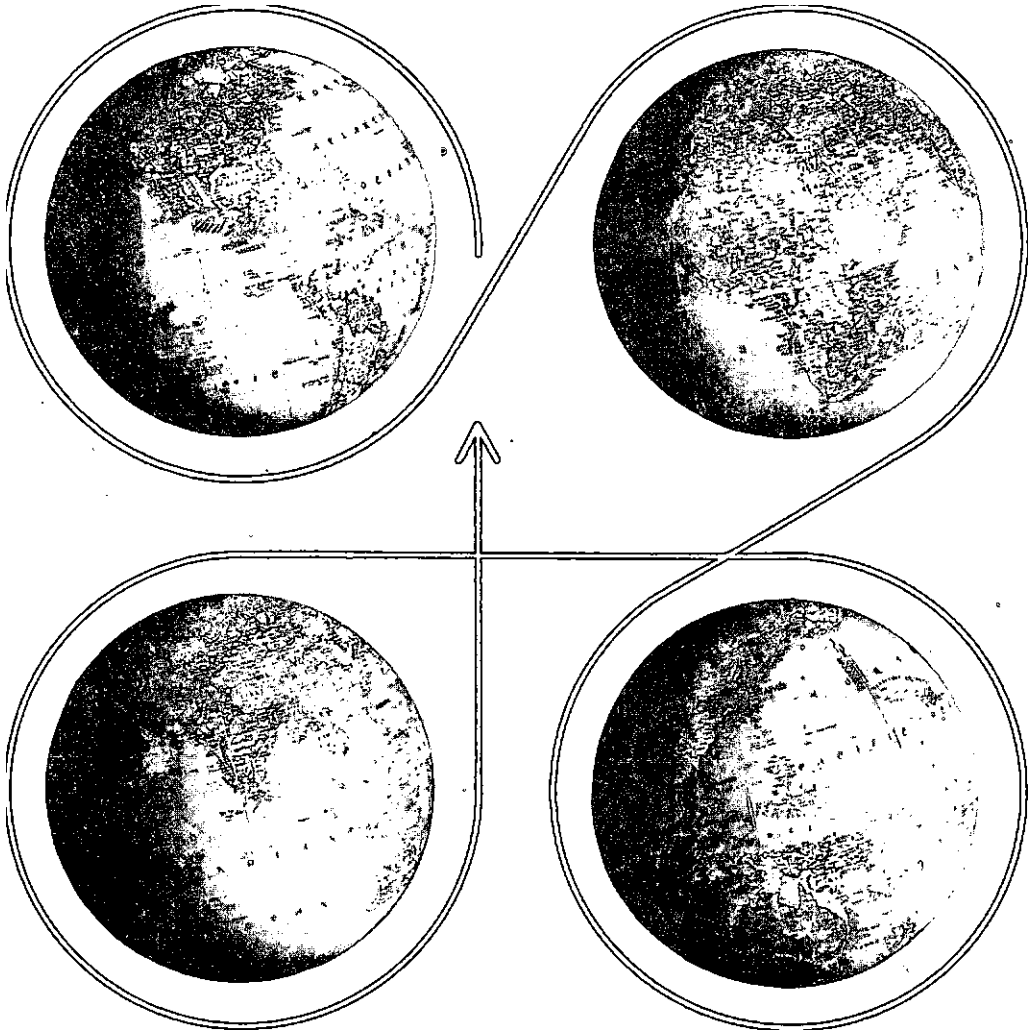
CORNELL INTERNATIONAL AGRICULTURE MIMEOGRAPH 85



ORGANIZATION OF AGRICULTURAL RESEARCH FOR THE BENEFIT OF SMALL FARMERS IN LATIN AMERICA

Enrique Ampuero

PROGRAM IN INTERNATIONAL AGRICULTURE
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York

May 1981

THE Program in International Agriculture publishes manuscripts resulting from international research and other activities of faculty and graduate students in the College of Agriculture and Life Sciences at Cornell University. A Bulletin Series and a Mimeograph Series include comprehensive and definitive topics relating to international agricultural and rural development. An annual Dissertation Abstract Series summarizes the Cornell Ph.D. theses concerned with agricultural and rural development abroad.

A list of topics published in these series may be obtained from the Program in International Agriculture, 252 Roberts Hall, Cornell University, Ithaca, New York 14853. Upon written request, educational, research and other public and private organizations will be placed on a mailing list to obtain future publications.

Single Copy Free
Additional Copies 25¢ Each

5/81 CU 1.2M

ORGANIZATION OF AGRICULTURAL RESEARCH FOR THE BENEFIT OF SMALL FARMERS IN LATIN AMERICA

by

Enrique Ampuero

Program in International Agriculture

New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York

May 1981

Forward and Acknowledgment

This is one of a series of three papers written by Dr. Enrique Ampuero, former Director General of the National Institute for Agricultural Research (INIAP) in Ecuador, during his sabbatical year at Cornell University. Dr. Ampuero served as a Visiting Professor of International Agriculture at Cornell from January - August 1980 under a Rockefeller Foundation fellowship award. Thanks are extended to both institutions for the support and encouragement given to the author during his program. His papers were translated from the original Spanish into English by Dr. Judith Lyman, Visiting Research Fellow, of the Rockefeller Foundation. Appreciation is expressed to her and to Dr. John A. Pino of the Rockefeller Foundation for the contribution of Dr. Lyman's time. Each paper is presented in both Spanish and English in order to assure a wide distribution of these documents.

The titles of the three papers are as follows:

"Organization of Agricultural Research for the Benefit of Small Farmers in Latin America," IA Mimeo #85.

"Organization and Administration of Experiment Stations in Developing Countries," IA Mimeo #86.

"Cooperation between National Research Organizations and International Centers: Opportunities and Limitations," IA Mimeo #87.

Dr. Ampuero is presently working with the Interamerican Development Bank in Washington, D.C.

ORGANIZATION OF AGRICULTURAL RESEARCH FOR THE BENEFIT OF SMALL FARMERS IN LATIN AMERICA

Enrique Ampuero*

Leaders of international institutions, governments, and people interested in agriculture are increasingly concerned about the need to augment agricultural production and food production, in particular, to meet the demand of the world population, which presently exceeds four billion people. It is estimated that the population will double by the year 2015 if the same growth rate is maintained. Probably not a single day passes on which a meeting is not held in an international forum or in an office of a Ministry of Agriculture or Planning to analyze the magnitude of the problem and to take initiatives leading to the solution of these difficulties.

Half the global population lives in rural areas, and in the developing countries the majority of the population is rural and agricultural, constituting 60 to 80% of the total population. Poverty and malnutrition are more severe in rural areas, and every year the number of individuals afflicted by hunger and despair increases. This situation is aggravated periodically by adverse climatic conditions such as droughts or floods in extensive areas or as a consequence of political disturbances. Children and lactating mothers make up the sector of the population always most vulnerable to these calamities.

