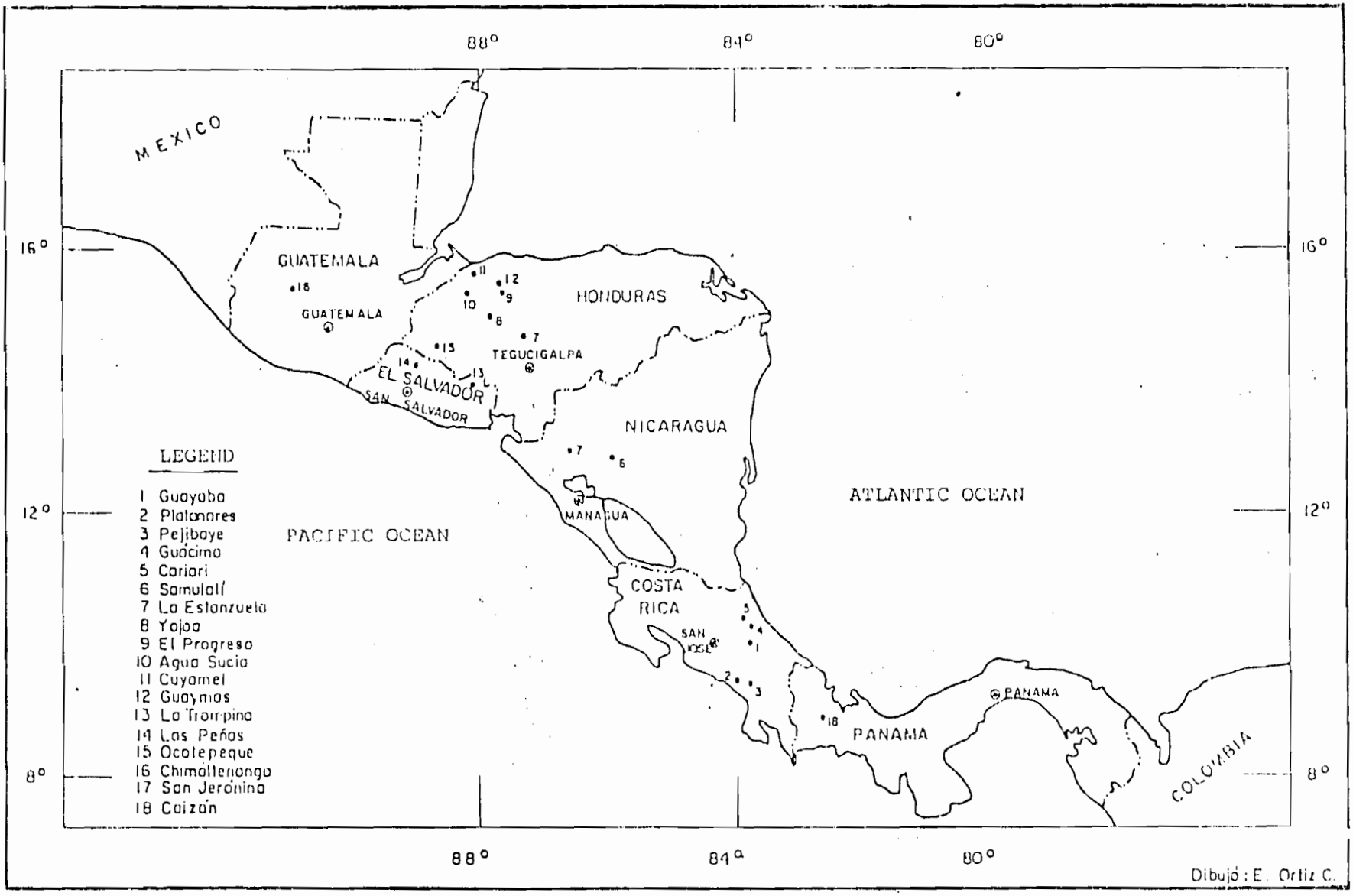

FIG. 1. SMALL FARMERS CROPPING SYSTEMS PROJECT, RESEARCH SITES LOCATION 1976-1978.

Even the localization and arrangement of those crops within the farm are accounted for the amount of water available in the ground.

Society's influence is shown first in the poor geographic and income-bracket location of small farmers. They have been relegated there by the general type of agricultural development and its present structure, based mainly on large scale, capital intensive, export-type production. However, society may also provide incentives and supporting guidance to those farmers. These may come as improvement to their products market (marketing institutions), reinforcement of their resource endowment (credit, subsidy, input and machine services institutions) and reinforcement of their knowledge (research and extension type institutions).

