

CATIE
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C I D I A
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RESEARCH AND TRAINING FOR DEVELOPING
CROP PRODUCTION TECHNOLOGY OF SMALL
FARMS IN CATIE'S MANDATE REGION

INITIALS

AID	Agency for International Development, United States
AVRDC	Asian Vegetable Research and Development Center
CARDI	Caribbean Agricultural Research and Development Institute
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Research and Training Center)
CENTA	Centro Nacional de Tecnología Agrícola (National Center for Agricultural Technology), El Salvador
CIAT	Centro Internacional de Agricultural Tropical
CIMMYT	Centro Internacional para el Mejoramiento de Maíz y Trigo
CIP	Centro Internacional de la Papa
DC	Developed Country
DIGESA	Dirección General de Servicios Agrícolas (General Directorate for Agricultural Services), Guatemala
EEC	European Economic Community
FAO	Food and Agricultural Organization
GTZ	Gesellschaft für Technische Zusammenarbeit (Agency for Technical Cooperation), Germany
IADS	International Agricultural Development Service
ICAITI	Instituto Centroamericano de Investigación y Tecnología Industrial (Central American Institute for Research and Industrial Technology), Guatemala
ICRISAT	International Center for Research in the Semi Arid Tropics, India
ICTA	Instituto de Ciencia y Tecnología Agropecuarias (Institute for Agricultural Sciences and Technology), Guatemala
IDB	International Development Bank
IDIAP	Instituto de Investigaciones Agropecuarias de Panamá (Agricultural Research Institute of Panama), Panama
IDRC	International Development Research Centre, Canada
IFAD	International Fund for Agricultural Development

IICA	Instituto Interamericano de Cooperación Agrícola (Inter-american Institute for Agricultural Cooperation)
IITA	International Institute of Tropical Agriculture
INCAP	Instituto de Nutrición de Centroamérica y Panamá (Nutrition Institute for Central America and Panama), Guatemala
INTA	Instituto Nacional de Tecnología Agropecuaria (National Institute for Agricultural Technology), Nicaragua
IPPC	International Plant Protection Center, Oregon
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
LDC	Less developed country
LHT	Lowland humid tropics
ODA	Overseas Development Agency, United Kingdom
PNIA	Programa Nacional de Investigación Agropecuaria (National Program for Agricultural Research), Honduras
PROCAMPO	Programas Campesinos (Peasant Programs), Nicaragua
ROCAP/AID	Regional Office for Central America and Panama Programs of the United States Agency for International Development
SAT	Semi arid tropics
SIECA	Secretaría Permanente del Tratado General de Integración Económica Centroamericana (Central American Integration Permanent Secretariat), Guatemala
SRN	Secretaría de Recursos Naturales (Natural Resources Secretariat), Honduras
US	United States
USAID	United States Agency for International Development

INTRODUCTION

World annual expenditure in agricultural research has increased over five-fold during the last three decades (16). This reflects the high rate of return on such investment found in different studies (14, 16), which in turn, reflects the efficiency of some research results in producing technical changes in agriculture. These technical changes have long been perceived as an efficient source of economic growth (14).

Agricultural research grades from fundamental and basic to applied and adaptive (9). It has been argued that because basic research could be expensive and of uncertain return, it should be left to rich and developed countries, while less developed countries should merely adapt and apply available technological knowledge (16).

The ability to screen, borrow and adapt scientific knowledge and technology to fit specific conditions requires, however, essentially the same capacity as that needed to produce new knowledge or invent new technology (14, 16). Furthermore, the efficiency of investment in research by any national research system depends also on the capacity in basic and supporting research (14).

Most national research systems in LDCs have not developed the administrative and professional capacity that is necessary even to absorb, adapt and transmit effectively the knowledge and technology that is available to them from research and development work in the international

research system and by institutions in DCs (14, 16). This limited capacity is now identified as a serious constraint on the returns to investment in the international research system (14).

The upgrading of the national research and development capacity has been, and will be, a priority for international assistance in agricultural development. As part of this assistance, over the most recent decades, three models for organizing professional resources to work on problems of agricultural and rural development have arisen. In chronological order, they are the counterpart, the university contract and the international research institute models (14). The counterpart model is still used by institutions, such as the World Bank in its lending programs. The university contract model is being reviewed and strengthened by means of the Title XII Program of the US. Both models put emphasis on institutional organization and building of professional capacity. The later international institute model is an attempt to bring that capacity to bear on the generation of more productive agricultural technology but avoiding the severe limitations of working within the framework of national institutions. New institutions, such as IADS and ISNAR, have as their explicit mandate the fortification of national research systems.

Evidently, no model has completely succeeded in transferring sufficient knowledge and expertise to strengthen the national capacity for research and development. Furthermore, present economic, social and political trends in LDCs give rise to a need for continuing effort from international development institutions. Different agricultural development projects

now include a research component and require an effective methodology for production of technology appropriate to the target area, all of which were lacking in most previous failed projects. Everything suggests the need for alternative or complementary more efficient approaches, based on past experiences, to support national agricultural research and development. Regional-international research and training institutions, working within the different countries of their mandate region, but still independent from limiting institutional forces in any particular country, provide a strong basis for a continuing and complementary effort to upgrade and support the national capability for agricultural research and development.

