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Issues in Organization and Management of Research with a Farming Systems Perspective Aimed at Technology Generation

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Acronyms

CATIE	Tropical Agricultural Research and Training Center (Centro Agronómico Tropical de Investigación y Enseñanza)
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center (Centro Internacional de Mejoramiento de Maiz y Trigo)
FSR/OFR	Farming Systems Research/On-Farm Research
IAR/ABU	Institute of Agricultural Research/Ahmadu Bello University
IARC	International Agricultural Research Center
IBRD	International Bank for Reconstruction and Development (World Bank)
ICRA	International Course for Development Oriented Research in Agriculture
ICTA	Agricultural Science and Technology Institute (Instituto de Ciencia y Tecnología Agrícolas)
IDIAP	Agricultural Research Institute of Panama (Instituto de Investigación Agropecuaria de Panamá)
INIAP	National Institute for Agricultural Research(Instituto Nacional de Investigación Agropecuaria)
ISNAR	International Service for National Agricultural Research

1. Introduction

This workshop was cosponsored by the International Service for National Agricultural Research (ISNAR) and International Maize and Wheat Improvement Center (CIMMYT). The small work group met from September 27-30, 1983, at ISNAR's headquarters in The Hague, Netherlands.

The idea for the workshop came from CIMMYT, which felt that enough countries had had sufficient experience with Farming Systems Research/On-Farm Research (FSR/OFR) to justify comparative stock taking. The aim was not the refinement of methodologies for carrying out Farming Systems Research, rather it was to see if reliable and generalizable principles in organization and management of FSR existed that could be recommended elsewhere. ISNAR's immediate interest in seeing that the workshop took place is understandable since ISNAR's primary objective is to help improve a national agricultural research system so that it can better plan, organize, carry out, and evaluate agricultural research, using its own human, natural, and financial resources.

Farming Systems Research has meant different things to different people at various times. These differences still exist, though perhaps not with the same severity. A CGIAR study in 1978 noted differences in approach to FSR between IARCs, and the terms of reference of a recently commissioned state-of-the-art report on FSR by the World Bank refers to the need for "definitions of farming systems research as commonly used by those dealing with the topic."

To maximize the usefulness of what was intended to be a small group, the themes to be investigated were carefully delineated in the precise, though perhaps less than elegant, title of the workshop. It was clear from the beginning that a small workshop could not be expected to raise – much less adequately answer – all the legitimate questions within its restricted terms of reference. A conscious decision was made to select presentations from organizations that carried out "research with farming systems perspective aimed at technology generation" using a broadly similar set of methodologies. The agricultural research systems involved were sufficiently dissimilar in their history, the moment, and degree to which they emphasized farming systems, to suggest the possibility of developing some insights into how best to incorporate a farming systems perspective in national agricultural research organizations.

Detailed presentations were made by Dr. G. Paez on the Tropical Agricultural Research and Training Center (CATIE) in Costa Rica, Dr. G. Abalu on experiences from Nigeria, Dr. R. Tarte on experiences in Panama, Dr. A. Fumagalli on the Agricultural Science and Technology Institute (ICTA), Guatemala, and Dr. J. Delgado on experiences in Ecuador. Dr. W. Chibasa was expected to present a report on the experience of Zambia but found at the last minute that he could not attend. Dr. D. Winkelmann of CIMMYT, an IARC which has been significantly involved in FSR/OFR in Latin America and Africa, also made a presentation.

Since significant sums of money have been invested over the past 10 years in FSR or in agricultural/rural development projects with an FSR component, the organizers felt it would be worthwhile to learn what the donor community and international development organizations had to say concerning their experiences and projected plans. Dr. J. Coulter of the IBRD agreed to make a presentation, and Dr. H. Davis attended on behalf of USAID. Also present were Dr. J. Mieman and R. Waugh, University of Florida, both of whom had extensive experience in Latin America. Dr. J. R. Poulain of the Centre National d'Enseignement et de Recherches Agronomiques des Régions Chaudes (CNEARC), Montpellier, France, and Dr. M. Wessel, Director, International Center for Development Oriented Research in Agriculture (ICRA), Wageningen, The Netherlands, were also invited and participated actively in the deliberations.

In developing countries, agricultural research was

carried on, less well supported than in developed countries, but still quite in evidence. Researchers, often trained in developed countries, looked to developed country institutions, especially those in the public sector, for research models.

Results were not, however, so dramatic, except in the plantation/export crops. There were, of course, major impediments to progress in agriculture in developing countries – inadequate infrastructure, inappropriate policies, insufficient capital in the agricultural sector itself – but there was a growing impression that the research, as revealed through farmer reactions to recommendations, was somehow not right, that it could be improved.

Various improvements were suggested and implemented – e.g., larger staff, more graduate training, larger investment in experiment stations, more emphasis on commodity research – but the results, measured through increases in productivity, still did not meet expectations. There were some notable exceptions, such as the rapid diffusion of new rice and wheat varieties, but these only added to the consternation as they gave ample evidence of the farmer's willingness to make changes when recommended technologies were appropriate to his needs.

The challenge became how to make the research apparatus more effective. A major response to that challenge is the current emphasis on reorienting research towards the needs of representative farmers. Beyond that, many argue that meeting those needs will require more attention to the systems of production which farmers operate.

Farming Systems and Technology Generation

Systems as the organizing unit for analysis have long been recognized in biology, ecology, and economics, and a substantial systems literature has developed since the 1920s. At the root of systems are interactions. Indeed, a system can be defined as an "aggregation or assemblage of objects joined in regular interaction or interdependence" (Webster's Second International Dictionary). With interactions, the whole is more or less than the sum of its parts. There are reports of research on technology based on systems in the 1920s and 1930s, with growing numbers in the 1950s and 1960s. Treating interactions is not a new idea.

What is only recently becoming evident, however, is the overriding importance of such interactions for representative farmers of developing countries, especially in subtropical and tropical regions, as compared with their role in developed country, temperate agriculture.

One recent paper (Byerlee, et al.) holds that the importance of interactions increases as two or more crops per year are possible; risk increases in importance, marketing margins widen, the opportunity cost of labor diminishes, and farmer-held resources are more heterogeneous. These considerations lead to complexity in the analysis of farming systems, increasing the importance of interactions. They are, moreover, among the prominent characteristics of representative farmers in the tropics and subtropics, hence the crucial importance of interactions in research on technology generation. Beyond that, and especially relevant to this workshop, attention to such interaction has significant implications for the organization and management of research on technology generation.

It is this view of the importance of interactions that sustains the growing emphasis being given to the system perspective – a perspective whose essence is to be mindful of interactions – in research aimed at technology generation. The importance of these interactions, along with such other considerations as the limited information available to researchers and the often vast differences between research station and representative farmer circumstances, support the need for a modified modus operandi in organizing research on technology generation.

The workshop came to a number of conclusions and recommendations. However, the participants agreed that equally important were the discussions which took place periodically between presentations and in the working groups. Numerous questions were raised, and partial answers suggested, which could not be readily included in the formal conclusions and recommendations of the workshop. A digest of these discussions is included under chapter 4 of the proceedings.

ISNAR firmly believes that a strong case exists for holding similar workshops in the future, with a different configuration of participants, where the organizational experiences of research with a farming systems perspective could be shared and discussed, and the findings of this workshop built upon.

2. Opening of the Workshop

2.1 Welcoming Address by M. Dagg, Representing Dr. W. K. Gamble, Director General of ISNAR

There is a rapidly growing interest in client-focused agricultural research with a farming systems perspective. This interest is evident in national research programs, in development assistance agencies, and in the international agricultural research centers of CGIAR. Attention is being focused on several aspects of the theme, including its role in technology generation, where an important client is the farmer with little capital. Many believe that this perspective offers an avenue for making research significantly more effective in generating and delivering appropriate technologies, especially to farmers in developing countries.