In many countries, small traditional or subsistence farmers produce most of the basic foods. For example, in the highland zones of the central Andean region, small farmers cultivate quinoa, fava beans, ulluco (a traditional tuber), fresh and flour corn, field beans, squash, and okra. Cassava, sweet potato, plantain, snap beans, and certain tropical fruits are cultivated by small lowland farmers, who depend on the

*Ex-Director General of the National Institute for Agricultural Research, INIAP, of Ecuador. This article was written at Cornell University in 1980, during the author's sabbatic year as visiting professor in the International Agriculture and Rural Development program, with the support of the Rockefeller Foundation.

products for their subsistence and also supply the local market. Similar examples could be cited in reference to cereals, legumes, roots, and tubers.

The number of small farmers in the developing countries has been increasing because of the growth of the population and subdivisions of the family farming plots through inheritance. Another factor contributing to the fragmentation of agricultural lands is the land reform programs, which are often well-intentioned and designed to achieve a better distribution of the land in favor of poor peasants or those with precarious means of support. Nevertheless, peasants have frequently been given tiny plots of land, located in marginal areas, which offer no hope of alleviating their poverty or assuring their subsistence in the future.

Many developing countries in Latin America do not possess reserves of agricultural lands for expansion or have a limited capacity for expansion, such as in the case of the republics of El Salvador and Haiti. Those countries that have undeveloped land with agricultural potential require enormous financial resources for infrastructure such as roads, irrigation and drainage systems, electricity, and water for human consumption, among other important elements. These resources are not available in many countries. If they were obtained from outside sources, a long term would be required to complete the projects. Therefore, all these aspects should be considered in the planning of agricultural development policy.

For the reasons given, an increase in agricultural production in the short term in many developing countries should come principally from agricultural lands already cultivated but with low production levels. Many of these lands are situated in areas with adequate soil fertility and rainfall distribution patterns and should be exploited. In these areas, the small farmers practice a traditional system of subsistence farming, which is very complex and, unfortunately, little understood and ignored by political leaders involved in agricultural development.

To meet the needs of the people, the governments of developing countries must stimulate all groups of farmers at all levels. A special effort will be required to liberate the small farmers from the passive

state in which they are languishing. In many countries they compose the largest stratum of the population, and-, though they suffer from severe poverty, malnutrition, and social backwardness, nevertheless, contribute appreciably to the production of agricultural food commodities and products indispensable to those countries. Already mounting social tensions will be aggravated in many Latin-American countries if the welfare of the rural population, and of the small farmers in particular, is not improved.

Since the author of the present study has been involved in the development of agricultural research in Latin America, the discussion will be focused in this hemisphere. In particular, the author will describe the experiences in his native country, Ecuador, when, in 1977, the National Institute of Agricultural Research of Ecuador organized a research program in agricultural production for the benefit of the small farmers (1). Similar programs have been undertaken in other South and Central American countries with the goal of developing methodologies and strategies that permit the generation of alternative and appropriate technologies for the circumstances and needs of the small farmers. Some of these initiatives will be discussed in this article.

The Small Farmer

When the situation of small farmers is analyzed, the diverse characteristics and socioeconomic circumstances that typify them must be examined. In the most traditional form, the native of the American tropics or the peasant settler practices a system of slash-and-burn subsistence farming to cultivate cereals, edible roots and tubers, grain legumes, plantain, and fruits. This type of farmer produces very little surplus for sale or barter in the market because of the lack of roads. This farmer tends barnyard animals such as poultry, swine, and in some cases cattle as part of the means of subsistence of the family unit.

Another type of small farmer is the small landholder of the highlands of Central and South America, especially in the Andean zone, who practices an intensive system of agriculture generally during the rainy season, although in some cases irrigation may be employed. This farmer produces what is necessary to support the family and sometimes takes surpluses to the local market when the harvest has been good.

Another type of small, commercial farmer is found in the tropical lowlands. In addition to cultivating subsistence crops such as corn, beans, cassava, rice and plantain, he raises crops for the international market such as coffee, bananas, cacao or produces raw materials for the local agro-industry such as cotton, oil crops, and African palm. Usually animals such as cattle, swine, goats, and poultry constitute an important part of the production system.

Recently greater interest has been shown in understanding the production systems of small subsistence farmers. For this reason, more information is available concerning the complexity of their multiple-cropping systems, associated with animals and sometimes with forestry components. All these elements are integrated into a rationally balanced system for subsistence.

Many peasants live in marginal lands on mountain slopes or in semi-arid lowlands where low soil fertility and lack of water impose serious restrictions to their progress. A contrasting situation is that of small farmers who live in lowlands subject to flooding or with high rainfall. They have limited opportunities to achieve a level of intensive agriculture and depend on certain less-unfavorable periods of the year for planting and harvesting traditional tropical products such as rice, corn, cassava and plantain.

Given the diverse and complex conditions that confront the small farmer, the question arises concerning how the agricultural research institutions, with the limited resources of a developing country, can generate alternative technologies appropriate for the conditions and necessities of the different classes of farmers. On one hand, the needs must be met for the country's general agricultural production, which is provided by commercial farmers who produce for the market. These farmers need and demand technologies appropriate for their production systems. On the other hand, the production of basic agricultural foods and commodities comes from an important sector of the rural population, which has remained aloof from technological advances in agriculture, which has low rates of production, and which struggles in the midst of poverty and complex socioeconomic problems. Many of the alternative technologies developed by the research institutes are almost always appropriate for

the conditions of the large farmers, but do not give results in the circumstances of the small farmers. A double responsibility confronts the national research institutions. To respond to the objectives and goals of development indicated by their respective governments, these institutions should reorganize their resources and adjust their priorities to reflect the double responsibility.

In general, technology developed by the national research centers is used by the business sector with its greater access to the information and adequate economic resources. This sector is almost always the best organized, it shares or controls the political power of the country and exerts a continual pressure on the experimental stations. The traditional sector is forgotten by the state and stagnates alarmingly.

Organization of the National Research Institutions

There are various models of institutional organization for agricultural research in Latin-American countries. However, the most common one is the autonomous or semiautonomous, decentralized unit of the Ministry of Agriculture. Examples of this model are INIAP of Ecuador, INIA of Mexico, EMBRAPA of Brazil, INIA of Chile, and ICTA of Guatemala, among others. In these cases, the transfer of technology to the producers is the responsibility of other institutions under the Ministry of Agriculture.

Other research institutions are also responsible for agricultural extension, such as INTA of Argentina and the new research institutions of Honduras, Panama, and Bolivia. An exceptional case is the Colombian Agricultural Institute (Instituto Colombiano Agropecuario), which is also responsible for postgraduate training. The number of countries is constantly decreasing in which agricultural research is a direct dependency of the Ministry of Agriculture (Costa Rica, Venezuela, Paraguay, Nicaragua, San Salvador, etc.).

The decentralized model of agricultural research arose as a copy of the model used in developed countries, principally the U.S., as a means of avoiding local political intervention, possessing adequate and reliable resources, and, above all, training scientists and offering them career incentives. In the model copied, technology transfer is the responsibility of extension agencies and private agricultural organizations, which perform their role efficiently.

The pros and cons of each of the alternatives mentioned have been discussed at length in Latin America. Perhaps a greater tendency may be noted toward decentralized agricultural research institutions with a better understanding of the importance that the technology generation be integrated with the transfer of technology to the farmer. The author favors this position because of the obvious difficulties that arise in attempting to coordinate research with extension, when these functions are situated in different divisions or institutions of the agricultural sector.