The background, objectives, organization and action of the Annual Crops Program of CATIE are presented, as one of these complementary efforts, drawing on the work experience of the Program over the last eight years, concentrated mainly in the Central American Isthmus. Most of this has been obtained interacting with national research institutions in cropping systems research directed toward the improvement of agricultural production, and the productivity as well as the rational use of resources of low income farmers in order to contribute to their well being.

BACKGROUND INFORMATION

The Institution

CATIE, the "Centro Agronómico Tropical de Investigación y Enseñanza" with headquarters in Turrialba, Costa Rica, was created in 1973 by an agreement between the Government of Costa Rica and the Interamerican Institute of Agricultural Cooperation. It is a non-profit autonomous institution designed to conduct and promote research and training in agriculture, forestry and livestock, in response to the needs and priorities of tropical American countries. Since its creation, CATIE has concentrated its efforts in the Central American Isthmus, where the governments of Guatemala, Honduras, Nicaragua and Panama have already joined the association. El Salvador and Dominican Republic membership is in process.

The four programs, Annual Crops, Perennial Crops, Animal Production and Natural Renewable Resources, constitute the elements with which the Center operates in research and training in Turrialba and across the countries in the mandate region. At country level, the Center works interacting with the respective national research and extension institutions.

Based on early experience of the Annual Crops Program, the Center has developed a research methodology with a systems approach, where all production factors are considered in order to identify the most limiting ones. This methodology is continuously tested by use on farmers' fields in order to develop and evaluate improved technological alternatives for the farmers' production systems, which are consistent with the farmers'

resource endowment, management capability and goals. Cooperative work and training activities try to build up the research capability of national personnel, particularly of those involved in projects which follow the same approach as the Center.

By direct petition of the governments and development authorities in the Central American Isthmus, the target population are the farmers with low income and limited resources. They are a majority of the total population and produce about 80 percent of the staple food consumed in the Isthmus. Their technology seems to be behind the state of development possible under present agricultural knowledge. This lag has negative consequences for the farmers in terms of income and welfare, and for society in terms of food production and resource conservation as well as equity in the distribution of agricultural income. Further studies are needed to understand and provide solutions to this situation.

The Central American Isthmus, CATIE's Present area of Action

The Central American Isthmus is made up of Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama. Approximately 60% of the total area lies in a basal tropical belt ranging in altitude from sea level to 800 meters. Only 32% of the Isthmus is located in the premontane belt which extends from 800 to 1,800 meters above sea level. Population density and the intensity of agriculture are greater in the premontane belt than in the basal tropical belt. Some small agricultural areas

are found at altitudes above 1,900 meters.

Of the regional area of 423,110 km² excluding Panama, 22.4 percent was under cultivation in 1970, another 28.1 percent was appropriate for cultivation and 49.5 percent was not suitable for agriculture according to SIECA (17).

Ecology and farming. The Central American territory can be divided into three main ecological situations that have the following area, population and agricultural characteristics:

	Percent of Total Area	Human Population		Farms	
		Per km ²	% of total	Per km ²	% of total
A. Atlantic basal and premontane belt					
1. Lowland Humid Tropics (LHT)	40.1	19	22	1.9	20
B. Pacific basal, premontane and montane					
1. Semi Arid Tropics (SAT)	22.6	44	28	3.5	27
2. Wet-Dry Tropics (WDT)	37.4	47	50	6.6	53

The wet-dry tropics include half of the population and farms, while the lowland humid tropics cover 170,000 km² (40.1%) of the region.

Farming systems in the LHT are the least intensive and tend to favor the production of perennial crops (banana, cacao, African palm) and beef

cattle, usually in large farms and as high investment enterprises. Smallholdings may also include cattle and cacao besides plantain, fruit trees, root crops and staple grains. Technology in small holdings is less capital intensive and more traditional. The principal food grain, produced mostly in small holdings, is maize. Rice is traditionally produced by smallholders but is also found in larger farms, usually under mechanization. Farming activities in the LHT are continuous during the year and the main production problems appear to be related to weed and pest control. Labor requirement is high and its availability low. High rainfall, temperature and radiation imply potential for great biomass production but also a very fragile ecological and soil environment. All this suggests that priority should be given to resource conservation and improvement of labor productivity at low cost in the production technologies to be developed.

Farming systems in different parts of the SAT, reflect the availability of soil water, which is the most limiting resource. Rainfall patterns are usually erratic, allowing one or two overlapping and short cropping seasons. This magnifies the concentration of agricultural activities during certain parts of the year. The consequence is a shortage of labor during the cropping season and high rural unemployment during the off season, which may last up to half the year. Rainfed farming systems favor the production of drought resistant food grains. The most common are adapted cultivars of maize and sorghum, usually planted in relay in the same land during the same cropping season. Besides food grains, which are mostly produced for family consumption, small farms under these circum-

stances include small stocks of animals which are partly fed with the by-products of the maize-sorghum cropping systems. They also include small home gardens which include some fruit trees and other species which survive with minimum manual irrigation. Some family members migrate during the off season in search of employment, the majority, however, stays unemployed in the communities. Under this situation, the main research priorities relate to the capture and management of rainfall water to stabilize production and allow a longer cropping season. Some areas within SAT have already benefited by more availability of water, including irrigation, under which situation the farming systems favor the production of high value export cash products including cotton, sugar cane and beef cattle. Other products include vegetable crops and fruit trees, usually tied to secure market outlets. Farms are larger and their technology more capital intensive.