These considerations allow differentiation of four basic stages in the Farming System Research (24) approach, as attempted by the Project:

1. Descriptive stage, in which the actual farming system, as it exists now, is examined in order to ascertain what the relevant cropping systems and real constraints for those systems are at farm level and therefore what type of technology are required in order to overcome them.

2. The Design and Testing Stage, in which a range of technology changes which are thought feasible and most relevant to overcome critical constraints are identified and tested under farm conditions with the farmer's participation. Support research needed for better design, requiring more experimental control, could be implemented on the farm as well as the experimental station.

3. The Validation Stage, in which a small number of the most hopeful technologies arising from testing are examined in comparison with the farmer's own technology and subject to their direct management. This would help to test how the "new" technology fits within the entire farming system circumstances and to anticipate feed-back on adoption possibilities.

4. The Extension Stage, in which the technologies which were found to best overcome the relevant constraints, as well as fitting into the farming system, are extended to farmers. This requires a strict interaction with extension and other institutions.

Ideally, certain levels of inter-institutional interaction should exist at every stage. The research group should have leadership in stages 2 and 3, be involved in stage 1 and support the planning and evaluation of stage 4. Under the Cropping System Project in the Central American Isthmus, the three first steps under the approach have been handled mostly by researchers. It is apparent that they will also need to get more involved than foreseen at the fourth stage. This is considered to be a transitory situation and is not a requirement for the approach.

The "Methodology" (Strategy?)

The "methodology" to be described is an attempt to distribute the purpose of the four research stages throughout different working phases. These phases are necessary to allow the proper and integrated work of a multidisciplinary research team subject to the usual personnel and budget restrictions at national level. Furthermore it attempts to allow and to promote the complementary action among agricultural institutions.

Simply stated, the phases in the "methodology" to implement this type of research in specific areas are as follows:

Beginning

a) Area selection, which is based on criteria such as national priorities, area potential for improvement, and possibilities for extrapolating results to and from other areas and farmers (being representative of important ecological and/or socio-economic environments).

b) Area delimitation and general characterization (technical and socio-economic). This is based first on background information complemented by reconnaissance visits to the area by a team. Such information should allow delimitation of relatively homogenous units (in terms of climate, soil, farm resources endowment, etc.) within the universe of study (selected area and farmers). These units should be used for surveys, experimental design and interpolation of results. Each of the selected units should now be further characterized through informal or formal surveys and/or measurement procedures. Methods used will vary depending on the completeness of existing information and available research resources. The purpose is to identify the relevant crops and cropping systems, their principal constraints on production and productivity, and other criteria for evaluating research focus, progress and results. An attempt should be made here to quickly identify "obvious" technological changes which could be introduced and adopted without lengthy testing and evaluations.

Every year

c) Team analysis of the actualized technical and socio-economic information about the area, farms, farmers and selected cropping systems. Appraisal of the available technical knowledge of the research team in order to:

1) Design and/or review the design of cropping systems modified for improvement. This should pay attention to cropping pattern, crop

components and/or different elements of management.

3) Classification of resulting designs according to the team expectation and knowledge of their performance. Resulting groups could: i) need further exploration or support research; ii) need agronomic and/or economic evaluation; iii) need validation under farmer management; iv) be ready for diffusion.

d) Planning of the field work for the year. All phases should be timed to allow the beginning of the field work in accordance with the agricultural season in the area. Planning should define type, number, experimental design and location of experiments. It should also identify and plan complementary studies for the area characterization and special studies. All should be guided by requirements and availability of research resources. The majority of field work should be located on farms and include the farmer's participation even in planning. Work to be implemented could consist of: i) work of an exploratory nature i.e. variety trials; ii) testing of newly designed modifications to cropping systems; iii) support research type experiments to solve doubts in design; iv) agronomic and/or socio economic evaluations of previously observed designs; v) validation under direct farmers' management of previously evaluated designs; vi) complementation, as needed, of area, farms and actual cropping systems characterization, especially in their dynamic characteristics needing multiperiodic observations; vii) especial studies of agronomic, plant protection and/or socio-economic nature. Efforts to report and transfer already validated technologies to appropriate institutions for their diffusion and/or implementation, should also be planned. This includes a definition of the timing and procedures for this and the additional required work interaction with other institution in the area. The planning should be a complete team effort so that most of the work and responsibilities are understood and accepted as appropriate by each member.

e) Implementation of planned field work. This should include at least a mid year revision of progress to include and rationalize necessary previous and future adjustment to field work in the year.

f) Team analysis of field work results and actualization of the technical and socio-economic information about the area, farms, farmers, and selected cropping systems. With this the team is ready to start the next year's work as in phase c).