Almost three decades have passed since the formal beginnings of agricultural research in Latin America. However, it may be concluded that the appropriate institutional model has not been determined. Observers of the evolution of agricultural research in Latin America blame the irregular support of the state in the early stages, followed by a period of institutional crisis in which funds are lacking or initial financial support is removed entirely. It is not the intent of the present article to analyze this interesting topic. Some research institutions are being criticized because their technological contributions are not being used by the majority of the producers, particularly the small ones, and the national production has not increased in those areas in which the institute is working.

The history of agricultural research in Latin America may well be short, with the majority of the research programs functioning irregularly for barely two decades and many of them still very young. Nevertheless, the present institutions must be evaluated, and their weak and strong points determined in the search for the most appropriate route for agricultural development in Latin America.

The subject areas for which a national research institution is responsible are diverse and complex. Some institutions are only responsible for crops, whereas others are in charge of animal science programs. In other institutions, both activities are found in the same organization. Generally, forestry research is carried out in a separate dependency of the Ministry of Agriculture or in an institute of forestry.

A general characteristic of many institutions is the organization of research by products, such as rice, potatoes, wheat, cacao, oil crops and cattle. Research is also carried out by disciplines, such as plant

pathology, entomology, agricultural engineering, soils, and agricultural economics. Research programs organized by-products are strongly oriented toward the genetic improvement of the plants, with occasional agronomic studies.

It is not unusual for an institution to have responsibilities not only for basic food products, but also for export products, which generate* revenue for the count

furnishing raw materials for local agro-industry (cotton, oil crops, and fruits). The supply of some of these products is short, and the government may wish to achieve self-sufficiency.

On other occasions, the research institution is required to establish a program for the development of new lands with agricultural potential, as in the case of the experimental stations located in the Amazon region.

The national research institutions must tend to a wide range of products grown by the large commercial farmers, either for the internal market or for export. These groups of large farmers generally wield political power, exert pressure on the central government, and demand attention from the research institution to products that interest them, to the disadvantage of the small farmers who produce basic food commodities for human consumption such as flour corn, cassava, sweet potato, plantain, beans, fresh corn, quinoa, barley, squash, and traditional fruits. Analysts of agricultural development in Latin America such as Crouch, Trigo, and Pineiro have indicated that agricultural research has tended to favor the dominant, large-farmer groups and that structural problems of the agricultural sector have impeded technological innovations favoring small and subsistence farmers.

Because of the limited availability of funds and the numbers of researchers needed to deal with a broad range of responsibilities, instead of directing their limited resources toward all sectors of producers, the research institutions many times yield to the continual demands of the commercial sector or to the priorities imposed by the government for self-sufficiency in certain crops. The dilution of resources among so many responsibilities has a negative effect on the efficiency of the institutions.

At times, it is unavoidable for the government to be interested solely in meeting total production needs in the face of an increasing

deficit in the balance of payments or continual demands by the urban sector. Then there is little opportunity, interest, or support for focusing the attention of the research institution on the problems of the small, traditional farmers. A policy decision by the national government to serve the needs of the small farmers is necessary. Though the institutions carry out research that may be useful to small farmers, such research is limited and often inappropriate for the actual circumstances of the farmers.

Limitations of the Traditional Structure

The most common strategy of a national research institution is to concentrate its efforts on research carried out at the experimental stations where there are laboratory and greenhouse facilities and experimental plots. Usually level land has been selected with adequate fertility, irrigation, drainage, and roads. This infrastructure allows the reduction of environmental variability and the management of genetic material under controlled conditions for carrying out sensitive experiments. Many stations carry out regional trials in the farmers' fields to study the behavior of genetic material under diverse agroecological conditions or to investigate specific regional problems. There is little participation by the farmers in this type of experiment. The researcher maintains almost total control of the experimental conditions from planting to harvest. Information resulting from these studies helps the scientist to make decisions in the advancement of a genetic program, the improvement of cultural practices, or the refinement of pest control methods, among other important aspects. Many of the regional trials are located on large farms since they have better facilities, and the risk of losing the trials is reduced.

Generally, experiments are designed to achieve maximum yields of a single crop, with a high level of inputs such as fertilizers, pesticides, and mechanized labor. Often the technology developed is applicable to a single crop or product. Problems arise when the attempt is made to transfer this technology to the small farmer with limited capital who uses few inputs. The production system of small farmers is very complex, since they usually practice multiple cropping with a broad range of variations and a system of rotation that usually involves animals. Nor

is it rare that tree species are included as a component of the system for use as a source of firewood or construction material. Some of these systems are described in the literature (2, 4). Nevertheless, most are little known or have not been described. Small farmers integrate all these components into stable systems, which are not intended to maximize the yield of the products per hectare, but to maximize total production of the plot, assure their subsistence, and decrease their risk. When possible they take any surplus to market.

Research and extension personnel are surprised and discouraged to note that small farmers do not adopt new technological recommendations and generally consider them ignorant, backward and resistant to change. The actual problem is not in the farmer but in the agricultural services, which attempt to introduce new technologies without understanding the conditions, circumstances, or needs of the traditional farmer. There is more and more evidence that small farmers are receptive to technological innovations that increase their income and respond to their needs. Such is the case of the native peasants who cultivate potatoes in the Andean highlands or produce vegetables for market.

The lack of coordination between researchers and extensionists, the degree of specialization of researchers, and their limited contact with farmers result in a marked failure to perceive the situation and needs of the small farmers.

Many research institutions do not have social science departments or only weak ones. As a result the researchers' lack of perception of the socioeconomic problems confronting the small farmer leads to technological recommendations that cannot be adapted to the farmer's conditions and needs.

Because the production systems of small farmers are complex, their resources limited, and their problems perhaps more serious than those of large farmers, multidisciplinary research teams, including social scientists and biological scientists, should be formed. This necessity has been recognized in several countries with the result that new efforts are being made to understand the production systems of the small farmers, to identify their limitations and problems, and to look for opportunities of helping them.

Experience Gained from the Green Revolution, the Puebla Project, and Other Sources

During the past decade, India, Pakistan, and Mexico achieved considerable increases in the production of wheat and rice with the use of improved, high-yielding varieties to which high rates of fertilizer could be applied in areas where water was not a limiting factor and irrigation was available. Geneticists of CIMMYT and IRRI, working with national scientists, produced widely adapted varieties, resistant to some diseases. Utilization of genetic material with these characteristics was extended to other countries in Asia and Latin America with great success, easing the shortage of food commodities in many critical areas of the world. The application of these technological innovations, products of agricultural research, to increase the production of food commodities has been called the Green Revolution.

In those areas in which dramatic yield increases were achieved, the governments acted determinedly to support the agricultural sector with incentive policies in prices, availability of inputs, and investments in infrastructure. There has been much criticism that the benefits of the Green Revolution favored the large farmers who possessed infrastructure for irrigation, who could afford to use high rates of fertilization, and who had immediate access to technological information. It has been shown that small farmers depending upon seasonal or rain-fed conditions have not received the benefits of the Green Revolution. It has also been said that the gap has widened between the welfare of the small farmers and the welfare of the large farmers who use the improved varieties. Finally, the scientists have been criticized for developing technologies that function under favorable conditions of irrigation and high levels of inputs, within the grasp of only the large farmers.