The Wet Dry Tropics include the most favorable environment for human settlement and also for agricultural production. Most large cities are located in this zone, implying a high demand for food, pressure on land and need for appropriate technology. Farming systems in this zone are highly diversified to include annual and perennial crops as well as livestock production. Grading from the intermediate altitude WDT to the highland WDT, the favored perennial crops include plantain, coffee and fruit trees. The purpose of cattle rearing changes from beef to dairy production. Poultry and swine production is included in most farms of the WDT. Goats are not generally included. Food crop production is

varied even within single farms. Maize is found across the WDT zone as well as beans. At lower altitudes sorghum and rice are common; in the highland they are replaced by vegetable production, Irish potatoes and small grains such as wheat. Associations and intercropping of annual crops are common in the WDT, which includes the "milpa" cropping system of the highlands (maize in direct association with beans and other crops). The WDT zone offers, perhaps, the highest potential for rapid impact from adaptive research. Research questions include the identification of appropriate technology components and their optimum levels and combinations to increase land productivity and diminish costs as well as labor use per unit of output.

Population trends and food production. A study of demographic trends and projections, recently published by the Division of General Studies of IDB, indicates that average increments in population continue above 3% per year for Central America. It also estimates that the total population, which was 15 million persons in 1970, will reach 35.7 millions by the year 2000. Food production, especially of basic grains, is already insufficient to meet the demand. SIECA (10), estimates an increase in the percapita annual consumption of basic food grains ranging from 5% in beans to 76% in wheat. This same study indicates that, in order to allow an increase of 10 percent in the annual percapita consumption of grains without increasing the import of those grains above the 1980 level, the Central American production should increase at the following rates, expressed in 1000 ton year⁻¹, from 1980 to the year 2000: corn

61.16, beans 7.55, rice 8.85 and sorghum 11.75. This increase could be obtained by an increase in the land resources allocated to grain production, by improving yields per unit area, or by both. Land resources are limited in their absolute level and also by alternative economic uses. This implies more pressure for developing production technologies to improve yields per unit area, particularly those of the main producers who are low income and limited resource farmers.

The small farm sector. Small farms, of less than 4 ha and with 4 to 35 ha, account for 76 and 18 percent of the Central American rural population respectively, and furthermore represent half of the total population in the region (17). Their resources, low in quality, amount to only one fourth of total farm land and less than one fifth of total farm input expenditures, while their mean percapita income is under US\$100 per year. They provide, however, two thirds of the total active rural labor force and over two thirds of total food crop production value, excluding rice, for the region. Their participation in rice, perennial crops and livestock production, which the region exports, amounts to 36, 29 and 21 percent of total production value. Given the forecasts for the next 20 years of population growth, economic expansion and energy costs, small farms will continue as one of the most important social and economic sectors in the Central American Isthmus.

The national research and extension institutions. Agricultural research and technical assistance in the Central American Isthmus has tra-

ditionally been oriented by commodity. Earlier interest was in a few exports crops such as banana, coffee, cacao and sugar cane while most of the available knowledge for improving basic food crop production was transferred directly from temperate developed countries. The methods and orientation of research were also transferred; this was stimulated by the "Green Revolution" success. About 1970, however, it became evident that not all farmers were benefiting from the new technologies. Many farmers had not adopted the new varieties, chemicals and production methods, although national productivity had increased. It was clear that many of the elements of the new technology did not fit their farms, and that the knowledge about their farming systems and the integration therein of component technologies was lacking.

Since its creation in 1973, CATIE has participated in the search for more appropriate objectives and methods for research and technology development. The orientation and methodology of CATIE have served as a prototype for the work of national teams. In some countries, the institutional situation already had this orientation; in others, total reorganization was needed. Today it is evident that the orientation and methods followed by CATIE, have been accepted and their use has influenced different national and international institutions working in the Isthmus. The successful efforts of this kind, by IRRI in the Philippines and by particular projects in different countries of Latin America and Africa, provided guidelines and a stimulus.

The acceptance of this new focus and methodology by national

institutions showed the need which existed for an appropriate method for designing technological improvements for specific groups of farmers. This need has also been manifested in different assessments of the institutions in the region made by the World Bank, IDB, USAID (1), IICA (10) as well as CATIE (12). The following summary review, country by country, of the situation of research and extension in May 1981, supports this conclusion.

In Guatemala, ICTA, one of the best endowed and oriented institutions in the Isthmus, even at the beginning of CATIE's activities in 1973, has lost momentum in its methodological development, and its personnel and operational resources have been diminished. Coordination with DIGESA, the extension institution, has progressed but is not nearly complete.

In Honduras, most attention is being given to the Agrarian Reform Institution. Research and extension have traditionally operated separately, even though both are part of a same institution, the SRN. The PNIA, the research component of SRN, attempted an organization similar to ICTA of Guatemala. The methodology followed a farming system research pattern and the training of personnel was build into the organization. Recently, a drastic change in personnel and orientation converted the PNIA once more to a commodity-oriented research institution with very limited resources. The systems approach to research is still being applied by a small team working with CATIE's collaboration in the highlands of Honduras.