In case of coordination of action with other institutions, phases c) through f) are mostly the responsibility of the research team. Phases a) and b) could be implemented with a strong participation from the team but with greater responsibility from other appropriate institutions. Other institutions such as Extension and Credit should also have leadership in the diffusion and implementation of produced (validated) improved technologies mentioned in phases c) and d).

The methodology, as presented, is the result of reviewing similar work carried out in several parts of the world, and the experiences gained in different Central American Isthmus countries independently or with CATIE's cooperation.

The Multidisciplinary Team

The need for a multidisciplinary team approach is implicit in the type of research and methodology.

The different teams formed during the project have tried to include specialists in agronomy, plant protection, social sciences and data processing. These teams are considered multidisciplinary with the need for at least partial interdisciplinary actions during the work. It is intended that no particular discipline or group of disciplines be solely responsible for any major portion of the work. However, it has been clearly seen that there is a need for letting individual scientists have certain responsibility for freer action which should be justified in terms of the whole team's objectives. This is reasonable since the whole team's effect is composed of contributions by individual disciplines and the results of their interactions.

The work requires a change in attitude from each scientist who has been trained as an specialist.

SOME FINDINGS AND RESULTS

Given the ecological and socio-economic conditions, most traditional cropping systems practiced by small farmers in the Central American Isthmus, are operated very close to a constrained optimum. As such they reflect farmer's goals, resource endowment and knowledge as well as the incentives they receive from society at a given moment. For the same reason they are in a constant state of "evolution", gradually incorporating fragments of "outside" technology to their operations.

The selection by the small farmers of technological components to be included within existing cropping systems is mainly based on the criteria of maintaining a maximum degree of control on the whole production system once the innovation is functioning.

Traditional cropping systems are usually highly efficient in the use of energy. Recent price increases in fossil energy may show such an efficiency to be an even greater asset.

Cropping systems characteristics as well as their combinations within the farming system show high sophistication in using existing resources in a rational way to achieve farmer's goals while minimizing risks (20).

A closer study of those systems may result in a learning process highly beneficial for society.

Given the high degree of adaptation of traditional cropping systems to their enviroment and its dynamics, an acceleration of the existing "evolutionary" process, instead of drastic changes, seems to be an appropriate approach for research efforts. More profound changes may require further and faster complementary actions from society which are seldom convergent.

Positive results from the project are shown first at the national institutional level, by their acceptance of the work philosophy and their efforts to accomodate to the work strategy.

At farm level results are also very promising, even though the process of extension of some available results by national institutions has not started yet. The most advanced situation is at the validation stage in Nicaragua, where the presence of CATIE and its proposed approach have survived the recent political and institutional changes.

Some general comparison indexes between on-farm research results and the farmers check cropping systems, obtained in different areas, are shown in Tables 1, 2, 3 and 4. These results have been obtained with the direct observance, councel and participation of farmers and farm labor. All changes tend to be adjusted to the possibilities and restrictions of the farm.

The adjustment between the proposed modified systems requirement and the farm availability of soil water, labor and operational cash along the production period were specially monitored.

The number of farms on which different experiments were replicated varied from two to ten depending on the area. In most cases the check cropping system performance indexes include data from more farmers than those direcly involved in the experiments. This is recommended.

All evaluated modifications can be classified as: a) changes to the cropping pattern and changes to the management or b) changes to the management only. In all cases changes are kept within the possibilities of the farm as discovered from the area characterization.

Table 1 is used to present the minor changes in cropping pattern when they existed. Following tables evaluate the effect of simple management or combined cropping pattern and management changes.

Management changes included simple modifications of one, or a combination, of the following possibilities: spatial arrangement of crops, fertilizer level, pest control, weed management.

Table 1. Location and cropping pattern characteristics of farm level tested modification to cropping systems practiced by small farmers of different areas in Central America (CATIE 1978-1979).