Unquestionably, the most appreciable increases in yield are obtained in areas with irrigation and where it has been possible to use high-yielding varieties with high rates of fertilization. When governments are confronted with a scarcity of food commodities and decide to increase production, they make decisions favoring the commercial farmer first to achieve self-sufficiency in the least possible time. These decisions are sometimes made independently of the governmental system. In the case of the Green Revolution undertaken by the People's Republic of China

to supply food for the population, the same dramatic increases in production were obtained in irrigated areas from improved varieties responding to intensive fertilization. At the same time, the necessary infrastructure was put into place.

Criticisms of the Green Revolution in its first years were undoubtedly exaggerated and lacked sufficient supporting information. Recent information compiled by the International Consultative Group (3) and the World Bank (9) clarifies the issue. Some evidence indicates that neither the size of the property nor the land tenure system is an impediment to the adoption of the new, improved varieties, and that the improved varieties are more productive than the traditional ones. The improved varieties and the technology for their management increase the demand for hand labor. The income of the small farmers increases in proportion to that of the large farmers. The low-income consumers were the ones who benefited most from the new technology. The nutritional benefit to the population resulting from the new varieties can be observed in localities that adopted the new technology as compared with those that did not.

Presently government authorities, international organizations, and national researchers are concerned about the need of the farmers who depend upon seasonal or rain-fed conditions to receive the benefits of science and technology necessary to improve their existence and to contribute to the development of their countries. Undoubtedly it will be a difficult task to achieve effective action on the part of the state to supply the necessary incentives such as appropriate infrastructure, for the production and marketing of commodities and on the part of agricultural research to focus its attention on the problems of the small producers and to supply adequate alternative technologies for their actual circumstances. To this end, other valuable experiences relating to small producers practicing a system of agriculture subject to the rainy season, such as the Puebla Project in Mexico, are mentioned.

This project was established by CIMMYT, in cooperation with national Mexican institutions, in an area of small landholders who practiced a traditional system of agriculture based on the cultivation of corn. The principal conclusions from these experiences can be summarized in the following points:

1. Small landholding farmers are receptive to technological change when it offers them the possibility of increasing their income. The technology previously developed by CIMMYT and INIA was not adequate for their actual circumstances, and for this reason the farmers resisted adopting it.
2. Traditional farmers are sensitive to factors in their environment and carefully examine the risk inherent in adopting or changing technology.
3. Credit and basic inputs such as fertilizers and pesticides must be available to the farmer. For this reason, the institutions responsible for these services must act in an efficient and timely manner.
4. The organization of the farmers is important for them to have better access to technological information and services; also, it gives the farmers the opportunity to call attention to their needs more forcefully.
5. The production systems of the farmer are complex and require understanding and attention of agricultural researchers to all components of the system, their interaction, and their relation to external factors influencing decision making.

Some of the methodological concepts developed in the Puebla Plan favoring the small farmer have been used in other Latin American countries such as Guatemala, Colombia, Honduras, and Ecuador.

Some countries are undertaking broader efforts with small subsistence farmers in integrated rural development in specific regions, with agricultural research, credit, and marketing all being part of the rural development scheme, as well as other important elements such as health and education (5).

Strategies for the Development of Appropriate Technologies for the Small Farmer

As indicated some Latin American institutions are developing programs for the benefit of the small farmer, such as ICTA of Guatemala, ICA in Colombia, and INIAP of Ecuador, among others. The strategies followed in these countries have some aspects in common and some differences. The case of Ecuador is analyzed in detail in this article. The author

took part in the organization of the research program in Ecuador from the beginning stages and participated in the responsibility of making institutional decisions.

Since the resources available to INIAP were limited, a loan was obtained from the Inter-American Development Bank to reinforce the research institute and to establish a production research program of benefit to the small farmers.

In 1977, during the initial phase of the Ecuadorian program, it was considered desirable to obtain experience with several production systems for important food commodities in which Ecuador was deficient or which had potential for expansion. It was also taken into account that INIAP had research results that could be used in the program. For this reason, corn, wheat, rice, potatoes, and dairy production systems were selected for study.

The next decision consisted in defining areas of work, according to the following criteria:

a) Production areas were selected in inter-Andean and tropical regions to obtain broad methodological information representative of other regions of the country.

b) Regions of low productivity that had the potential for improvement with the use of technological innovations and in which the small, traditional farmer predominated were selected. In addition, areas that had production systems based on the indicated crops were selected.

c) Regions of small farmers where certain communication facilities already existed and preferably in which the farmers belonged to some association were selected. The latter aspect was critical since the success of these projects must be based upon the active participation of the small farmers in all phases of the program, just as their opinions and needs must serve to orient the investigations.

Initially, it was decided to keep the size of the projects small, between 20,000 and 30,000 hectares, because of the limited resources and the desire to be able to change procedures.

The active participation of CIMMYT in terms of support and advice to INIAP should be mentioned. CIMMYT assigned an agricultural economist

to assist the production research program in the Andean region. In addition, corn and wheat breeders worked on the development of genetic material having better characteristics than the traditional varieties. It was agreed with CIMMYT that INIAP would facilitate the interchange of information with other countries in the Andean region. The Swiss government offered economic support for the corn project from the initial phase, and the government of Canada endowed funds for CIMMYT's regional program in cereal breeding.

Subsequent methodology included the following stages, as described in detail by Larrea and Moscardi (6).

1. Definition of work regions, taking into consideration uniform agroecological zones with well-adapted production systems. The borders of the regions were to be adjusted with information from surveys and trials.
2. Study of a representative sample of farmers from the agroecological zones to determine the agroeconomic conditions relevant to the increase of productivity.
3. Use of the information supplied by the sample, and in subsequent years by trials to evaluate desirable alternative technologies and to establish the range of conditions under which the trials would be conducted.
4. On-farm trials to obtain information on yields resulting from selected treatments at each stage of the project. The trials undertaken with corn and wheat were of three types: qualitative, quantitative, and verification of technologies. In the first type of trial, multifactorial experiments were carried out to determine adequate levels of inputs. In the verification experiments, information provided by other experiments was combined to formulate different alternatives for the farmer. This was a dynamic process based on trial and error, precisely that followed by the farmer, with the objective of formulating recommendations to improve the situation of the farmer.
5. Concurrent with the on-farm trials, studies on the market for inputs (agrichemicals, agricultural credit) and products (transport, prices) affecting the adoption of the recommended alternatives.

6. Economic evaluation of the alternative technologies, analysis of all date provided by the trials, surveys, and market studies.

The system began again at the first stage with each new production cycle. In this way, flexible technologies could be formulated with the necessary periodic adjustments in response to the circumstances of the farmers. A figure is attached which summarizes the methodology described.