In the realm of technology generation with a farming systems perspective, considerable attention has been given to methodology, to fieldwork itself, and to analyses and documentation of results. Little has been done, however, about the emerging issues in managing such research. With increasing resources being allocated for this kind of research, there is some urgency in examining appropriate guidelines for their efficient management on a sustained basis.

Good progress has been made in the development of methodologies for carrying out farming systems research, and there are several units operating more or less successfully in different countries. However, in many cases the units have been created as special projects with external backing, and the experience of their absorption into the main body of agricultural research in the national system has been varied and inconclusive. This workshop has been called to benefit from these experiences, to tap the combined wisdom of national practitioners, and to learn if there are reliable and generalizable principles in organization and management that may be safely recommended elsewhere. It would also be instructive to examine common difficulties encountered in different patterns of research organization.

The small group at this workshop therefore includes a selection of national research managers who have had direct experience in farming systems research in a national research system, those who have or have had responsibility for the organization and management of resources committed to such research.

It is hoped that the workshop will help to identify the problems peculiar to such research, to review from practical experience the management strategies which offer promise for resolving them, and to frame topics for research in management where experience suggests that solutions have yet to be found. Ultimately through the workshop and subsequent efforts, it is expected that ISNAR and others can offer guidelines which would assist national programs to better organize and manage this increasingly important aspect of the agricultural research systems.

We at ISNAR are pleased that you managed to find time to be with us here this week. I would like to express my own very special thanks, and the gratitude of all the participants to Dr. Carlos Valverde, who has been in charge of organizing this workshop, for his unstinting efforts, and for a job very well done indeed.

3. Technical Presentations

3.1 Recent Views on Farming Systems

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Introduction

Most agricultural research seeks to enhance the efficiency of resources committed to agriculture, usually through improved technologies and through the fashioning of more appropriate policies and institutions. The principal concern in this paper is with the development of improved technologies, and with the recent emphasis on appropriate technologies for representative farmers of developing countries. This paper reports on selected aspects of such research, concentrating on the process of technology generation with a systems perspective. Its purpose is to develop a common point of departure for subsequent discussion about managing such research.

The paper has three parts, organized around different themes. The first part provides a brief perspective on the evolution of agricultural research. The second treats what has come to be called farming systems research. The last deals with that component of farming systems research which is of central importance to the ISNAR/Workshop.

The Antecedents

Systematic, formal research on improved agricultural technologies dates from the mid-19th century with work on the biological sciences undertaken in Europe. Early efforts were usually in the hands of publicly supported research entities. By the early 20th century, most of the research effort tended to be closely focussed on the immediate problems of farmers. Throughout the 20th century, reinforced by an expanding scientific knowledge base and the introduction of formal extension networks, a growing proportion of research was aimed at more fundamental problems. Immediacy and the farmer were still important, but basic research and professional peers received even more consideration especially in publicly supported centers. The trend there was towards specialization in disciplines.

Simplifying, but not unduly, it can be said that the evolution of agricultural science found great success in what has come to be called a reductionist approach. The underlying paradigm is that understanding – and with it the capacity to guide and to orchestrate – comes from reducing the whole into parts/partial problems for study, with understanding/solutions of the parts leading to understanding/solutions for the whole. This paradigm works wonderfully well, especially where interactions among the parts were not important, that is, where the whole is essentially the sum of its parts. The successes encouraged the emphasis on disciplines, for better understanding of the parts, which in turn fostered ever more understanding of ever more refined parts. And with the disciplines came, as accompaniments, disciplinary standards, and norms to guide and evaluate the work of adherents.

In the 1940s and 1950s, some centers began giving more relative emphasis to commodities, combining specialists from various disciplines around the problems of a specific commodity. Even so, for the most part, the organizing format for research rested on individual disciplines.

Through this period commercial interest in agricultural research developed, with rapidly rising commitments after World War II. Here the accent was more on the immediate needs of farmer clients as commercial firms competed for the profits promised by the resolution of significant production problems.

From the 1960s on, it was evident that the entire research process, public and private, was yielding dramatic results in developed countries through widely adopted technologies and rapid increases in productivity.

* The views expressed here are not necessarily those of CIMMYT.

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It should be noted that the disciplinary/reductionist approach was not devoid of attention to the systems which farmers operated. Many researchers, and especially those from commercial firms, were conscious of the systems within which their recommendations would have to fit. At times the improvements they were offering were so large that they compensated for market changes in the systems and those changes could be sustained by the capital of the farmers. What was being advocated, then, was not a totally new process but a substantive shift in emphasis.

Much of the interest in the systems perspective has coalesced around the term "farming systems research." Who first used the term is less important than is the explosion in its use since the 1970s. Its appearance in articles in agriculture, ecology, and economics has mounted steadily, giving evidence of the widening awareness of its promise.

Among the better known early attempts to introduce into research on technology the elements which are now said to describe "farming systems research" were Mexico's Plan Puebla, the work at Ahmadu Bello University in Nigeria, ICA/IDRC's Caqueza effort in Colombia, ICTA/RF's Guatemala initiative (Hildebrand). From reports and published papers of the time, it is possible to derive a sense of what the strategy was then thought to entail. The major elements of emphasis are listed in the first column of Table 1. They, along with elements in columns two and three, were derived from reports of the time.

Table 1. Adjectives commonly used to describe FSR at three times.

	1972	1977	1982
Conceptual:			
Farmer centered	XX	XX	XX
Societal needs			X
Technology generation	XX	XX	XX
Policy implications		X	X
Rural development needs			X
Operational:			
Interactions	XX	X	X
Holistic		XX	XX
On-farm	XX	X	XX
Near term			X
Interdisciplinary	X	XX	XX

XX = Stressed
X = Included

From early on, proponents have emphasized the need to link FSR research with research undertaken in experiment stations and with extension activities. Some of that research will be discipline oriented. How that linkage is to be sustained over time was not made clear and indeed that point is one of the themes of the ISNAR/CIMMYT Workshop. Clearly, however, the argument was not to replace one class of activities by another but to modify the emphasis. Furthermore, there has been a continuing recognition that the system includes, or ought to include, consideration of livestock. Even so, most attention still focuses on crops and, most specifically, on food crops.

By the mid-1970s, development assistance agencies were manifesting an increasing interest in farming systems research, developing country research directors were stepping forward to test its promise, and several of the international agricultural research centers had programs.

Indeed, so much activity and interest were in evidence that the CGIAR commissioned, through TAC, a review of the farming systems research programs in the IARCs. That review concluded, among other things, that FSR refers to research which views the farm in a holistic manner (with interactions emphasized), that the terminology of FSR is confusing (a vocabulary was included), and that FSR is a valid and essential activity for the IARC system. This CGIAR review has served as a point of departure for much of the subsequent discussion on farming systems research. Its sense of what constituted farming systems research is portrayed in the second column of Table 1.

In the years since the report, the issues have become more varied and the terminological difficulties more acute. It is little wonder that terminology is a problem, as ideas which had their roots in biology, ecology, and economics will almost certainly be described with different terms by adherents of the three disciplines. Add to that the terminological preferences of agronomists, anthropologists, sociologists, and systems specialists, and lapses in communication should be expected.

But it is more than this. Farming systems research has come to mean a great many things, depending on the user. As evidence of this, the third column of Table 1 presents a synthesis of the current sense of the term as evidenced by literature currently cited. The whole farm (holistic) concern has gone from awareness and knowledge to understanding. While technology generation remains at the forefront, other themes receive more emphasis, for example, policy, infrastructure, and – for some – rural development.