In El Salvador, CENTA is a strong institution within the Ministry

of Agriculture. It includes both crop research and agricultural extension components. Its physical plant is possibly the best endowed in the Isthmus. Present circumstances, however, have led the government to focus CENTA's work on direct physical support for agrarian reform.

In Nicaragua, the government has made a complete change of all the agricultural institutions. The former INTA has been converted from an autonomous Institute to a division within the Ministry of Agricultural Development. Its systems orientation and methodology has been changed to commodity-oriented action with main attention on the production of export crops. Research oriented toward farmers of limited resources is now the responsibility of PROCAMPO, an institution with little experience and few personnel. PROCAMPO's needs are increased by its responsibilities in extension and credit.

In Costa Rica, the organization of public agricultural research is the most traditional in the Isthmus. It follows a commodity-oriented approach and its operation is almost completely uncoordinated with the extension body. Both research and extension are however, under the same Ministry of Agriculture. Recently, the extension division has been reorganized to accommodate the "Training and Visit" methodology which imposes requirements for applied research at the area specific level.

In Panama, IDIAP is at present developing as an autonomous institution with responsibilities for the development of methodologies in research and agricultural extension. It is the newest institution in the Isthmus, and its organization and methodology is partly based on the

experience of other similar institutions in the area, and partly on CATIE's methodology.

The Annual Crops Program of CATIE has been working with all these institutions during the past five years. On occasions this work has strengthened existing efforts, as in ICTA; in most cases it implied reorientation and training, on other occasions, direct participation in institutional reorganization was necessary, as in Nicaragua and Panama. At present, institutions in other countries outside the Isthmus are becoming interested in this type of interaction with CATIE.

The Program Background

In 1973 the former Tropical Crops and Soils Department, which became the present Annual Crops Program, led CATIE in its new research orientation and methodology for developing technologies for small farms. This was initiated by a research project on cropping systems for small farms at the Turrialba headquarters. Through the work of the technical staff and the graduate students, a basic research methodology was developed before the outreach phase of the program was attempted.

The approach grew from the awareness that: a) small farmers in Central America work under very complex and dynamic agronomic and socio-economic circumstances b) this complexity leads to farming systems developed by those farmers and adapted to such environments, that are very different from those of the temperate zone c) there is little knowledge about their technologies and the forms to upgrade them d) discipline and analytically oriented research is ill-equipped to study the numerous

important interactions which characterize the production systems under such complex situations e) the process of integrating component technologies into small tropical farming systems could profit from a holistic approach, which involves taking into consideration the wide range of physical elements, biological processes and human activities that transform agricultural resources into socially desirable goods f) to be practical and make its results suitable to the farms, the processes of problem and priority identification for research, and of hypothesis-solution generation and testing is needed, which when appropriate, should be carried out with the farmer on his land.

In 1975, ROCAP the regional office of USAID, provided the initial financing for the outreach phase of the program across the Central American countries. This initial effort was identified as the Small Farmers Cropping Systems Project. It allowed the former Department to increase its research staff and further develop the approach which later was internationally recognized as a variant of the Farming System Research Approach (2, 7, 9). In summary, it includes five interrelated phases, any of which may be reduced or eliminated if sufficient information is already available. These are a) target area selection; b) characterization of target farms to identify the production systems and technical problems with priority for research and the criteria to evaluate research progress and results; c) design of technically feasible and viable solutions; d) evaluation of the solutions with increasing degrees of participation by

farmers; e) diffusion of the technology and possibly adoption and impact evaluation.

The methodology has been developed for the work of multidisciplinary teams whose participants are trained and willing to interact guided by a system approach. Team composition in the different countries has varied, but the tendency is to have at least two representatives from the agronomic sciences and one from the behavioral sciences. The most common disciplines are Agronomy, Plant Protection and Agricultural Economics. The team also needs strong support by other disciplines. Furthermore, the research approach reemphasizes the need for interaction among researchers and extensionists in the process of developing and diffusing agricultural technology. The extension element is also encouraged by its inclusion in the teams working at area level. The on-farm research approach executed by these teams is thus suitable as an interphase between research and extension, stimulating a working coordination between these entities.

The outreach program grew to have teams working in all Central American countries. Several evaluations of the progress, results and opinions at country level about the project have been made by USAID (6) and other institutions (2). The favorable outcome of those evaluations directed other financing institutions to support additional similar projects which filled the gaps in the original one (5). ROCAP itself renewed the initial project to begin a second phase, the Small Farms Production systems Project, which now included Panama. This second phase

included initial research in the extrapolation of results across sites, the transfer of technology developed to a wider number of farmers, as well as the study and development of production systems which included both crops and animal products and their interactions.

At the international level, the Program has maintained formal and informal working agreements with: a) IARCs including AVDRC, CIAT, CIMMYT, CIP, ICRISAT, IITA, IRRI and ICARDA; b) regional institutions including CARDI, ICAITI, INCAP and SIECA; c) universities in the US including California, Florida, Iowa, Michigan, Missouri and Oregon; d) universities and national research institutions in other Latin American countries including Brazil, Colombia, Ecuador, Mexico, Peru and Venezuela, e) other institutions concerned with international agricultural development including FAO, IADS, IICA, IPPC, ODA, AID/ROCAP, EEC, IDRC, IFAD and GTZ.