Geographic Area		Cropping Pattern		
Country - Location	Gen. Charact.	Studied	Check	New variety?
COSTA RICA				
Guácimo-Pococí	H	cassava corn / beans	cassava corn	No Yes, yes
Guácimo-Pococí	H	corn / corn	same	yes, yes
Pérez Zeledón	H+S	corn / beans	same	yes, no
Pérez Zeledón	H+S	corn / corn beans / beans	corn / beans beans	yes, yes no, no
HONDURAS				
Yojoa	S+H	corn / corn pipián / pipián **	corn / corn squash / squash	yes, yes N.C., N.C.*
Yojoa	S+H	corn / corn cow-pea	corn / corn	yes, yes N.C.
Yojoa	S+H	corn / cowpea rice	rice / beans	yes, N.C. yes
NICARAGUA				
Samulalí	H+S	corn beans	same	yes yes
Samulalí	H+S	sorghum / sorghum beans / beans	beans / beans	N.C. N.C. yes, yes
SALVADOR				
Chalatenango	S	corn sorghum	same	yes no

H = humid; S = dry with a short rainy period; S+H = dry period tends to to be longer than the humid period; H+S = humid period tends to be longer than the dry period.

* N.C. = change or added crop to the cropping pattern.

** Pipián is a type of squash (*Cucurbita* spp.) consumed as an immature fruit.

Table-2 allows several observations. Almost always the "improved" technology is more expensive and requires more labor than that of the farmers. In general, but not always, it is possible to increase by a substantial proportion the net and family income per ha provided by cropping systems based on food grains. However, the relative impact on the per ha income levels are due mostly to the present low levels and less to the absolute increment resulting from the modifications. It should be recalled however, that these modifications were restricted to be kept in line with the present possibilities at farm level.

Table 3 contains several efficiency indexes. It is clear that it will seldom be possible to improve the efficiency in the use of all the different factors of production at once.

Usually the efficiency in the use of labor can be increased as a consequence of the higher level of complementary capital. Almost always the return on labor is higher than common wages in the area. It is difficult however, to increase or even maintain the efficiency in the use of cash for input observed in the check cropping system.

As expected from the relative increase in labor and capital, the economic efficiency of land use is generally improved. The long term technical efficiency in the use of land would need longer term observation. However, provision for conservation of the land resource productivity level is included by a) carefully selecting modifications to present cropping systems and b) requiring that the economic performance of the selected technology allows a proper compensation to the land. In the ideal situation such compensation should be used to implement some land resource conservation practices.

Table 4 contains the expected levels and changes in crop production and productivity for the different cropping systems and their modifications. It is clear that neither the present nor the "improved" productivity levels are impressive in relation to other research results. However they are important at farm level and in agreement with the discussed evolutionary approach to technology development.

While society is not willing to improve its support to small farmers, through proper pricing of their product and a stronger and coordinated institutional support, this step by step improvement seems the only viable approach. Society's requirement to accelerate food production increase will be met only partially if such a situation is maintained.

As a closing commentary, present agricultural land and labor resource endowment and productivity potential in Central America are still sufficient to increase food production even at a small farm level. Any gap between existing and socially required production levels can be attributed to inappropriate policies. Such policies affect the agricultural technology development and implementation process as well as other necessary institutional support to agricultural food production processes. Any

Table 2. Changes in some technical economic indexes as a result of farm level evaluated modifications to cropping systems practiced by small farmers in different areas of Central America (CATIE 1978-1979).

Geographic area "cropping pattern"	Labor Man day/ha %Δ	Inputs CA$/ha (b) %Δ	Total cost (d) CA$/ha %Δ	CA$/ha	Net Income CA$/ha %Δ	Family Income CA$/ha %Δ	CA$/ha
COSTA RICA							
Guácimo-Pococí							
Cassava + (Corn//Beans) (a)	72.2	172.8	100.1	1305.7	181.9	140.6	2494
Corn - Corn	30.7	94.7	53.2	904.1	19.1	25.3	698
Pérez Zeledón							
Corn - Beans	15.0	269.0	51.0	673.3	403.0	130.0	1255
(Corn#Beans) - (Corn#Beans)	57.7	553.8	115.5	1043.9	-147.8 (-43.5) (c)	-40.9 (+9.35)	461
HONDURAS							
Yojoa							
(Corn#Pipián) + (Corn#Pipián) (a)	-1.0	83.0	23.0	369	152.0	62.0	605
(Corn#Cowpea) - Corn	17.0	42.9	26.0	351	19.3	19.0	672
(Corn+Rice) - Cowpea	8.4	27.0	15.0	395.8	-26.0 (+273.0)	-2.0 (+90.0)	328
NICARAGUA							
Samulalí							
(Corn#Beans)	28.1	22.2	24.1	576.4	62.9	38.5	668
Sorghum + (Beans//Beans)	22.9	-1.5	10.1	586	5002.0	126 0	713
EL SALVADOR							
Chalatenango							
Corn#Sorghum	16.4	105.3	37.2	599.4	62.7	36.5	805

(a) Pipián is a type of squash (Cucurbita spp.) consumed as an immature fruit.