During the development of the program it was necessary to make some changes, such as in the case of the rice project. A survey indicated that INIAP had technology available only for rice in irrigated areas, which accounted for a small percentage of the total rice-producing area; the majority of the farmers required technology for rainfed regions or floodplains. The rice breeding program established trials with genetic material appropriate for these conditions.

This project was established in an area of 30,000 hectares in the rice region around Samborondon in the province of Guayas, an area representative of the lowland floodplains of the Cuenca system of the Guayas River Basin. A total of 30,000 km may be suitable for development in the river basin. The land in this region has tremendous agricultural potential, which is poorly developed at the present because of heavy flooding in the rainy season and a lack of water in the dry season, since the water drains quickly to the streams and estuaries, finally flowing into the Pacific Ocean. The peasants transplant rice to this region when the water level descends sufficiently. Some water is retained in low areas called pozas or "pools," from which water can be pumped to the rice fields. Because of the closeness of the sea, salinity presents a problem. Generally, the small farmers can plant only once a year.

Since the initiation of the project by INIAP in 1977 (8), technical cooperation was obtained from IADS, as part of a contract held by that organization with the government of Ecuador. IADS assigned a rice production technician to the Samborondon project through financing from the World Bank and support from the Rockefeller Foundation.

To help rice cooperatives in the region, short-term priorities were established for the development of irrigation systems in the dry season and drainage in the flooding period, using existing infrastructure and simple pumps with high-volume turbines designed by the IADS technician,

Dr. Lloyd Johnson. These pumps are being made locally with funds provided by the Ministry of Agriculture. This example demonstrates that agricultural research programs can be reoriented to meet the immediate needs of the small farmers. They can take initiatives to promote rural development while the national government organizes its efforts. Unavoidably, governmental projects require time to mature.

INIAP participated in a project for small farmers called the Quimiag-Penique project in the province of Chimborazo. Here, a more detailed analysis was made of the socioeconomic conditions of the farmers and family unit, and also of the external forces which influence their behavior in the decision-making process. In cooperation with technicians from the Ministry of Agriculture and IICA (7), INIAP and Cornell University have carried out agronomic studies to improve production systems of the peasants.

Requirements of the Production Research Program

Since the beginning of the program, the direct participation of the small farmer has been important. The small farmer takes part in the whole process, from the experimental trials of production components and levels to the verification of alternative technologies, in which the system used by the farmer is one of the treatments. The farmers must give their opinions on the appropriateness of the alternatives developed and provide suggestions for the next series of experiments based upon their needs.

Another important element has been the participation of the extensionists from the beginning of the program in surveys, execution of experiments, analysis of results, and planning of the next experiments. In this way a level of confidence and respect is established between the researcher, the extensionist, and the farmer. Many of the problems stemming from a lack of coordination between the researcher and the extensionist are due to lack of confidence and professional jealousy.

The Ministry of Agriculture of Ecuador has responded adequately in terms of support for the programs since the beginning stages and has assigned full-time extension personnel to work with the researchers with initial supervision by INIAP. This decision by the Ministry of Agriculture represented a far-reaching step in the search for adequate mechanisms for institutional coordination.

Problems Arising During the Development of a Research Program for Small Farmers

During the initial phase of the program, frequent meetings are necessary with the heads of programs and researchers to analyze the objectives, goals, strategies, and responsibilities of the personnel. Some researchers have a negative attitude toward participation in production research programs, because of their preference for the work traditionally carried out at the experiment station. To attain the required level of understanding, frequent seminars and meetings of personnel are needed. The steady interest and participation of the directors of the institution at all levels is of great importance for the success of the program, since all possible support is required by the central and regional administration and experiment stations. The coordination and integration of the agricultural and social scientists in this type of program is another problem to be resolved, since these scientists have not been accustomed to work together with a multidisciplinary focus. The economists should reorient their activities to production aspects and establish close contact with the researchers, farmers, and extensionists. Extension personnel may also demonstrate a jealous attitude at the beginning of the program. For this reason it is important that the group as a whole analyze the objectives and projections of the program, which in essence include the following:

a) Reorganization of agricultural research to develop alternative technologies that help the small farmers to improve their income, nutrition, and general welfare, with a contribution toward increased total production of basic food commodities being made at the same time.

b) Reorientation of research toward closer contact with the farmers and with public sector institutions to better understand the needs and problems of the farmer and to respond more knowledgeably to the needs of the country.

c) Establishment of mechanisms of interinstitutional coordination and action, principally with the Ministry of Agriculture, and elimination of barriers preventing the coordination of collaborative field projects.

d) Finally, development of methodology for the generation, transfer, and adoption of technology that can be used on a national scale.

Training

From the beginning of the program it was noted that the INIAP scientists tended to establish complicated experiments with many variables and levels for each component in the study, following traditional research methodology employed at the experiment stations. It was also evident that the researchers were not trained to identify nonbiological constraints on the small farmers. For this reason, training courses were set up for technicians in production research to provide them with skills like the following:

1. Identification of biological and economic restrictions and limitations affecting the small farmers.
2. Training in basic production systems in which the technicians carry out all phases of the cultivation practices.
3. Training in basic agricultural research methodology, principally in experimental design and on-farm execution for verification of technology.
4. Methodology for economic analysis of experimental data to formulate alternatives.
5. Principles of market analysis, production costs, investments, etc.
6. Basic communication techniques.

INIAP researchers and extensionists from the Ministry of Agriculture were selected for these courses. Later, technicians specializing in credit, marketing, and irrigation were included, among others. The courses ran for the duration of a complete crop cycle. In the case of crops such as flour corn of the inter-Andean region, which requires nine months until harvest, the participants were brought together during four important phases of cultivation from planting until harvest. The participants were required to carry out all the tasks of cultivation. The classes were organized so that no more than 20% of the time was spend on theory and 80% of the time was devoted to the experiments in the farmers' fields. CIMMYT has been participating actively in the production courses dealing with the cultivation of corn.

Following the termination of the experiments, the participants analyzed the results and organized field days for the farmers of the region. This exercise gave them practice for future extension activities. Based on these experiences, some young professionals made plans for future postgraduate training in production research.

The content of advanced training programs in production research should be carefully analyzed. Technicians should receive broad agronomic training, permitting them to recognize biological constraints to increased yields and to carry out the necessary research to solve the problems. In addition, the production technician should receive training in some principles of the social sciences, such as economic analysis of agronomic data, marketing principles, production cost analysis, and principles of agricultural communication. The organization of postgraduate training will require cooperation between an international institution and a national institution in Latin America.

The Need to Institutionalize the Program

From the beginning it was evident that it was not possible to operate the project under the direct responsibility of the crop programs, either because of limited personnel or because of a lack of understanding of the essential requirements for an activity of this sort. Most importantly, the traditional organization of divisions by products or disciplines did not fit the production research needs of the small farmers. Although the traditional strategy works well in the development of specific technologies, it does not succeed when the components of complex production systems must be integrated, as in the case of multiple or associated crops such as corn and beans, root crops, cereals, and animals, as well. For this reason, INIAP decided to establish a special research program in production with its own personnel who had received the training described. The need arose to establish coordination and liaison with the research programs of the experiment station. ICTA of Guatemala also established an agroeconomic unit of a multidisciplinary nature to work with the small farmers, as did ICA of Colombia, among other Latin American institutions.