And it is not only the farmer's decision criteria which must now be satisfied, but that of society as well (Baker, et al.).

By now, according to one source, "... there is little activity concerned with agriculture and rural development which cannot claim some relationship with farming systems research), however tenuous. Further, the breadth of activities included in FSR underlies both the growing consensus about its desirability as well as the considerable diversity of opinion about how it should be organized and undertaken." (Gilbert, et al.)

With this range of potential topics and this diversity of opinion about methods, research administrators might be reluctant to commit resources to farming systems research. What is to be done? How is it to be done? What will be the utility of results? What expectations are being created for potential users of results? With these as relevant questions, a certain apprehension or skepticism is understandable.

Against this ambiguity, this uncertainty about topic and method, some argue for reconcentrating energies on what were the central elements of the case, viz. near-term technology generation for representative farmers with interactions playing a central role in the analysis. That is the tack taken in the ISNAR/CIMMYT Workshop.

Whatever advantages the broader approach offers, the central theme of the workshop covers a more restricted field than the ever growing terrain of farming systems research. This clear determination concentrates the discussion. It should have the further advantage of relieving at least some apprehension about the availability of suitable methodologies and of reducing the range of opinion about which of those are appropriate.

The Elements for Emphasis

Earlier, it was claimed that developing country research has not, for differing reasons, had the success that was projected and that one important reason is insufficient focus on the special problems of representative farmers. One interpretation of this charge is that researchers saw no need to single out the problems of representative farmers. Moreover, with capital, infrastructure, and market insufficiencies, with farmers regarded as so bound by tradition as to reject even what was held to be in their best interest, and with disparagement on all sides about the extension services, there were many ways to explain the shortcomings of research. However, a new view is gaining ground which argues that, in spite of the other shortcomings in the environment, there is still scope for effective research and that to be effective, new dimensions will need emphasis and new practices must be followed. At the center of this view is recognition of the crucial role of interactions – synchronic and diachronic, biological and economic, production and familial.

Starting with emphasis on near-term technology generation for representative farmers and with the recognition of the role of interactions among enterprises in shaping their decisions, a class of research has evolved which features collaborative interdisciplinary work, based on the needs of a defined set of farmers, and with a great deal of on-farm activity. The process has a variety of names, e.g., at CIMMYT it is called on-farm research with a systems perspective.

This has brought to the fore a new set of considerations in organizing research. In a general sense, the several methods that have evolved or have been adapted for its undertaking have much in common. First, there is the question of which farmers are to be served, their identification being guided by societal concerns. That question answered, attention shifts to assessing, describing, and diagnosing the circumstances of those farmers. But not all circumstances are identified, only those are singled out which are thought to impinge in important ways on productivity.

At this juncture opinions differ. Some advocate going to the countryside with an open mind as to what problems will be researched, in effect leaving all aspects of the farmer's system open to investigation (Baker, et al.). Others argue for concentrating early attention on the most measurably important enterprise or enterprises of the farmer, treating other activities as fixed, but recognizing their complementarity and competitiveness with the enterprises under scrutiny. Proponents of the first approach are concerned about missing new opportunities, while those of the second point to probable payoffs derivable from the focussed commitment of scarce research resources.

In either case, this step has as its end the identification of potential problems and provides a framework against which potential solutions to those problems can be assessed. If asked, most would agree that the identification of problems is far easier than is the identification of appropriate solutions to those problems. The class of research under consideration gives heavy emphasis to the latter.

The next step involves establishing priorities for the experimental activities. These priorities are heavily influenced by a ranking of significant problems of representative farmers. These priorities, too, are

fixed against the background of the circumstances of representative farmers.

Next is experimentation under representative farmers' circumstances. Given the differences commonly found between these circumstances and those of the experiment station, it is usually preferable to carry out experimentation in the fields of the farmers. This preference raises the probability of close farmer involvement in the experiments. The participation by the farmers can increase the relevance of the trials and the correctness of judgement about appropriateness. One point here: the trials, their scope and organization, are guided by hypothesis testing. These are not "demonstrations," but can serve that role, and they are not necessarily simple adaptation.

And finally there is the issue of diffusing the technology after sufficient trials have been undertaken. The method of transferring the recommendations will differ from place to place because of differing relationships between research and extension. Most would agree, however, that on-farm research itself represents an excellent opportunity for involving extension staff. With effective collaboration, by the time recommendations have been framed, agents are already fully aware of the characteristics of the improved technology.

To summarize, the process features singling out groups of farmers in terms of society's concerns, assessing the circumstances of those farmers, assigning priorities to experimentation on apparently appropriate solutions to important problems, and undertaking experiments under the circumstances of representative farmers. Characteristics of the process are collaborative, multidisciplinary research, much of it done on farms and most of it based on the immediate needs of representative farmers. The desired objectives are useful recommendations which will lead to increased productivity in the near term.

The purpose of the workshop is to talk about the management issues associated with integrating such research into conventional, publicly supported research systems. There are myriads of possible questions; an idea of their range follows.

Who should carry out such research? Some argue that specialized teams are essential while others hold that the on-farm research should be undertaken by the same staff that currently works on experiment stations.

How will the work be evaluated? Currently research tends to be evaluated in terms of the criteria established by disciplines. To shift to other standards is itself a problem. To shift to a standard which might include the diffusion of the results of research adds further complications.

How will incentive systems be maintained? The rewards must induce a lasting commitment to the process, should compare favorably to those already sustaining interest in disciplinary research, and must be sufficiently broad as to recognize the contributions of those whose products are themselves inputs into the process. Furthermore, the incentives may have to overcome reluctance based on hardship and problems of status ambiguity.

How will communication be maintained with other parts of the research apparatus? To be truly effective there must be considerable exchange between on-farm researchers, station researchers, and other researchers. Such communication is costly.

Who will be responsible for making recommendations and for dealing with extension service?

What local and central administrative frameworks are required to sustain extensive on-farm research over an extended period of time?

How will training for on-farm research be undertaken? The process seems to lend itself to learning by doing and favors training *in situ* with considerable follow-up. If so, it is unlikely that the kind of training which supports and sustains the disciplines will suffice.

The above are but a few of the questions particular to the management of on-farm research with a systems perspective. There are others. How effectively they are answered will have a marked influence on the extent to which the approach fulfills its promise.

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3.2 Activities of Development Agencies in Support of Farming Systems Research

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Introduction

A wide variety of reports and discussions suggest that both the multilateral and bilateral development agencies are increasing their interest and support for farming systems research. However, there is not, as far as I am aware, any inventory of their activities in this field. Such an inventory would be quite difficult to set up since the development agencies' involvement in agricultural research covers a wide range of activities which are often aggregated under the broad heading of agricultural development. Some donors do, however, provide quite detailed information, and at two informal meetings of bilateral and multilateral donors held in January 1981 and May 1982, a few provided specific information on their activity in farming systems research. Thus, FAO (An overview of FAO in strengthening national agricultural research in Africa: WP 7986) provided a summary of the agency's research, extension, and training program in Africa. Of the 224 projects in this category, two deal specifically with farming systems research, one in Egypt for improved farming systems in the Nile valley, the other in Kenya for development of dry-land farming systems at Katumani. Bilateral donor agencies, active in promoting farming systems research, include USAID, IDRC, Australia, and the Netherlands. Australia has had two long-standing programs in northern Thailand, dating from 1967 and 1972, to try to develop improved farming systems in areas of shifting cultivation and in the hill tribes' territories. In 1981, USAID listed two projects, one in Africa and one in Latin America in this category, but I gather that this activity has greatly expanded in the past few years. The UK-ODA had a dry-land farming project in Botswana and IDRC has supported projects in several countries.