Objectives and methodologies of all ongoing projects are part of the same general approach but each project has required special attention to comply with specific requirements of sponsoring institutions.

Constant solid financial support to permit effective coordination of these projects is thus an important requirement of the Program.

THE ANNUAL CROPS PROGRAM**Program Objectives**

The Program objectives are contained in the mandate of CATIE. They can be specified as the orientation of the Program research and training resources, methodologies and actions toward the following goals, purposes and products:

GOALS:

- Agricultural development in the mandate region.
- Improvement of the well being of low income farmers in the region.
- Rational use and conservation of the productive capacity of resources.
- Enhancement of the food, energy and income obtained from production systems that include annual crops.

PURPOSE:

- Help countries in the mandate area, to develop and maintain an agricultural research capability, appropriate for a self sustained advancement to specified goals.

PRODUCTS:

- Improved technologies for the production of annual crops, which are appropriate for and adoptable by the farmers of specific areas.
- Improved knowledge of the characteristics of important annual cropping systems in the region and their relationship with the

environment.

- Methodologies for cropping system research and for development of corresponding technologies.
- Trained national personnel in the methodology, organization and management of multidisciplinary teams for cropping systems research and development of crop production technologies.

Program Strategy and Structure

The working strategy of the Annual Crops Program is based on research and training for the development of production technology in important cropping systems in the region. It consists of promoting, stimulating, and participating in the formation, training, work and support of national multidisciplinary research teams. It is realized by the interaction of two main elements 1) outreach for direct support to research institutions and 2) activities at CATIE such as supportive research, methodology development and training in support of outreach (Figure 1).

The first element acts and interacts with national institutions in the countries of the region. An Outreach Coordinator will have the basic responsibility to provide a two-way communication between national research programs and their cropping systems research teams and also with the support components of the Program. This communication stimulates the exchange of knowledge and experience as well as requests for and offers of support. It will also allow the outreach teams' members to participate with ideas and suggestions as inputs to the orientation and planning of