(b) 1CA$ (Peso Centroamericano) = 1US$ (United States Dollar); %Δ = percentage of increment in relation to the farmer's check cropping system performance.

(c) All comparison are based on the worst on-farm experimental results or 70% of experimental averages. Cases on parenthesis show the effect of experimental averages.

(d) Total cost compensates all factors including land, management and use of capital.

(e) + is in the ground with; - is followed by; # in relay with; // followed shortly after by.

Table 3. Technical economic efficiency indexes for some farm level evaluated modifications to cropping systems practiced by small farmers in different areas of Central America (CATIE 1978 p. 79)

Geographic area "cropping pattern"	MRR RETURN OVER Additional Investment CA$/1CA$ (b)	RETURN TO Cash Input Costs CA$/1CA$	Δ% (c)	Labor CA$/man day	Δ%	Land CA$/ha	Δ%
COSTA RICA							
Guácimo-Pococí							
Cassava + (Corn//Beans) (e)	1.7	2.95	9.7	20.6	49.3	1695	112
Corn - Corn	.2	.80	-30.9	10.0	-4.6	448	17
Pérez Zeledón							
Corn - Beans	2.8	3.60	36.0	11.7	117.0	854	307
(Corn+Beans) + (Corn+Beans)	-.3	-.17	-121.0	3.0	-66.6	-121	-130
						(253)	(-38)
HONDURAS							
Yojoa							
(Corn+Pipián) + (Corn+Piolín) (a)	3.2	2.7	38.0	3.5	155.0	406	127
(Corn+Cowpea) - Corn	1.5	4.9	-17.0	6.8	2.0	702	18
(Corn+Rice) - Cowpea	-.5	.6	-4.0	.7	-29.0	115.2	-18
	(+5.9) (d)		(+193)	(+3.6)	(+246)	(+444)	(+215)
NICARAGUA							
Samulalí							
(Corn+Beans)	1.0	2.6	17.0	4.1	4.0	310.0	54
Sorghum + (Beans//Beans)	6.3	.7	450.0	2.7	400.0	378.0	908
EL SALVADOR							
Chalatenango							
Corn # Sorghum	1.0	2.0	-20.7	7.4	19.5	474.0	51

(a) Pipián is a type of squash (Cucurbita spp.) as an immature fruit.

(b) 1CA$ (Peso Centroamericano) = 1US$ (United States dollar).

(c) Δ% percentage of increment in relation to the farmer's check cropping system performance.

(d) All comparison are based on worst on farms experimental results or 70% of experimental averages. Cases in paranthesis show the effect of experimental averages.

(e) + is in the ground with; - is followed by; # is relay with; // followed shortly after by.

Table 4. Effect on production and productivity of several farm level evaluated modifications to cropping systems practiced by small farmers of different areas of Central America (CATIE 1978-1979).

Geographic Area		Cropping Pattern*			
Country-location	Gen. Charact.	Modified		Farmers check	
COSTA RICA					
Guácimo-Pococí	H	Casv. 30.5 - 32 T Corn 1.4-1.6 T	B.9-1.1 T	Casv. 10 - 12 T Corn 1-1.8 T	
Guácimo-Pococí	H	Corn 3-4.2 T	Corn 3.2-4.5 T	Corn 1.6-2.6 T	Corn 1.0-1.8 T
Pérez Zeledón	H+S	Corn 4.7-6.4 T	B.6-1.2 T	Corn 1.6-2.2 T	B.4-.8 T
Pérez Zeledón	H+	Corn 2.2-3.1 T B.1-.2 T	Corn 1.3-1.8 T B.1-.2 T	Corn .6-2.4 T B 0-.15 T	B.3-.5 T
HONDURAS					
Yojoa	S+H	Corn 2.2.5 T P. 3.5-5TU	Corn 1-1.5 T P. 3.1-4.4TU	Corn .8-1 T SQ. .9-1.1TU	Corn .3-.8 T SQ. .8-1 TU
Yojoa	S+H	Corn 2.5 3 T CP.5-.6 T	Corn 1.5-2 T	Corn 1.0-2.5 T	Corn. .4-1.8 T
Yojoa	S+H	Corn 1.0-1.5 T R 1.0-1.5 T	CP. .4-.8T	R.5-1 T	B 0.-.5 T
NICARAGUA					
Samulalí	H+S	Corn 4-5.2 T B.8-1 T		Corn 2-3 T B.5-.6 T	
Samulalí	H+S	S. 1.1-1.6 T B.9-1.3 T	SR .6-.8 T B.6-.8T	R.8-1 T	B.6-.1 T
EL SALVADOR					
Chalatenango	S	Corn 3-3.5 T S 2.5-3 T		Corn 1.5-2 T S 1.1-1.5 T	

* Symbols: Casv. = Cassava; Corn = corn; B = beans, P = pipián; SQ = squash; R = rice; CP = cowpea; SR = sorghum ratoon; T = metric ton; TU = thousand units.