The World Bank is presently preparing a "state-of-the-art" paper on farming systems research and, in the course of this, is attempting to find out which national programs in our borrower countries have farming systems research activities. We have not yet completed this exercise but it would appear that there are probably around 25 to 30 developing country national research programs with this component. Most of these programs are of fairly recent origin and, by and large, it would appear that the term, though not necessarily the concept, is a creature of the 1970s.

World Bank Support for Farming Systems Research

I think that there is probably enough common ground in terms of objectives between our support in this field and that of other agencies to make it worthwhile taking the Bank approach and experience as the background for a discussion of the topic. A brief description of the scope of our support for agricultural research generally will provide an overall picture of the research activities. Like most development agencies, the World Bank designs its agricultural investment projects around already existing agricultural systems. There have been major investments in tree crop projects, rubber, oil palm and cocoa, and in livestock, irrigation, agricultural credit, roads, and other forms of infrastructure that could promote agricultural development.

There have been major investments also in a wide variety of agricultural and rural development projects that have been designed mainly to improve rainfed crop production. Most of these investments have been designed to make use of existing technology generated by other agencies such as the bilateral donors, the FAO/UNDP program, and the national and international research programs.

The Bank's first major involvement in agricultural research was a loan for a national agricultural research project in Spain in 1972. The organization is

* The views expressed here are those of the author and not necessarily those of the World Bank.

therefore a relative newcomer to the support of research. Several factors have contributed to the present deep involvement and to the plans to continue major investment in this subsector as laid out in the Agricultural Research Policy Paper, World Bank, June 1981. One of the factors influencing the decision to increase investment was the impact of the new rice and wheat varieties on agricultural production; another was the growing realization that better technology was needed, particularly in rainfed cropping, as investments in this subsector increased and as assessment of project performance indicated that the lack of improved technology contributed to low project performance.

Investment in Agricultural Research

The Bank is presently involved in four avenues of investment in research. These are

* National agricultural research projects.

* Research components in agriculture and rural development projects.

* Education projects which have a component of agricultural research support.

* Support for the CGIAR.

Tables 1, 2, 3, and 4 give some of the details of investment in agriculture and rural development projects (ARD) for the fiscal years 1981, 1982, and 1983.

National Research Projects

Details of national research projects over the past three financial years are set out in Table 4. Among the objectives of each of these national research projects is the reorganization of the national research systems, training, the provision of equipment and research station development, and consultancy services. Each has some element of farming systems research and these are described briefly in the following section.

Brazil. The second research project is a follow-up of an earlier project which became effective in 1976. The second project supports six commodities not included in the first project and also supports new, high-priority national programs for animal health, bioenergy, food technology, and agricultural engineering. Both the first and second projects support farming systems research at three regional centers representing the north (humid tropics) northeast (arid and semiarid tropics), and center west (campos cerrados or savannah). Farming systems research is carried out in three phases: the first is an inventory and evaluation of the natural and socioeconomic resources of the region, including a study of current farming systems; the second phase is a more detailed study of how the available resources can best be utilized, using the results from the studies at the commodity centers as a starting point and including information on soil management; the final phase is to bring together the results of the second phase into a coherent farming system.

Perhaps one of the unique features of the Brazilian farming systems program is its attention to the inventory of natural resources, which is essentially a compilation of information on soils, vegetation, and moisture regimes.

Colombia. The project's most important objectives are training and additional funds for operating expenses, the rehabilitation of 15 existing stations, and the development of a new station, mainly for livestock. There is no farming systems research component identified as such but there is a socioeconomic studies support unit and also a multiple cropping program that will do research on systems to increase production. In the socioeconomics unit, high priority will be given to increasing the research workers' understanding of the socioeconomic conditions in the farming sector. Staff of this unit will participate in the design and analyses of research projects and in the translation of research results into practical recommendations. The socioeconomics unit, as a support unit, will not be integrated into any of the biological research teams.

Nepal. This project combines agricultural extension and research; the research component proposes to strengthen and change the direction of applied and adaptive research in four regional stations of the project area. The cropping and farming systems component will be done by a research outreach officer at each of the stations. He will evaluate priorities and adapt the new technology, developed by the research station, according to the agroclimatic conditions and requirements of farmers. Interestingly enough, the extension component of the project will have a monitoring and evaluation unit which will, among its many functions, carry out studies to obtain data on present agricultural conditions of farmers and their present practices, including the use of inputs and their yields.

Pakistan. The project has three basic objectives: (i) to bring about institutional reforms, (ii) to increase the capacity of federal and provincial institutes to

improve their research, and (iii) to provide training and technical assistance. The project also includes a subproject financing scheme whereby the Pakistan Agriculture Research Council (PARC) can provide grants for financing research proposals submitted by other institutions.

There are no specific proposals for developing or strengthening farming systems research per se, but five agroeconomic units will be established under the director general of the research institute. These units will examine the economic viability of new agricultural technology, determine factors limiting farmers' yields, and carry out farm management studies. These agroeconomic teams will thus carry out some of the functions of a farming systems research group.

Peru. One of the specific objectives of this research project is to introduce a farming systems research capacity. This will be a new feature of Peruvian agricultural research and is expected to play a role in analyzing the factors which have a bearing on adoption of improved practices (including such factors as access to credit and attitude toward risk). There will be a farm systems analysis coordinator, and at least 10 staff with economic, agronomic, or sociological backgrounds will be trained by CIP.

The description of this program indicates that the farming systems research program is essentially directed at providing a capacity for analyzing farmers' problems, including biological, social, and economic factors.

Senegal. As with other national research projects, this project will strengthen the national research organization, reorganize research along commodity rather than disciplinary lines, and provide training. One of its specific objectives is the introduction of a farming systems research program. Five production systems programs would be located in five different ecological regions. All would be mixed agriculture/livestock systems but one station would have emphasis on irrigated agriculture, another on rainfed agriculture, a third on rice production, and the remaining two on livestock production systems. Production systems research would be guided by identified farmer constraints and would have three components:

* to identify and quantify technical, economic, and social constraints through the study of existing production systems;

* to carry out research on stations and farmers' fields to solve these constraints;

* to test the solutions on farmers' fields.

Each team would consist of a general agronomist, a livestock specialist, an agricultural economist, a rural sociologist, and a subject matter specialist on agricultural extension. A central systems analysis group would be responsible for overall planning and supervision. This unit would have expertise in systems analysis, farming systems research, animal production, sociology, and economics.

The Senegal project has the largest component of farming systems research of any of the Bank-supported projects. This component is central to the whole research organization and places a very strong emphasis on the systems approach at all three stages of problem identification, problem solving oriented research and technology testing using multidisciplinary teams.

Thailand. A major feature of this research project is the reorganization of the Ministry of Agriculture so that many more research scientists will work outside Bangkok. Eighteen national research stations will be developed, and farming systems research will be concentrated at two centers in the northeast, where it is considered that improved farming systems are urgently needed. However, the program would utilize most of the other stations for segments of its program.

One of the major reasons for the emphasis on this program has been the extension of cropping into new areas, often with unreliable rainfall and poor soils, and the stated objective is to develop farming systems "that provide optimum returns on farmers' investments" by devising crop combinations that suit the local soil and agroclimatic conditions; farming systems research is also expected to provide the technology for intensification of cropping in the irrigated areas.