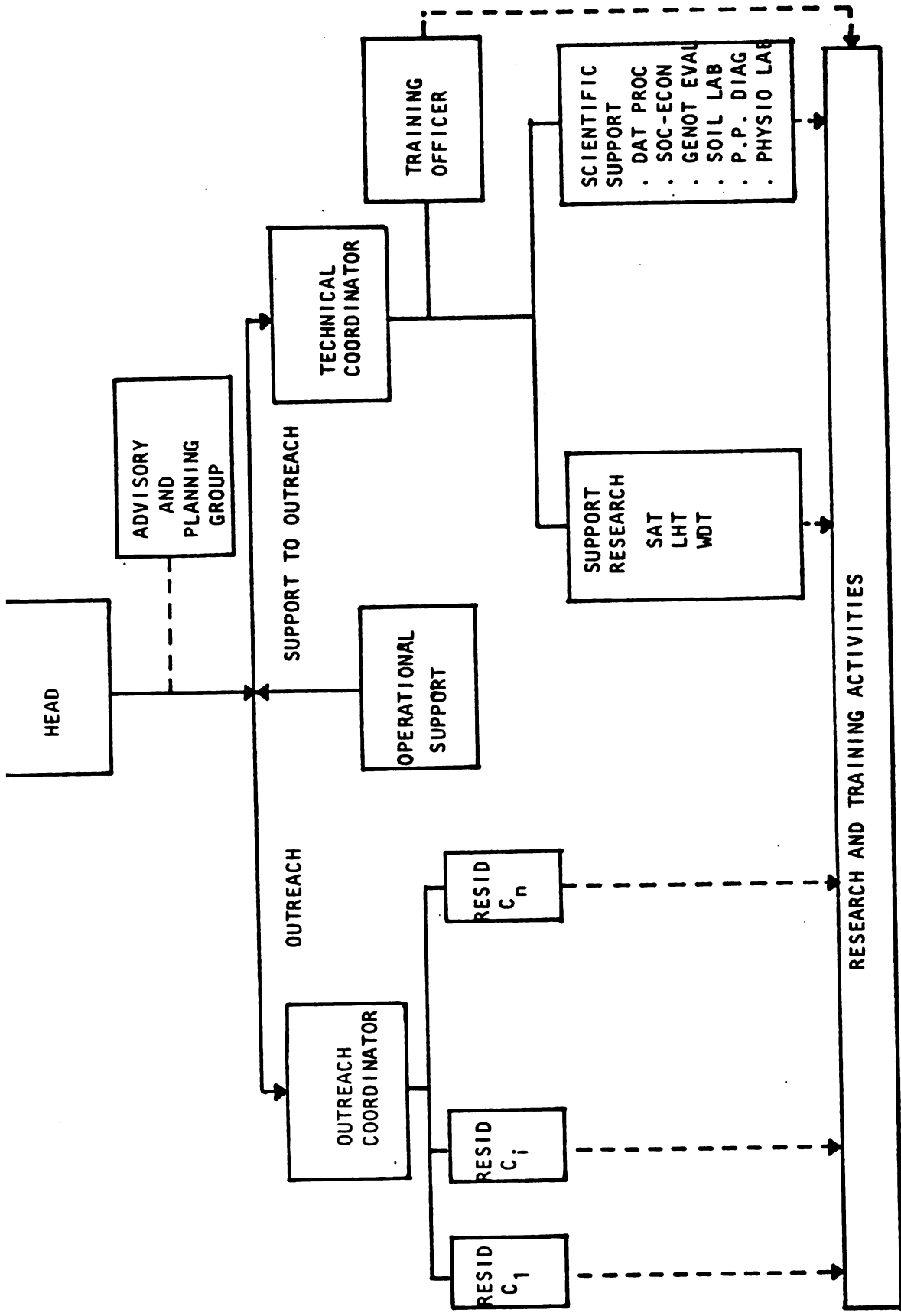


Fig. 1. Annual Crops Program organization, (June 1981).

Resid. C_i = The resident in the ith country

the Program and CATIE, as well as to maintain their operation within the Program and CATIE scope of work, goals, purposes, plans and available resources. To accomplish this the Outreach Coordinator will have close interaction with and participation in all outreach team planning and progress evaluations. He will encourage national program support of cropping systems research and the inclusion of interdisciplinary teams with regional research responsibility in those programs. He should be aware of the activities of other CATIE's Programs in the same target areas at country level so as to stimulate interaction and exchanges when appropriate.

The second element provides a linkage of research across countries and ecological situations within the mandate region. This is achieved by lending scientific support to country teams in terms of genetic materials, research methods, specific component technology, documentation and laboratory and biometric services. In addition, results from indepth research on constraints to increased production in the semi-arid tropics, the lowland humid tropics and the wet-dry tropics (support research in Figure 1) will back up teams working in those environments. The training program supports the network of research sites by providing task-specific training in a clearly described methodology for interdisciplinary research that can be conducted with farmers' participation.

A technical coordinator will orient the support activities as direct backstopping to the work of outreach teams. He will do this with the help of the Outreach Coordinator and by encouraging communication

between scientists active in support research and training and members of the outreach teams. This will help assure that the activities of the three units, the support research team, the scientific support group and the training group are in response to the needs of national programs in the region and the interdisciplinary research teams of these programs.

Outreach for Direct Institutional Research Support

The need for support in research and training for research at national institutional level, independent from political and budgetary cycles and tied personnel, is clear. The same is true of the need for a better coordination among agricultural institutions. Because of political and financial constraints, personnel turnover in national research programs is fast and resource allocation to projects changes continuously, while institutions often work separated, without coordination, and must compete for limited resources.

Furthermore, the research approach being promoted by the Program is new for the region, which implies a need for training of personnel at all levels in the different aspects of this approach.

OBJECTIVES

1. Participate, with national agricultural research institutions, in the formation and maintenance of teams to implement area-specific and problem-oriented cropping systems research for the development of crop production technology.

2. Coordinate a working group of national program leaders that will help develop the on-farm research methodology such that it will fit the institutional limitation of national research programs. This group will also help the Annual Crops Program identify priorities for research and program development.
3. Help to transfer to the national teams, the recent methodological advances and resulting knowledge from cropping systems research and technology, available from national and international sources.
4. Help to transfer to team leaders the recent methodological advances in organization and management of multidisciplinary research teams, particularly how to:
 - a) maintain the team work orientation and activities within the institutional mandate and priorities;
 - b) maintain the leaders of the institution informed of the objectives, advances and results of the teams' work in order to obtain continuing support;
 - c) help prepare specific research and technology development projects of the team for submission for funding by national or international sources;
 - d) improve communication and coordination of activities with other agricultural institutions working in the same target areas;
 - e) improve communication with other agricultural research institutions at national and international level, to make better use of the technical knowledge they are producing and to provide them with field observations and research priority identification to help orient their work.

5. Channel and coordinate the support research, training and scientific support available from the Annual Crops Program of CATIE to the country teams.
6. Help in the networking of the outreach work, across countries, stimulating an exchange of results and experience, as well as a complementarity among specific research activities of the teams.
7. Help to channel funds and support available from national and international sources to strengthen and maintain the activities of national program teams.

PERSONNEL AND MANAGEMENT

In every participating country the Program will place a resident professional with a Ph.D. or M.Sc. degree in an agricultural discipline. He will be responsible for the outreach activities in the country which may involve several interdisciplinary teams of national program researchers. He will have the appropriate budget for field, administrative and secretarial assistance, transport and operation.

The installation of a resident professional should be preceded by a manifestation of interest by the country in question. His presence will continue while the interest lasts or until the national cropping systems program can continue the work independently.

The institution in which the resident professional acts will be chosen by mutual agreement. The same holds for the type of relation of

the resident with the leadership of that institution and his position within the institutional structure. The availability of personnel, equipment and budget for a national team for cropping systems research and development of crop production technology, which will be directly supported, should also be clarified.

The Program should previously explain the nature of the national teams and promote their formation and maintenance in each country. The support available from the Program should also be clarified.