According to INIAP the production researchers should live in the region selected for the project so that the technicians could establish closer contact with the farmers and with the community and, above all, so that they could obtain a better perception of the problems and needs. A special incentive system with a bonus in salary according to geographic location, living expenses, and the opportunity for postgraduate studies after 2 or 3 years of service was developed. The response of the young personnel to the program was very favorable. Regular visits and consultations with the personnel of the experiment station, as well as frequent visits of the researchers to the production regions, were organized.

Institutions of the public sector reacted favorably to the program and frequently requested INIAP to designate technicians in production research for other regions in the country, especially for rural development projects underway or for new projects to be initiated.

Implications for the National Research Institution

Upon the initiation of a production research program focusing on the small farmer, various issues with important implications for the organization of the research arise.

1. A continuous system for the feedback of information to the central research programs is established to indicate to the center whether the technology being developed by the breeders and the agronomists is relevant to the needs of the small farmers. New research is required to solve the problems of the small producers different from those of the more-favored large farmers. Initially in the project, the need for early corn varieties stood out. These varieties were essential for the semiarid regions of Manabi in the Ecuadorian tropics and for areas with long dry periods in the highlands, since the traditional long-cycle varieties have demanding production requirements. The necessity arose for corn varieties with stiff stalks, which would perform well in association with beans and would support the weight of the crop at harvest. Some improved corn varieties developed by INIAP were rejected because they would not support the weight of the beans. The international centers were also requested to develop corn

genotypes adequate for association, a mechanism of information exchange being established with the international centers. The corn and bean varieties grown by the small farmer associate well, but productivity is low. Improved varieties would be of use to the farmer. Short-cycle varieties would permit the introduction of another crop such as peas, thereby increasing the income of the farmers and improving their nutrition. INIAP and CIMMYT researchers also noted the necessity for the development of genetic material resistant to ear rots and insect damage in flour corn varieties of the Andean region. Losses at harvest due to these problems were considerable and, in some regions, were so alarming that little corn was left to nourish the peasant family.

Another example of the feedback effect arose in the rice project area, since INIAP lacked varieties adapted for uphill, rainfed areas and for the floodplains where the majority of the small farmers live. In Ecuador, the largest part of the rice produced comes from rainfed areas without irrigation. The needs of rice farmers working under seasonal or rainfed conditions had not received enough attention from the international research institutions, and therefore, appropriate technology was not available.

The examples cited indicate the beneficial effect of a production research program for small farmers when an efficient feedback mechanism is established to reorient research.

2. The social unit of the institution must be strengthened to integrate multidisciplinary teams that can identify the problems of the producer; assist in research planning; participate in the execution, analysis, and interpretation of the results; and finally, help to elaborate alternative technologies that contribute to the betterment of the productivity and welfare of the peasants.
3. A research program in production demands a better balance between the amount of research done by the experiment station (including regional trials) and on-farm production research. The latter requires a greater number of field experiments.

4. The research institute must review its overall assignment of human and physical resources to fill the requirements of the production program. For example, the research program must cover high-priority food crops, such as quinoa, cereals, fava beans, root crops, grain legumes, vegetables, and fruits. Or, new research programs relevant to the small farmer must be initiated, including animal science projects, the development of small, agricultural machinery, simple storage systems, minimal tillage methods, etc.
5. The station must carry out research in multiple or associated cropping systems including animals to establish the best combinations that optimize productivity, decrease risk, improve the nutrition of the peasant family, increase the farmers' income and their capacity to participate in the market and reduce the erosion of their land.
6. Through a production research program, a substantial number of professionals achieve a better understanding of the problems and needs of the producers and become capable of generating and disseminating alternative technologies for the improvement of the productivity and welfare of the rural family. The production research program establishes mutual respect and trust between the researchers and extensionists working in the field. The system permits the formation of a stable and integrated system based upon field work. Subsequently, the program can be broadened to include courses, and new production projects in other regions until the entire country is covered. The research institute must carry out some follow-up activities to support the extensionists. If the initial efforts to establish a production program involving the farmer and the extensionist are not strengthened and consolidated, new frustrations may only widen the technological gap.

One aspect of the program subject to differing opinions is the nature of the field trials. Some favor the establishment of trials with limited inputs from the farmer, in which increased productivity would be brought about by gradual improvements in some of the components of the production

systems. The experiments are designed with minimal use of inputs and with small variations in the traditional systems.

Others maintain that field trials carried out by the research institute should encompass all the alternatives that could increase yields and improve agricultural productivity by increasing the efficiency of the technological components and eliminating biological constraints. The author favors the second approach.

Resources limiting to the farmer at any given moment can change over time because of new incentives in agricultural policy; alternative technologies generated through agricultural research would have to be disseminated to respond to the situation. Once alternative technologies adapted and appropriate for each locality are available, the extensionists can press forward with the technological innovations within the recommended agroeconomic boundaries. These technologies provide the necessary base from which the government can initiate a production campaign in food commodities or other basic agricultural products in short supply.

Implications for the Government

The development of new, alternative technologies through research can contribute decisively to the improvement of agricultural productivity, income and nutrition for the population, and to its welfare in general. However, without complementary actions on the part of the government in its areas of responsibility, the desired benefits cannot be achieved. These actions are the following:

1. Far-reaching political decisions in favor of the rural population of the country, increased investments in irrigation and drainage, secondary roads to facilitate the movement of harvested crops to the market and link isolated rural populations to the urban centers. Investments must be increased for electrification, water for human consumption, sanitation, and the expansion and improvement of basic community services, especially in health and education. These decisions will require great political courage to balance or invert priorities presently favoring the urban sector because of its greater political influence.

2. Establishment of incentive policies favoring rural production with regard to –
   a) Adequate price policies assuring a fair return to producers, covering production costs and providing reasonable profits to meet their needs. Announcement of the new price policies should be made before planting time, so that farmers are aware of them and can make their decisions in time.
   b) Regulation of marketing and trade to support farmers who sell their products at the guaranteed prices. Distortions of the marketing system should be corrected since the intermediaries often obtain 30 to 60% of the profits, should go to the producer or to benefit the consumer. The government will probably have to increase storage facilities to stabilize the market.
3. Provision of inputs basic to the farmer, such as seeds of the new varieties in sufficient quality and quantity, fertilizers, and pesticides, in the production centers. Generally, the small farmer does not have access to the required inputs in the production centers. The availability of seed and fertilizer is limited and expensive. The availability of credit to small farmers must be increased to free them from the grasp of intermediate agents who charge usurious rates of interest and pay low prices for the farmers' products, taking advantage of the farmers' need to survive. Also, excessive bureaucratic regulations, which are incomprehensible to the small farmer, should be eliminated, since they impede the transaction, add to its cost, and alienate the farmer from the benefits of the state bank services.
4. Definition of agrarian reform policies and acceleration of the process to correct social injustices. Title to the land should be given to the peasants so that they are eligible for credit and can gain control of their own destinies. Above all, the state must not become the new landholder in Latin America, the peasant being made just another wage earner who has changed

employers. Technical assistance, credit, and marketing services should be included in regional agrarian reform programs.