Yemen Arab Republic. The project is designed to develop three regional research centers. The research programs will be mainly commodity oriented but will include livestock and range management. As part of the central support services there will be an agricultural economics section to conduct economic evaluation of the new technology packages. It would advise the ecological research group on farmers' needs as identified by farm surveys. Shifting production patterns would be identified and their importance for the research programs monitored.

Research Components in Agriculture and Rural Development Projects

During FYs 1981-1983, there were 87 projects with research components. Since many of these components were quite small – over 40% were

Table 1. Number of projects concerned with agricultural research.

FY	Total Number of ARD Projects	Full-scale Research Projects	ARD Projects w/Agric. Res. Components	Education Projects with Agric. Research Implications
1981	86	4	28	5
1982	67	3	24	–
1983	70	1	35	1
Total	223	8	87	6

Table 2. Bank financing for agricultural research ($Million).

	Loans/Credit			
FY	Total Investment in ARD Projects	Full-scale Agricultural Research Projects	ARD Projects w/Agric. Res. Components	Education Projects with Agric. Res. Implications
1981	3,862.9	131.5	1,297.8	75.4
1982	3,078.4	66.1	1,262.2	–
1983	3,918.6	63.4	1,308.6	117.25
Total	10,859.9	261.0	3,868.6	192.65

Table 3. Agricultural research component cost as a percentage of total projects costs.

FY	Total Costs of ARD Projects with Agri. Res. Comp.	Agricultural Research Component Costs $M	Agric. Res. Comp. as % of Total Project Costs $M
1981	3,748.2	187.69	5.0
1982	3,218.8	91.55	2.8
1983	2,861.96	71.49	2.5
Total	9,828.96	350.73	3.5

Table 1 shows that while a significant number (40%) of the ARD projects have a research component, Table 3 indicates that they form only a minor part of the total costs.

Table 4. National agricultural research projects.

FY	Country	Loan/Credit $M	Total Proj. Cost $M
1981	Thailand	30.0	91.5
	Brazil	60.0	150.1
	Nepal*	17.5	20.8
	Pakistan	24.0	40.1
	Subtotal	131.5	302.5
1982	Senegal	19.5	106.1
	Yemen Arab Republic	6.0	32.4
	Peru*	40.6	83.3
	Subtotal	66.1	221.8
1983	Colombia*	63.4	206.4
Total		261.0	730.7

* With some extension components.

budgeted for less than $1.0 million, I do not propose to discuss them in any detail. However, 16 of the 87 projects are recorded as having some farming systems research objectives in the component. The countries involved are Bangladesh, Benin, Brazil, Burma, India, Indonesia, Ivory Coast, Malawi, Nigeria, Philippines, Rwanda, Sudan, Togo, Zaïre, and Zimbabwe. Such projects are usually described as aiming to develop "improved" farming systems. Probably their most useful feature is the focusing of research on the more important problems of the areas concerned.

Agricultural Research Components in Education Projects

During the past three years there have been five educational projects, in China, Egypt, Kenya, Niger, and Syria, with agricultural components, some part of which is directed towards research. Although there have been suggestions from time to time of encouraging universities to develop graduate courses in farming systems research, there has not, as far as I am aware, been any development of courses of this nature either in these projects or in other education projects.

CGIAR and Other International Research Activities

Over the three-year period, 1981-1983, the Bank contributed $49.8 million to the CGIAR system. The system as a whole is calculated to spend about 6% of its annual budget on farming systems research. By the end of 1987, it is calculated that the IARC system will have invested about $125 million (in 1983 constant $) in farming systems research. Since the activities of the centers are well known, I will not attempt to describe their research, but perhaps I might mention the Bank's interest in trying to introduce some of the results from these research programs into agricultural development projects. One of these projects is that in Iloilo in the Philippines where a project was designed to make use of some of the results of IRRI's cropping research program. One of the interesting outcomes of this, which involved double cropping with rice, was the problem of drying the rice crop harvested in the middle of the rainy season. Another difficulty was the lack of sorghum or maize varieties with the correct maturation period to fit the cropping sequence. A third problem has been the lack of credit. The farmer has to pay back the credit he receives for one crop before he can get new credit for the next crop. However, the turnaround period between the first and second rice crops is only a matter of two to three weeks and the credit institutions are not geared to operate within such a short time span. I mention these as examples of the problems that agricultural development will have to face in moving from the experimental phase of new cropping systems to the widespread adoption of a new system.

It should be noted also that the CGIAR centers are not the only international research agencies involved in farming systems research. Others like CATIE and ICRAF are also involved, particularly in the agroforestry field. The new water management institute, IIMI, will also be very much concerned with systems research, albeit with a strong irrigation orientation.

Discussion

I have described in some detail how Bank-supported agricultural research programs are involved in farming systems research. The reason for doing so is not to provide a catalogue of our activities but rather to give a background against which I can discuss the reason for such support, the expectations of what can be achieved, and the problems of organizing successful programs in farming systems research. From the project descriptions it will be seen that there is a great diversity in the perception of what consitutes farming systems research and of what can be expected from it. Obviously, some of this diversity arises from the way in which the Bank operates: each region organizes its projects independently. A good part is due also to the countries' own views of their agricultural research problems, since they are usually deeply involved in the preparation of projects.

In spite of this diversity, there are three major themes running through the reasons given for the development for farming systems research programs. The first is that the existing research does not focus on the real problems of the farmers. The researchers do not move off their research stations and so their priorities and those of the farmers do not coincide.

The second theme, closely allied to the first, is that technology must be tested outside the experiment station under actual farmer conditions; the statement is often made that farmers do not adopt the improved technology because it has not been tested under their conditions. However, in this kind of discussion there is often considerable confusion about the aims and objectives of testing. For example, is it the yield and performance of a new variety under the ecological conditions on the average farm where the fertility may be lower, the water management less good, and the weed control poor? Or is it the ability of the new technology to fit into the overall agricultural timetable of the farmer, that is, to fit his social and

economic circumstances, including his labor situation? The results in the experiment station and on relatively few farms are probably sufficient to answer the first part of this question. Much more farmer testing is probably needed to answer the latter, for the farmers' social and economic circumstances are generally much more diverse than their ecological ones.

A third theme of the discussion on introduction of farming systems research is the need for new farming systems. A number of the research programs seek to make major changes in the current farming systems, for example, replacement of shifting cultivation with continuous cropping, or introduction of a cropping/livestock system. The problems of doing this are often exacerbated by the ecological conditions in the area concerned, which may have unreliable rainfall, poor soils, steep lands subject to erosion, or areas with a very poor infrastructure of roads or markets.

One point worth bearing in mind here is that "revolutionary" changes in farming systems have usually come about by the introduction of some major extraneous factors: the introduction of irrigation, the opening up of new markets by a new road system, or the introduction of some major technical breakthrough like herbicides. The influence of the latter in cereal growing in Europe is a good example. Prior to the discovery of herbicides, cereals were grown in rotation with "clean" (root) crops in order to control weeds by cultivation. The introduction of herbicides, with a continuing stream of new products to deal with the changing weed flora revolutionized cereal growing. If we look at the problem of shifting cultivation, we see that the resting period has three major functions, it enhances soil fertility, it controls weeds and pests, and it provides protection and physical improvement of the soil. Major changes in this system therefore require new technologies to fulfill these objectives.

Why Farming Systems Research? As stated in my introduction, bilateral and multilateral development agencies are increasing their investments in farming systems research. Thus, it is appropriate to ask the question as to why this has occurred. After all, there has been much research in the past, which can be regarded as successful in that it has had an impact on production, yet it was done in the absence of formal farming systems research. This applies to most of the research in the developed world as well as to a considerable amount of commodity research in the developing world of cash crops such as rubber, oil palm, sugar cane, cotton, as well as food crops such as rice and wheat.