H = humid; S = dry with a short rainy period; S + H = dry period tends to be longer than the humid period; H + S = humid period tends to be longer than the dry period.

rational and progressive capital transfer to agriculture, complementing existing land and labor endowment and potential, promises a high pay-off for society as a whole.

OTHER ACTIVITIES IN CATIE

Besides the discussed Project, CATIE operates different lines of research and training distributed among its different programs (see Fig. 1). All programs share a common goal and philosophy. Their methodologies are also similar, except in those details appropriate to the biological characteristics of the production systems. The common goal, philosophy and methodology calls for an integration and complementing of objectives and actions among projects within programs and among programs within CATIE. The institution is evolving towards that idea. Several projects already involve personnel and resources from more than one program.

Among the several lines of research and training, some specific projects and results will be mentioned as examples.

Annual Crops Program

The Project discussed in this document describes most of the specific characteristics of the Annual Crops Program. Other particular projects within the Program include research on: a) legumes other than beans; b) vegetable crops for diversification; c) weed management with emphasis on minimum tillage; d) insect control in cropping systems; e) research on specific and widely used cropping systems such as those based on maize and sorghum and maize and beans. All projects follow three lines of research: a) technology development at area level; b) support research to facilitate a; and c) development of methodologies for a and b as well as for 1) extrapolation of research results and 2) transference of technology to small farmers.

Cattle and Small Farm Animals Program

The Cattle and Small Farm Animals Program has been working in beef, milk, and combined milk and beef production systems. It is now beginning research work with "small animal species", at small farm level.

Among the most promising results is the "CATIE's Milk Production System". This consists of a one-adult-man family operated milk production unit with the following characteristics. Land: 3.5 ha in humid tropical areas with pasture of Cynodon nlemfuencis. Animals: 19 lactating cows and 16 other animals of different ages, which include, pregnant or non-lactating cows and replacements. This is an equivalent of 6.4 to 7 animal units per ha. All male animals are excluded at birth. Feeding

consists of a rotational grazing system of lactating cows followed by the other animals. Each group stays one day per pasture division. Suplementary feeding for lactating cows consists of 2 Kg/animal/day of sugar cane molasses with 3% urea. Replacement animals are fed 2 Kg/animal/day of a diet with 24% protein until their first breeding. Each pasture division should rest at least 21 days before the next grazing and be fertilized with up to 250 Kg/ha/year of Nitrogen. Milking is mechanical and twice a day. Evaluated milk handling facilities allows two cows at a time.

Studied animals are breeds of specialized for milk production and local animals for adaptation.

The system's performance shows an average production of 15280 Kg/ha/year of milk (41.86 Kg/ha/day). Return on investment depends on milk price, and costs of animals and facilities but averages of 17.4% have been observed. This specialized milk production unit has been studied in Turrialba and other areas of Costa Rica. Use of the unit, with minor modifications, has been initiated in two small farm areas under a Costa Rica government program.

Other research projects in the Cattle and Small Farm Animal Program includes: a) study of a milk and beef double purpose production unit for small farms; b) cattle feeding using the farm's common crops derivatives, especially: bean and corn residues, cut sweet potato leaves and non commercial roots; c) small animal species including pigs, chickens and small ruminants.

Natural Renewable Resources Program

The Natural Renewable Resources Program is focussing attention at two levels: 1) At the watershed level, to research their rational management in relation to their influence on the well-being of the affected small farmer communities, through conservation of their land resource quality. 2) At farm level, to study and develop production systems which include forestry species with several purposes.

Particular projects include: a) Fire wood and charcoal production systems at small farm level; b) Use of forestry species as shading for commercial crops such as coffee and cacao at small farm level. Attention is given to their handling facility, benefits to soil quality (i.e. legumes) or potential additional economic benefit (i.e. a third canopy level composed of wood trees such as Cordia alliodora in coffee and cacao plantations); c) Handling of forestry species in mixed tree-pasture grazing units (i.e. trees as fences, sources of animal feed or wood with potential additional economic benefit); d) Agroforestry techniques of the "Taungya" type to better utilize the ground, sunlight and time available during the establishment of a forestry specie; e) Fast growing forestry species for fence poles, banana plant support or other commercial uses.