5. Encouragement of the peasants to organize cooperatives or to strengthen the traditional communal system or any other type of association that permits them to improve their agricultural efficiency and to avail themselves of government services. The association should facilitate their participation in the decision-making process for agrarian policies that affect them, especially those concerning research priorities, technical assistance, and all rural development issues. Generally, planning in the national organizations is done in the name of and in favor of farmers, but without their participation and without adequate understanding of their problems, goals, and needs. Planning handed down from above without the required perception of the rural reality leads to many failures and wasted resources and does not alleviate the stagnation of the rural sector.

Closing Remarks

The task of increasing agricultural production to meet the needs of the country, as well as to improve the situation of the small farmers, requires an important policy decision on the part of the national government and its executive branches, since it involves reorienting human and financial resources of the small producers in the rural areas. A government may decide to attend simultaneously to the needs of a whole region or the whole country, establishing a special organization in the Ministry of Agriculture. An alternative is to select specific rural areas in which to accelerate agricultural production for the benefit of the small farmers. Many integrated rural development projects, in which agricultural research is one of the important components, have been started in various countries. It is intended that research be linked with other elements of agricultural development such as credit, technical assistance, provision of inputs, and marketing. Furthermore, some countries have broadened the scope of integrated rural development with additional elements such as health, education, roads, and other types of infrastructure. The nature of these integrated rural development projects makes them much more difficult to administer. Whatever the type of

project, agricultural research should be a vital component in agricultural and rural development. It may be preferable for these projects to begin on a small scale, which is more easily managed and administered, than on a large, complex scale, the reason being the complexity of coordinating multiinstitutional integration in a specific area, either because of limited resources or because of institutional jealousies in certain cases. Perhaps the most important reason is that it is difficult even to design adequate rural development models for multiinstitutional or multisectorial organization. This organization should be aimed not only at activities in the selected region, but also toward integration with the national institutional mechanism at high levels of the public administration. If these institutions are not able to work collaboratively, agricultural research by itself, as efficient as it may be, cannot promote agricultural development. The generation of technology will go on without its adequate exploitation in Latin America, in spite of the apparent needs of the farmers.

Although agricultural research can certainly help improve the nutrition of the small subsistence farmers in marginal areas, other state dependencies should make the greatest effort to create nonagricultural employment opportunities favoring marginal groups in the rural sector. Jobs could be created in public works (roads, housing, and other civil construction), irrigation and drainage projects, agroindustries, crafts, and light manufacturing industries, among other activities.

Undoubtedly the best opportunity for agricultural research is found in the extensive rain-fed areas where the small farmers practice seasonal agriculture. These lands are relatively fertile; consequently, there is a great potential for increasing agricultural productivity and thus improving the welfare of the farmer and meeting the total food requirements of the country.

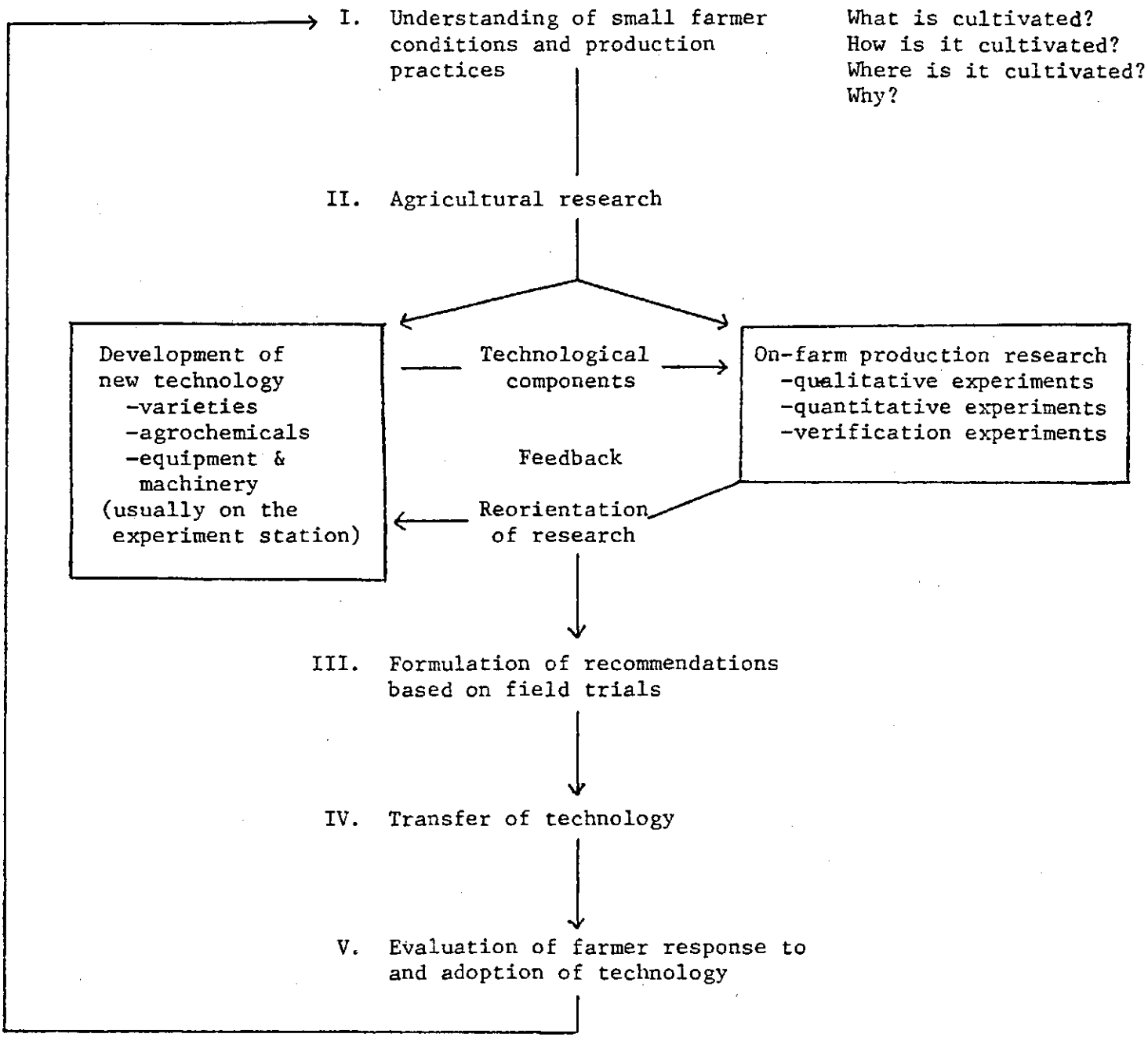
Undeniably rain-fed or seasonal agriculture has high risks due to changing climatic conditions. Generally, only one harvest can be made per year, except where residual moisture makes a second, short-season crop possible. The construction of irrigation and drainage systems would enable the small farmers to cultivate two crops per year and would reduce the risks of losing the harvests.

It is not an easy task to reach these goals. It will be a difficult challenge for agricultural research and for the state institutions, requiring important decisions with great political implications.