Once an outreach team is established, the resident professional will be directly involved in the activities of at least one team working at the area level within the country. The resident professional will provide continuous support to the country program leader. The coordination of the national team with the CATIE Program support activities and outreach activities in other participating countries, will be carried out by the resident professional with the Outreach Coordinator. The latter will interact directly with the Technical Coordinator and the Head of the Program.

Support to Outreach

This element of the Program will be structured to give support to the teams working in cropping systems research for the development of crop production technology, by means of three types of activities, Training, Support Research and Scientific Support.

TRAINING

The formation of the appropriate human capital, through training, is a key element for the enhancement of the indigenous research and development capacity at country level. In the Central American Isthmus there is a marked need for this type of training but, owing to political and institutional circumstances, the expression of demand varies considerably.

To encourage adoption of CATIE's multidisciplinary research approach, substantial emphasis is needed on task-specific training for members of on-farm research teams. The Program will continue to contribute to the M.Sc. course with a systems emphasis which is conducted under an agreement between CATIE and the University of Costa Rica.

OBJECTIVES

1. Be conversant with the needs and priorities for training at country level, particularly of outreach teams, for formation and improvement of personnel in national teams and development of training activities conducted by the teams themselves.
2. Plan and coordinate all Program training activities, with special attention to those required to support outreach activities and the graduate training program in Turrialba.
3. Orient and participate in the development of methodologies and material, and channelling and obtaining resources for these training needs.



PERSONNEL AND MANAGEMENT

The training team composition includes: a training officer and an assistant training officer. The training officer will be a professional with a post-graduate degree in an agricultural discipline, with experience in teaching and training organization, who will be responsible for the programming and coordination of training activities and the reporting of results. The assistant training officer will be a professional with a B.S. degree in Agriculture and suitable experience. Those professional members of the Program who have both research and training responsibilities will also participate.

Appropriate secretarial support, transportation and operational budget will be provided. Funds are needed both for the training activities, travel and expenses of the instructors as well as for providing grants covering fees, travel, per diem and other expenses of trainees.

Training is provided at a non-degree level and also as part of the Graduate School in Agriculture (UCR/CATIE) Program.

At the non-degree level it takes the form of short courses, in-service training, seminars and workshops. The organization and timing of delivery is oriented to support, as needed, the different objectives specified for the outreach teams. Training needs therefore to be coordinated with the outreach activities at country level. The yearly planning and programming of training will be executed by the training officer, interacting with the outreach residents, under the supervision of the Outreach Coordinator and the Technical Coordinator.

Participation in the Graduate School includes teaching of key courses related to the research and approach used by the Program, as well as the orientation and financing of selected theses which support the Program's lines of work.

SUPPORT RESEARCH

The efficiency, success and progress of research at the area level depends on the availability of appropriate methodologies and a strong base of technological knowledge to support the team's applied research work.

The provision of methodologies and knowledge is needed particularly in important applied questions for which the country teams will not be able to find answers by themselves, without additional time and control of environmental conditions. The Support Research activities attempt to provide those answers and methodological backup.

OBJECTIVES

1. Study, and model for posterior purposeful manipulation, the relation of the characteristics and performance of cropping systems to the characteristics of the environment and the objectives of the cropping systems. This will improve the understanding of cropping system design and aid the extrapolation of results from site specific research for use in other areas.
2. Study and satisfy the requirements of multidisciplinary teams, working in cropping systems research for the development of crop production technology in specific areas. These teams will be used as prototypes

of the cropping systems research methodology. The methodology proposed by the Program will be regularly evaluated, tools will be adapted and the scientific backing necessary for efficient operation of the teams will be identified.

3. Provide answers to questions of broad relevance to cropping systems research that have resulted from the work of the teams at the sites, and that require more time and control than available to those teams.
4. Screen agricultural research knowledge and technologies produced by Universities and IARCs, and fit these to the mandate region.

The Support Research activities are oriented to include considerations of natural resources conservation, soil nutrient recycling, energy saving and production, and diversification of food production in limited resources farms. They are organized by two main criteria, ecological situations and principal cropping systems. The main ecological situations and production systems have been identified in the background information of this document.

PERSONNEL AND MANAGEMENT

The organization of the Support Research by ecological complexes and principal cropping systems requires the constitution of different research teams operating within the respective subregions. The different research priorities of these ecological complexes and their principal cropping systems make necessary the participation of different disciplines in the

different teams. Based on previous experience in the Program, support research teams should basically include these disciplines:

Semi Arid Tropics: soil-plant-water relations, cropping systems agronomy.

Lowland Humid Tropics: soil management, crop protection (phytopathology-entomology), crop management, and weed management.

Wet Dry Tropics: crop management (horticulture or agronomy), farm management.

Each support research team requires appropriate secretarial and administrative help and, at field level, assistance with transport and operational budget for field work, coordination, training and publication of results. One of the team members will act as leader and report to the Technical Coordinator who in turn will report to the Head of the Program. This connection will allow the teams to obtain the required scientific support available from the Program in other disciplines, as well as in data processing and laboratory services. It will also allow the coordination of Training and other support activities which these teams by ecological subregions provide to the national outreach teams.

At least one basic prototype team should be put in operation in each of the ecological situations in which the Program has a support research team. This will allow on-farm testing of component technology generated by the support team and access to existing production systems for problem specification. Each team will contain a crop manager (in agronomy or horticulture depending on the subregion), a plant protectionist and an agricultural economist.