Attached to this Program there exists a group working in a Germplasm Bank Project. In this bank a growing collection of food tropical annual plants as well as perennial plants is being established to maintain material for the future of the region. They are kept as viable seeds and/or in appropriate gardens.

Perennial Plants Program

The Perennial Plants Program is focussing attention on two types of production systems existing on small farms: 1) Those which include traditional export-type perennial crops (i.e. coffee, cacao). The first step is to understand their role and particular characteristics at small farm level. 2) Production systems which include other perennial crops usually existing in small farms, but less developed in their technology for the area (i.e. plantain and other fruit trees). The present Program's action includes the production, handling and selling of hybrid cacao seed to different countries. Most other projects are in their initial stage which includes area characterization of farms and particular production systems. At the Turrialba research station an experiment including annual and perennial crops, forestry species and pasture in different combinations is chiefly under the supervision of this Program. However, it is a common ground for studies from different programs.

Training

Training is another responsibility of CATIE. Training is implemented through two main programs.

A) Post Graduate Training Program. This Program is implemented by the University of Costa Rica and CATIE. Students in the Program obtain a Master of Science degree. Professionals entering this Program are mainly from National Agricultural Institutions within the mandate area.

B) Training Programs at other levels. This type of training is very much related to the methodologies and research being implemented in the different programs and countries. It includes in-service training as well as special short courses, seminars and workshops. This training program is oriented to farmers, technicians and professionals in agriculture from the National Institutions within the mandate area.

Another special type of training program is under the heading of Technical Cooperation. It includes CATIE's cooperation in particular projects or programs being implemented by National or other related agricultural institutions within the mandate area. They include production programs, seminars, workshops and other endeavors for which CATIE may have appropriate experience and available resources.

SUMMARY

CATIE is engaged in development oriented research, with special attention to small farmers, in several areas throughout the Central American Isthmus. The research is being done by national multidisciplinary teams formed with CATIE's cooperation. The teams' work is guided by a methodology which puts emphasis on field work at small farms level and the interaction with other rural development institutions.

The work methodology has emerged from the Small Farmers Cropping System Project, which attempts to develop improved cropping systems for small farmers of specific areas. The project has entered a second phase to include the study of extrapolation and technology transfer methodologies as well as animal production systems in small farms.

The methodology includes area selection; its characterization to identify relevant cropping systems and constraints; design, testing and evaluation of promising modifications; validation under farmer's management of the best evaluated alternatives; and preparation of validated alternatives for extension to farmers.

The work methodology incorporates the basic Systems Approach to research principles and it is designed to facilitate the team's work and the complementary interaction of its members throughout all phases.

The methodology has emerged in great part from the experience gained from the work done by different Central American Isthmus countries independently or with CATIE's cooperation.

Today all countries in the Isthmus include the described type of work as part of their agricultural research and extension efforts.

Advanced results obtained at small farm level experiments, in different areas throughout the Isthmus, are highly promising. Net income as well as productivity per unit of land could, in some cases, be doubled by introducing changes which are acceptable to farmers. The need for other institutional support of farmers for using "improved" tecnologies is also clear.

Other research lines and promising results from CATIE include: a 3.5 ha, 41.86 Kg/ha/day of milk production unit, firewood and charcoal production systems for small farms; and mixed production systems including fruit trees and other perennial crops. Training is implemented at M.Sc. degree as well as at other non-degree levels. Some type of technical cooperation is also part of CATIE's responsibilities.

BIBLIOGRAPHIC NOTE

Selected references which could provide additional information about CATIE as an institution and its work are listed here, including those quoted in the text.

BIBLIOGRAPHY

1. AGENCY FOR INTERNATIONAL DEVELOPMENT. Agricultural research and information system and small farm production systems (Project paper). Washington, D.C., AID/ROCAP, 1979. 245 p.

2. BURGOS, C.F. Bósquejo sobre la metodología seguida por CATIE en la ejecución del Proyecto de Sistemas de Cultivo para Pequeños Agricultores. Turrialba, Costa Rica, CATIE, 1977. 29 p.

3. CENTRO AGRONÓMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA. El nuevo enfoque del CATIE para el desarrollo agrícola y rural de Centro América y Panamá; su política, organización y principios de operación. Turrialba, Costa Rica, CATIE, 1976. 17 p.

4. _____. A farming system research approach for small farms of Central America. Turrialba, Costa Rica, CATIE, 1978. 28 p.