Strategies applied in developing countries to increase agricultural production are of limited use because of institutional inadequacies in the agricultural sector and complex socioeconomic problems affecting the small farmers. Each country must develop its own strategies, perhaps requiring new agricultural policies to accelerate production and, above all, to benefit the small farmer. The strategy described in the present article represents a step forward and an additional alternative in the search for institutional strategies.

The present situation of extreme poverty and despair of the rural sector, scarcity of food, continual importation, and social tension in the urban areas due to peasant immigration does not presage an encouraging future for political stability in the developing countries; nor does it help establish a solid basis for a society in which equal opportunities are offered to all citizens.

Figure 1. Research Procedures for the Generation of Alternative Technologies.



LITERATURE CITED"

1. Ampuero, E. 1979. Filosofia, politicas, objetivas, prioridades, estrategias y perspectivas de la investigation agropecuaria del INIAP (Philosophy, policy, objectives, priorities, strategies, and perspectives of the agricultural research of INIAP). Instituto Nacional de Investigaciones Agropecuarias, Ecuador. Miscellaneous publication no. 39, August, 1979.

2. CATIE-ONU. 1979. Workshop on Agro-forestry Systems in Latin America.

3. C.G.I.A.R. 1978. Integrative Report. Washington, D.C.

A. I.C.R.A.F. 1979. International Conference on Agro-Forestry. Nairobi, Kenya.

5. International Agricultural Development Service. 1979. Workshop on Defined Area Projects: Implications for National Agricultural Research Systems. Bellagio, Italy.

6. Larrea, P., and E. Moscardi. 1977. Proyecto de organizacion para el funcionamiento de los programas de investigacion en produccion del INIAP (Organizational plan for the operation of production research programs in INIAP). Internal Communication. Ecuador.

7. Ministry of Agriculture - IICA. (Simon Bolivar Fund.) 1979. Proyecto integrado de desarrollo agropecuario Quimiag-Penipe, sistemas y tecnologia de produccion del pequerio agricultor. (Systems and technology of small farmer production. Integrated agricultural development project Quimiag-Penipe.) Ecuador.

8. Ministry of Agriculture. Proyecto integrado de desarrollo agropecuario Samborondon. Informe de la unidad ejecutora. (Report of the executive unit on Samborondon integrated agricultural development project.) Ecuador.

9. Scobie, G. 1979. Investment in International Research. Some Economic Dimensions. Consulting Report. The World Bank, Washington, D.C.

Only those parts in Spanish were translated.

BIBLIOGRAPHY

1. Consultative Group on International Agricultural Research, Technical Advisory Committee, Farming Systems Research at the International Agricultural Research Centers, 1978.

2. Crouch, L. and De Janvry, "The Class Basis of Agriculture Growth," Food Policy, February 1980.

3. Falcon, Q. P., "The Green Revolution: Generation of Problems," American Journal of Agricultural Economics, 52: 698-710, 1970.

A. Harwood, R. H., Small Farming Development: Understanding and Improving Farming Systems in the Humid Tropics (Westview Press, 1979), 160 pp.

5. Hildebrand, P. E., "Generating Technology for Traditional Farmers: the Guatemala Experience," Instituto de Ciencia y Tecnologia Agricola, Guatemala. Articulo presentado en "Symposium on Socio-Economic Constraints to Crop Production" in International Congress of Plant Protection (Washington, D.C, 1979).

6. Instituto de Ciencia y Tecnologia Agricolas, Un Sistema Tecnologico Agricola (Guatemala, No. 26, 1977).

7. International Agricultural Development Service, Workshop on Defined-Area Projects: Implications for National Agricultural Research Systems (Bellagio, Italy: 1979).

8. Kass, D. C. L., "Polyculture Cropping Systems," Cornell International Agriculture Bulletin, 32: 69, 1978.

9. Laird, R. J., Investigacion Agronomica para el Desarrollo de la Agricultura Tradicional (Colegio de Post-Graduados, Chapingo, Mexico, 1977), 175 pp.

10. Mayer, E. y C. Fonseca, Sistemas Agrarios en la Cuenca del Rio Canete (Lima, Peru: Universidad Catolica, 1979).

11. McDowell, R. E. and P. E. Hildebrand (eds.), Integrated Crop and Animal Production: Making the Most of Resource Available to Small Farms in Developing Countries (Bellagio, Italy: The Rockefeller Foundation, 1980), 78 pp.

12. Moreno, R., R. Bazan, N. Mateo y J. Soria, Un programa de investigacion en sistemas de agricultura para pequenos productores (Turrialba, Costa Rica: Centro Agronomica Tropical de Investigacion y Ensenanza, 1975).

13. Navarro, L. A., Dealing with Risk and Uncertainty in Crop Production: A Lesson from Small Farmers (Costa Rica: CATIE, 1977), 27 pp.

14. Norman, D. W., "The Farming System Approach: Relevancy for the Small Farmer," Michigan State University, Rural Development Paper No. 5, 1980.

15. Perrin, R. K., D. L. Wlnkelman, E. R. Moscardi and J. R. Anderson "From Agronomic Data to Farmers Recommendations: An Economic Training Manual," CIMMYT Information Bulletin No. 25, 1976, 51 pp.

16. Perrin, R. K. and .D. Winkelman, "Impediments to Technical Progress on Small Versus Large Farms," American Journal of Agricultural Economics 58(5), 1976, 11 pp.

17. Pineiro, M. y E. J. Trigo, "Planificacion de la investigacion agricola a partir de programas por productos: algunos comentarios criticos," Informe Tecnico No. 39, ICA, Colombia, 1977, 41 pp.

18. Stevens, R. D. (ed.), Tradition and Dynamics in Small Farm Agriculture (Ames: The Iowa State University Press, 1977), 266 pp.

19. Streeter, C. P. "Reaching the Developing World's Small Farmers," The Rockefeller Foundation Working Papers, 1975, 48 pp.

20. Trigo, E. J., M. Pineiro y J. Ardilav, "Modelos de generacion tecnologica en America Latina: notas para una evaluacion critica," Desarrollo Rural de las Americas 11(2): 85-100, 1979.

21. Valdez, A., G. M. Scobie and J. L. Dillon (eds.), Economics and the Design of Small Farmer Technology (Ames: Iowa State University Press, 1978).

22. Winkelman, D. L., "La adopcion de la nueva tecnologia de maiz en el plan puebla," CIMMYT, Mexico, 1976, 27 pp.

23. Winkelman, D. L. and E. Moscardi, "Aiming Agricultural Research at the Needs of Farmers," CIMMYT, Mexico. Trabajo presentado en el seminario "Socioeconomic Aspects of Agricultural Research in Developing Countries," Santiago, Chile, 1979, 11 pp.

24. Whyte, W. F., "Toward a New Strategy for Research and Development Agriculture: Helping Small Farmers in Developing Countries," Desarrollo Rural en Las Americas 9.(12): 51-61, 1977.

25. Zandstra, H., K. Swanbert, C. Zulberty and B. Nestel, Caqueza: Experiencias en Desarrollo Rural (Ottawa, Canada: International Development Research Center, 1978), 386 pp.