SCIENTIFIC SUPPORT

For an on-farm research methodology to be applicable by national programs in the region, limitations in personnel, budget and management must be considered. This suggests a minimum size for multidisciplinary teams for field work and the inclusion of only the disciplines most necessary for the team's efficient work. Certain other disciplines will be needed only intermittently or can be offered by one professional serving several teams and will be provided by a back-up group of specialists, constituted in the Scientific Support Group of the Annual Crops Program.

OBJECTIVES

1. Provide specialized counselling and participation in team work planning and implementation when requested.
2. Provide specialized services to outreach teams and support to national entities. These include socioeconomics, genotype evaluation, laboratory services, data processing, soil analysis, documentation and literature abstracting.
3. Study, adapt and develop appropriate tools and methodologies for the field teams' work within each discipline.
4. Prepare specialized training and participate in training activities.

PERSONNEL AND MANAGEMENT

Many members needed in this group are already present in the Program due to needs already identified. Infrastructure, laboratories and equipment for some elements already exist within CATIE or in the national

institutions but need some strengthening and reorientation.

The disciplines needed, will include:

Soils and climate, socio-economics, agronomy and crop sciences, plant protection, data processing and scientific documentation.

Each division should include a minimum number of personnel and the necessary infrastructure and equipment required to support the work of the field teams. Some of the specialists listed will be included in support research teams and will be involved in both types of activities. Other specialists may be obtained through the hiring of consultants.

The orientation of scientific support activities is the responsibility of the Technical Coordinator in consultation with the Outreach Coordinator and the Training Officer.

REFERENCES

1. BANCO MUNDIAL. Investigación agronómica y servicios de asesoramiento al agricultor en América Central y Panamá, Oficina Regional de América Latina y El Caribe. Report. 2348-CA (mimeo) 1979, 105 p.
2. BENGTTSSON, B Rural Development Research the Role of Power Relations, SAREC report R4:1979, 89 p.
3. BRANDAO, A. Alternative Agricultural Development Models Commonly Advocated in Latin America, In: Rural Change: the Challenge for Agricultural Economists, Proceedings XVII International Conference of Agricultural Economists, GOWER 1981, p. 346-354.
4. CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA. A Farming System Research Approach for Small Farms of Central America, CATIE, Turrialba, Costa Rica, 1978, 25 p.
5. _____ . Cropping System Research in Semi-Arid Regions of Central America (a proposal), CATIE, Turrialba, Costa Rica 1978, 40 p.
6. _____ . Small Farmer Cropping System for Central America, Final Report, June 1975 - March 1979, Contract AID 596-153 (CATIE/ROCAP), Turrialba, Costa Rica 1979, 101 p.
7. CONSULTATIVE (THE) GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH TECHNICAL ADVISORY COMMITTEE. Farming Systems Research at the International Research Centers. World Bank, Washington D.C, 1978, 66 p. + annexes.
8. EVENSON, R.E., WAGGONER, P.E. and RUTTAN, V.W. Economic Benefits from Research: An Example from Agriculture. Science 205: 1101-1107, 1979.
9. HARRINGTON, L. Methodological Issues Facing Social Scientists in on-Farm/Farming Systems Research, report on a Workshop at CIMMYT, April 1-3 1980 (mimeo) 26 p.
10. INSTITUTO INTERAMERICANO DE COOPERACION AGRICOLA. Seminario sobre Investigación Agrícola de Centroamérica y Panamá, Informe No. 183 cursos y reuniones, Guatemala 1979. p. irr.
11. INTERNATIONAL RICE RESEARCH INSTITUTE. Symposium on Cropping Systems Research and Development for the Asian Rice Farmers, Los Baños, Philippines, 1977. 454 p.

12. NAVARRO, L. CATIE's Small Farmers Oriented Agricultural Research Effort in the Central American Isthmus. In:FAO consultation meeting on Natural Resources on Small Farms in the Caribbean Region, Kingston, Jamaica 1980, 22 p.
13. POWERS, R.C. Transfer of Agricultural Technology: Some Reflections on the U.S. Experience and the Convergence of Problems in Achieving Small Farmer Technology Transfer in the U.S. and Developing Countries (Draft); San José, Costa Rica 1977, 24 p.
14. RUTTAN, V. The International Centers of Agricultural Research and Modifications of Comparative Advantages. In:Seminario sobre los Aspectos Socio-económicos de la Investigación Agrícola en los países en Desarrollo, Santiago, Chile 1979. Sem- 07, 26 p.
15. SCHULTZ, T.W. Transforming Traditional Agriculture. Yale University, New Haven, 1964. 212 p.
16. _____ . Research in Rural Development. In:Seminario sobre los Aspectos Socioeconómicos de la Investigación Agrícola en los países en Desarrollo, Santiago, Chile 1979. Sem -01, 21 p.
17. SECRETARIA PERMANENTE DEL TRATADO GENERAL DE INTEGRACION ECONOMICA CENTROAMERICANA. Perspectivas para el Desarrollo y la Integración de la Agricultura en Centroamérica. Vol 1 and Vol 2 Guatemala 1974. 281 and 287 p.