There are obviously several answers to this question, but it should be emphasized that any research that turned out to be useful must have had an implicit understanding of priority problems at the farm level. However, that understanding could obviously have been reached in several ways, one of which would have been the researcher's own understanding and familiarity with farmers' problems and another the activities of extension services. The role of the latter is particularly important to us because of the Bank's present involvement in promoting extension systems, particularly the Training and Visit (T&V) system, with its emphasis on farmer contacts and feedback of information on farmer problems. Such systems typically are planned to operate with about one agent per 500 farmers. With the intensive contact designed into the system, the opportunities for diagnosis of farmers' problems and analysis of priorities are excellent. Where such a system is operating effectively, do we need the analytical capacity of farming systems research as well? The other end of the process, on-farm testing, should also be taken care of by the extension service as the subject matter specialist is responsible for "adaptive" research, which is essentially on-farm testing. There is thus the potential for considerable overlap between a T&V type of extension service, or indeed, any kind of farmers' advisory service and the diagnosis and testing components of farming systems research; this seems an area worth closer examination as research and extension services develop.

A second aspect of the current emphasis on farming systems research centers around the lack of improved technology for rainfed annual crops. This is perhaps the aspect which is raised most often when farming systems research programs are being discussed. The reasons for this are presumably due to the fact that technology for, say, irrigated rice or wheat is relatively straightforward to generate and has a major impact when properly applied. In rainfed crops on the other hand, often grown on poor soils and in areas of unreliable rainfall, new technology is more difficult to generate, e.g., drought tolerance. When applied it has less of an impact, and in fact the synergism of several improvements, applied together, is probably very important. Thus, a substantial impact might require the use of better germplasm, the improvement of soil and water management, better weed control and better timing of operations, for these are the kinds of problems that one is facing in trying to improve rainfed agriculture.

Is farming systems research the right mechanism to analyze these problems, to come up with potential solutions and to test the more complicated packages? To answer this question we need a very clear idea of the sequence of improvements that we seek to bring about, and we need to be realistic about the kinds of improvements that can be brought about.

Management of Farming Systems Research Programs

None of the foregoing is meant to argue against the idea of farming systems research; it seeks to clarify the conditions under which the various components of such research can be introduced with benefit. Once a decision has been made to introduce this component, its proper management obviously becomes very important, particularly at the team leadership level. It is relatively easy to put together a multidisciplinary team. But the younger scientists who predominate in many of the developing country research systems generally lack experience in managing this kind of team, for it is not only a question of effective operation as a team, in that individuals cooperate together, but it is also a question of experience to give the team a balanced approach to the problem. I believe that the need for experienced team leadership is often ignored in our rush to build up numbers and sizes of teams. A small number of well-led teams is likely to be far more effective than a host of poorly led and badly organized teams. The former can be achieved only by a slow build-up, with on-the-job training.

Conclusions

Agricultural development, through its concentration on poor countries and poverty areas, is having to deal more and more with difficult physical and ecological conditions. High hopes are being placed on agricultural research to provide improved technologies to accelerate this agricultural development. Yet, these countries often lack large research resources so their effective use becomes extremely important. The concept of farming systems research is being increasingly used as a way of improving effectiveness by providing better focussed programs. This is a major undertaking, and farming systems research programs need especially good planning and leadership if they are to fulfill these high hopes.

3.3 Concepts and Implementation of Farming Systems Research at CATIE

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Introduction

This paper is intended as a modest contribution by CATIE to the workshop on Issues in Organization and Management Research with a Farming Systems Perspective Aimed at Technology Generation. It describes the experiences of CATIE in production systems research with emphasis on cropping prototypes design, implementation, validation, extrapolation, and strategy for technology transfer. The evolution and development of methodology, and the implications for readjustment of personnel and financing at CATIE are presented.

Methodology development is discussed, with reference to implementation and development of the organization and research management of the Crop Production Department at CATIE.

From 1942 until 1969, research at CATIE was fundamentally oriented by commodity or by discipline, alternating or superimposing the two forms on many occasions. Beginning in 1970, documentation from the Center began to appear. These publications contained information and concepts directed towards multidisciplinary investigation (2,16).

During 1970 and 1971, the Center suffered from severe budgetary restrictions, with its future not clearly defined. This undoubtedly obligated the administration and its scientists at the Center to visualize new directions for future work, even to the extent of considering combining the three departments of Crop Production, Animal Husbandry, and Natural Renewable Resources, in order to develop programs sufficiently capable of attracting external support.

The focus on systems evolved in a gradual form in the different technical fields. It was initiated in the Department of Tropical Crops and Soils, then, after four years, it was applied in the areas of animal husbandry and natural resources.

Conceptualization and implementation of production systems-oriented research, particularly aimed at resolution of small farmer problems, was a continued process based on experiences as they were acquired. These experiences influenced the management of resources and organization. It is difficult to differentiate phases during the process. However, for this presentation three closely related phases are considered in sequential order.

The first phase in the development of CATIE's systems approach began in 1971 and involved only the Crop Production Department because the conditions did not yet exist for implementing this approach in the areas of animal husbandry and natural renewable resources. In 1973 the Department of Crops and Soils designed and implemented the largest field experiments that had ever been attempted by the Center at Turrialba, or elsewhere: The central experiment and its satellite experiments covered several hectares and combined hundreds of crop and treatment combinations. Simultaneously, the strategy of the Department of Crops and Soils required that all of its scientists and students work and do their research in these giant systems experiments.

The second phase was initiated in 1976 with consolidation and expansion of the concepts and operation in systems and models for small farm production. A number of improved systems were implemented, resident scientists were installed in the different Central American countries, farming systems training was increased, and CATIE's physical presence at the country level was secured. The operation of this phase brought important changes to the Center.
The third phase, initiated in 1981, emphasized

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validation and extrapolation of improved production prototypes. The production prototypes were conceived as instruments not only to improve production, but also as units for training, technology transfer, and research.

The evolution of the systems approach of CATIE produced changes, adjustments, and reallocations of finances, human and physical resources, and operational-organizational aspects.

Without doubt, the process of putting into operation the systems approach produced reactions of varying magnitudes among scientists in the Center. Some scientists wanted to maintain the status quo in a way that allowed them to conserve their identity as specialists; other scientists considered it convenient to leave the Center; and yet others promoted the change because they believed the new approach would produce more stability in training and research programs at CATIE.

Technical and Institutional Dynamic: Transition from Disciplinary Research to Complex Systems Research

In 1970, CATIE's staff members initiated discussions about the idea of a research approach which could directly benefit the small farmer. In 1973, the Center at Turrialba designed and implemented a five-hectare central experiment comprising various alternative production systems (11,20). This complex experiment was designed on the basis of soil-use gradients dictated partially by the type of crops, permanency of the cropping systems (alone, associated, or in rotation) and technological gradients of cultural practices. Of the 216 cropping configurations, arranged in 54 cropping patterns, some produced interesting alternatives.

During subsequent years until 1977, the central experiment was maintained with several readjustments (13).

The central experiment generated various satellite experiments that were developed to enhance understanding of certain production factors or to increase coverage of inferences derived from the main experiment in which some factors were confounded. Most of the experiments were conducted as thesis studies by postgraduate students in the UCR/CATIE Graduate School. Important characteristics of this stage follow:

Focus change

It appears absolutely necessary, in this initial phase of systems research, to establish the relation between the concepts of systems, partially represented in the central experiment, and the classical concepts of agronomic experiments (at that time practiced by all of the CATIE investigators). Many interesting changes were originated by the central experiment, for example, the large plots constituted production complexes where innumerable interactions occurred and consequently required the combined attention of multidisciplinary research staff (13).