5. _____. Small farmer cropping systems for Central America; final report June 1975-March 1979; Contract No. AID 596-153 (CATIE/ROCAP). Turrialba, Costa Rica, CATIE, 1979. 101 p.

6. _____. Descripción de una alternativa para el sistema de cultivo maíz asociado con yuca practicado por los agricultores de la zona de Guácimo y Pococí, Costa Rica. Turrialba, Costa Rica, CATIE, 1979. 118 p.

7. _____. Descripción de una alternativa para el sistema de cultivo maíz-maíz practicado por los agricultores de Pococí y Guácimo, Costa Rica. Turrialba, Costa Rica, CATIE, 1979. 53 p.

8. _____. Descripción de alternativas para el sistema de maíz y frijol asociado en primera seguido por frijol solo en postrera practicado por agricultores de la zona de Palmares de Pérez Zeledón, Costa Rica. Alternativa 1: maíz asociado con frijol en ambas épocas; alternativa 2: reemplazo del frijol por Vigna unguiculata (L) Walp. Turrialba, Costa Rica, CATIE, 1979. 55 p.

9. _____. Descripción de una alternativa para el sistema maíz en primera y frijol en postrera, practicado por agricultores de la zona de Palmares de Pérez Zeledón, Costa Rica. Turrialba, Costa Rica, CATIE, 1978. 169 p. 71 ref.

9. CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA. Descripción y evaluación del sistema de cultivos (maíz+pipián) - (maíz+pipián): una alternativa para el sistema (maíz+ayote) - (maíz+ayote) practicado por los agricultores de Yojoa, Honduras. Turrialba, Costa Rica, CATIE, 1979. 114 p.

11. _____. Descripción y evaluación del sistema de cultivos maíz/frijol de costa-maíz: una alternativa para el sistema maíz-maíz practicado por los agricultores de Yojoa, Honduras. Turrialba, Costa Rica, CATIE, 1979. 117 p.

12. _____. Descripción y evaluación del sistema de cultivos (maíz+arroz) - frijol de costa: una alternativa para el sistema arroz-frijol practicado por los agricultores de Yojoa, Honduras. Turrialba, Costa Rica, CATIE, 1979. 135 p.

13. _____. Sorgo y frijol asociados en fajas alternas, una alternativa para el mejoramiento del sistema frijol en monocultivo practicado en Samulalí, Matagalpa, Nicaragua. Turrialba, Costa Rica, CATIE, 1979. 73 p.

14. _____. Descripción de una alternativa para el mejoramiento del sistema maíz-frijol en relevo practicado por pequeños agricultores en una comunidad agrícola de la región interior central de Nicaragua (Comunidad de Samulalí, Matagalpa). Turrialba, Costa Rica, CATIE, 1978. 65 p.

15. _____. Descripción de una alternativa para el sistema de producción maíz asociado con sorgo practicado por agricultores del Municipio de Tejutla, Chalatenango, El Salvador. Turrialba, Costa Rica, CATIE, 1979. 54 p.

16. _____. Objetivos, actividades y resultados de la acción del CATIE en 1979. Turrialba, Costa Rica, 1980. 72 p.

17. DILLON, J.L. The economics of systems research. Agricultural Systems No. 1:5-22. 1976.

18. DON VICTOR: A small farmer in Costa Rica. Activities at Turrialba (Costa Rica) 6(1):3-8. 1978.

19. FARMING SYSTEMS research at the international agricultural research centers; I. Analysis by the TAC Review Team of Farming Systems Research at CIAT, IITA, ICRISAT and IRRI. 1978. 66 p.

20. NAVARRO, L.A. Dealing with risk and uncertainty in crop production, a lesson from small farmers. Turrialba, Costa Rica, CATIE, 1977. 27 p.

22. NAVARRO, L.A. El problema general de la agricultura y la investigación agrícola basada en el enfoque de sistemas. Turrialba, Costa Rica, CATIE, 1979. 25 p.

23. _____. Generación, evaluación, validación y difusión de tecnologías agrícolas mejoradas y apropiadas para pequeños agricultores. Turrialba, Costa Rica, CATIE, 1979. 31 p.

24. _____. Una metodología general de investigación agrícola aplicada basada en el enfoque de sistemas. Turrialba, Costa Rica, CATIE, 1979. 24 p.

25. NORMAN, D.W. Farming systems research in the context of Mali. Presented at: Workshop on Farming Systems Research in Mali, Bamako, Mali, Institute d' Economie Rurale, 1976. 11 p.

LAN/idev
12/6/80