This mixture, where general principles of classic experimentation are partially maintained and at the same time several new elements are incorporated, produced a positive general balance. This strategy partially facilitated the acceptance of the concept by a respectable number of investigators who were usually accustomed to conducting specific experiments related to their field of specialty.

Human resource adjustment

Complex experiments of great coverage demanded the joint attention of interdisciplinary specialists. The Department of Tropical Crops and Soils implemented, as an operative strategy, the participation of all staff, students, and collaborators in the central experiment. The fundamental decision was made that disciplinary efforts would not be developed independently of the complex experiment. As expected, varying reactions were soon manifested to the multidisciplinary and complementary efforts that the department demanded for adequately conducting the complex central experiment. Some investigators preferred to resign because they believed that their specialty contribution would be lost in the complex of activities, negating the possibility that they as individuals would receive recognition from the common effort leading to a mutual final product. In contrast, other scientists rapidly assimilated the concepts of the systems approach, evaluated its implications and decided to continue participating in the operation of the central experiment; they accepted the risk that their identities as specialists would be diluted within the complexity of the multidisciplinary team action. A third group of colleagues left CATIE for reasons entirely unrelated to the new circumstances and focus on systems research. In any event, there was a notable turnover of personnel. Those who formed part of the systems team developed a zealous, quasi-mystic conception of their work and a firm conviction that the systems focus for agricultural research unites the researchers as professionals with the producers, who are the users of agricultural technology.

Physical and financial resources change

From the beginning it was evident that the resources

demanded by an experiment of this nature were considerable. However, comparing the cost in physical resources necessary to realize independent experiments with those utilized in the central experiment demonstrated that a substantial economy exists in the central complex experiment and its satellites. The experimental complex requires less space, less investment, less cost, and can be managed more directly and efficiently.

Organizational implications

It is obvious that a research and training institution in the process of transition from one mode of organization to another suffers from reverses of opinions and interpretations of various kinds. Some classified the new focus and strategy of systems research (3) as the end of serious research in CATIE and considered it as the beginning of a new stage in extension work, one of luxury, but one less related to the generation of new knowledge of the technical problems and scientific problems that affect agricultural production and productivity. On the other hand, the change attracted the blessings of many who considered that this type of research would put appropriate technology in the hands of producers with greater rapidity and efficiency.

Systems and prototype building

The second phase was characterized by the development of production systems designs based on surveys conducted at the producer level (12,15). Systems considered more typical and more frequent were improved in various technical aspects and offered as alternatives to the farmers who put to trial the performance and adaptability of the system. The most important characteristics of this stage were

Focus adjustment. It was relatively easier for the professional team of CATIE to pass from the central complex experiment conducted at the experiment station in the Turrialba Center to a larger scale and new mode of experimentation, developed on producers' farms. The evolution in the crop production systems research concept at CATIE coincided partially with the designing and implementation of dairy production systems for small farmers and the agroforestry systems that were consolidated, and these encountered greater unity of criteria for their application among CATIE researchers.

Human resources change. The evolution of complex experimental concepts to more specific or typical production systems designed in producers' farms did not encounter major difficulties, and moreover, attracted the attention and interest of the scientists towards the new type of investigation. On the other hand, new high-level professionals hired by CATIE found themselves forced to work specifically with this new line of activities of the Center, facilitating the "internationalization" of the approach.

The great quantity of personnel working within this focus dominated, in number and volume of operation, all other actions that have not yet been incorporated into the new concepts and systems technologies developed by the Center and applied throughout the Central American region.

Physical and financial resource implications. Due to geographic expansion of activities carried out in various locations of the six countries of the Isthmus, physical and financial resources have increased substantially. This type of activity requires significant physical, human, and operative resources. However, for the coverage and inferences that can be derived from this investigative model, it is very probable that its cost is lower than that of classical research conducted at experiment stations.

Organizational implications. By nature, this research activity has generated close associations between CATIE and national research organizations, even though initially it was difficult to consolidate institutional criteria and the research focus. However, this was accomplished because CATIE's concern for developing technology that brought researchers, extension workers, and producers close together was well received.

On-farm production prototype validation and extrapolation

The third phase of the systems research approach in CATIE is still being carried out, with emphasis on validation of systems investigated in the second phase and incorporation of adjustments to make the production prototypes more efficient (10). At the same time, activities were initiated in production systems extrapolation based on analysis of determinant and conditional factors that affect the productivity of the systems (among others, physical factors, management factors and socioeconomic aspects related to the system).

Model farms or improved prototype production farms also served as instruments for training and technology transfer. The main characteristics of this phase follow:

Focus refinement. There has not been a change in focus per se, rather, there has been a continuing process where emphasis has been placed on validation of the prototypes already tested at some level and scale (10).

Human resources change. This aspect merits more detailed analysis because during this phase some key elements were incorporated into the crop production team. Their specialties are more closely identified with technology transfer and with research. However, the systems researchers remained in the department and complemented the labor of the economists, extension workers, and biophysical researchers.

This phenomenon was also observed with validation of the dairy production prototypes throughout the Central American countries. The agroforestry systems followed a slightly different path but used similar concepts and implementation at the country level (4,5,6).

Physical and financial resource change. There were no important physical and financial resource changes required for this type of investigation. Concepts mentioned in the previous phase were still valid at this level (20).

Organizational implications. One of the most interesting aspects derived from the prototype validation and extrapolation activities was the decision by CATIE to implement a program of training in development and transfer of agricultural technology (7).

The plan does not intend to create a department of strategy for technology transfer per se, but a program solidly articulated with the departments of Animal Husbandry, Crop Production, and Natural Renewable Resources. This implies that the reseachers of the program (specialists in farm management, sociology, and economics) will conduct their functions while assigned to the technical departments. The idea of placing these professors-researchers in these departments facilitated association with and training of students in systems-oriented work, including research, validation and technology transfer.

This type of program tends to produce a prototype professional with knowledge and expertise in the elaboration of technologies and strategies for rural community development. These researchers are knowledgeable about the farmers, their traditions, needs, attitudes, and aptitude for changing.

Graduate students conduct thesis research in their disciplines, within their technical department, but on themes that give continuity to the process of generation, transfer, and adoption of the technologies.

General Remarks on Development and Implementation of the Systems Technology

Pressure and demand generated by systems research implementation

At the beginning, research and training activities were carried out primarily at CATIE's base in Turrialba. The new orientation of the crop production research forces changes in research strategies, training, and technical cooperation. These changes occurred slowly during the process of methodological development and were in response to continual and cumulative experiences.

Research. Research orientation became clearer during the process. Initially, a separation between disciplinary research and the recently integrated orientation was created; however, little by little the necessity of complementary scientific research support on specific subjects was understood. This understanding helped improve harmony within the disciplinary groups. The existence of professionals in charge of specific research and support permits a research group in a specific area to remain small and flexible.

With the extension of the work area to the countries of the region, research at Turrialba, basically on physical and biological aspects of cropping systems, was enlarged to incorporate socioeconomic aspects. This extended the external projection, particularly of the Crop Production Department, to other countries, primarily in technological development work, and thus resulted in on-farm research with the participation of the farmers. The integration and use of national investigative resources through the use of concentrated action modules was sought.

In response to the complexity of validating experimental results, researchers oriented their activities in investigation by ecological areas, aiming to improve the transfer-adoption possibilities of those results. This has permitted progress in research to develop a methodology for extrapolation of the cropping systems alternatives.

The methodological development shifted its emphasis at different stages, depending on logical learning processes and the experience of the technical group. During the first years, much emphasis was placed on area characterization, diagnosis, field trials, and evaluation. Later, criteria for work area selections were developed and attempts were made to improve design capability. In the last years, the design stage was clarified, with the connection between diagnosis and field trials being firmed up. Finally, the stage of validation and technology transfer was developed.

This has permitted a demonstration of the advantages of the methodology, including the advantages of a close relation between farmers, extension workers, and researchers.

The methodological development tends to find adequate mechanisms to increase the validity of the research results in specific sites through extrapolation. Moreover, it seeks to arrive at the transfer of the validation and transfer stage results.

Training. Postgraduate and short courses training programs at CATIE were varied in content in accordance with the experience and results that were obtained in the development of the research methodology.

When CATIE was founded, the graduate school continued its activities through an agreement with the University of Costa Rica. Although the academic responsibility is the University's, production systems-oriented courses have been incorporated into the curriculum, that is, Agroecosystems, Cropping Systems, etc. In these courses, information obtained by the department is used in discussion topics. Most postgraduate student theses are conducted within the guidelines of the departmental research program, thus familiarizing the student with department orientation.

Short-course training was conducted at Turrialba and was primarily characterized by the teaching of courses focusing on concepts. As the department developed a research methodology, the content of the course on conceptual ideas was varied to include demonstrations and case studies. Later the short courses were taken to the countries of the region, thus expanding coverage. Short courses cycles have been organized to follow the phases of research methodology and technology development. They cover the principal concepts discussed in an intensive short course of 14 weeks taught in Turrialba. The same course is offered in the other countries by methodological stages following the training approach of learning by doing. In these countries, the phases of the course are separated by periods in which the trainees realize and develop the corresponding work. In the following stage, progress made in the application of the methodological concepts is evaluated and discussed prior to continuing with the next phase. The total training time requires approximately one and one-half year.

Technical cooperation. The technical assistance by discipline and by commodity previously used by CATIE has been changed completely to cover the new demand generated by systems technology implanted at country level. The technical cooperation offered by the Center, in general, responds to the need generated by the systems research implantation at the country level. The areas of cooperation in systems technology go from concept, design, and layout, to implementation, testing, training, etc. On the other hand, the mode of cooperation goes from the indirect and weak contact to direct participation and sharing of responsibility.

Institutional aspects

Operational structure. Initially, CATIE maintained its departmental organization. Later it created programs and finally returned to the departmental structure. During the first years when the department of crops and soil extended its work to the countries, resident scientists for each country and a technical coordinator were appointed. This team of resident scientists was mainly in charge of the execution of the work plans and was directly responsible to the department head of CATIE. In the following years, with the creation of programs (previously departments), three subdivisions were formed: research, training, and administration. The program was known as the Annual Crops Program. Each project has a technical coordinator and the residents were maintained in the countries. Finally, with the return to departments (Crop Production Department), country residents and project coordinators were maintained.

During the last period, good logistic support was sought from the IICA offices in the countries. The Crop Production Department is being subdivided into programs and projects due to budgeting reasons. The structure is now in its last phase of evolution and indications are that it will be appropriate for the departmental research focus.

Interorganizational cooperation. Financial and technical cooperation agreements to strengthen crop production systems research include universities of countries outside of the area, principally the United States, and technical international financing organizations. CATIE was able to continue with the conceptualization and experience obtained through signing of an agreement with the Regional Office for Central America and Panama of USAID (ROCAP). Later agreements, oriented towards cropping systems research were signed with IDRC of Canada; later and with similar orientation, agreements were signed with the European Economic Community (EEC), the International Fund for Agricultural Development (IFAD), the German Agency for Cooperation (GTZ), and others on specific aspects. All of these agreements have considerably strengthened the systems research at CATIE.

Financial resources. Financial resources during the first years were from regular sources. Resources

from external agreements and contracts were rather limited. Thus, until 1977 funds of regular resources of the Center were very important, while those funds from external agreements were not important. In 1978, funds from regular resources of the Center increased about 3.7 times those of 1977 while the project increased 5.3 times. In 1980 funds from regular resources passed 6.8 times those of 1970 and those of projects were 15.7 times more. This accelerated growth in funding precipitated difficulties in management, resulting in financial disequilibrium and an elevated deficit. Since 1981 financial resource management was reorganized and regulated, leading to normalization and stabilization of Center activities.

Human resources. For various reasons, professional personnel paid with regular funds increased at different rates at Turrialba in comparison to in-country staff. This created some disproportion with regular personnel at some points during the methodology development.

In Crop Production Systems, CATIE maintains some multidisciplinary teams in selective areas of Central America. These basic teams are composed of professionals in production, plan protection and agricultural economics. They are responsible for the implementation of cropping systems prototypes and for production of technologies in their respective areas. They are trained and supervised in the use of methodology, as well as motivated to channel the support available in CATIE and other institutions that attend the area to benefit agriculture. In particular, they are encouraged to seek the support of the agricultural extensionists, demonstrating use of developed innovations to increase their area coverage, particularly in the validation and transfer phase. This implies that the team can increase temporarily the personnel in particular disciplines as needed and practicable. The basic group is responsible for work continuity but must maintain a minimum size, three in the case of cropping systems work with a farm perspective.

Since 1982, these teams have been used to study training needs, support, and supervision; also for demonstrating and training other scientists at the national institution level, including university students. Various additional multidisciplinary teams have been established in the different countries of the Isthmus.

Maintenance of effective working teams in the areas requires not only adequate logistical support, but also permanent motivation. Strict supervision appears to be necessary in the first stage, primarily to detect training needs until the teams can discover their own needs and request support. Supervision after this initial stage takes on more of a character of bridging connections with other groups and institutions, contributing to the team motivation.

To maintain connections between these multidisciplinary teams that receive support from CATIE in the different countries, the institutions dispose of the following elements of structure and organization: (a) resident agronomists in the country; generally interacting with some national institution in fieldwork involving the multidisciplinary teams stationed in the different parts of the country; (b) external project coordinator: a scientist who travels continually between the Turrialba base and each country, and between countries. Both elements permit the maintenance of adequate contact and communication between the Crop Production of CATIE, the residents, national institutions, and the multidisciplinary teams that need to be supported. The same elements permit a synchronization of requests and answers for support between the teams, the national institutions and CATIE. This support can be in terms of methods or it may involve support of research, training, or technical scientific services based on available resources or those which can channel the national institutions and CATIE.

To maintain motivation and work between multidisciplinary teams at the area level, CATIE is promoting the formation of a network for scientists interested in practicing the methodology of research and technology development oriented towards systems. This network will permit another type of connection between teams, permitting an exchange of experience and results as well as a professional projection of the members. Part of the members of this network will constitute a work group selected by CATIE for consulting related to the institutionalization and development of methodology at the country level; and also for specialized work that may be necessary in the countries.

Final Remarks

In the first stage, as a consequence of the process, a series of restrictions due to necessary institutional changes has emerged. Solutions were elaborated as the restrictions became perceptible. The principal restrictions were at the beginning necessary logistic changes that accompanied the new organization made it necessary to restructure installations and improve fund management mechanisms. It became necessary to produce a methodological process that helps researchers in application of conceptual criteria developed in this stage.

In this phase, serious difficulties were encountered with the acceptance of the new focus by research

institutions in the countries. There was a marked lack of interest for the acceptance of the new approach, and a strong tendency toward the classic orientation of research by discipline or commodity.

In the middle of the second phase, the marked increase in external resources, with a consequent personnel increase at the Turrialba base and in the countries, created a marked disequilibrium between the large number of special project personnel in comparison with permanent base personnel, a situation that could jeopardize CATIE's identity if it complied with all of the acquired obligations. Fund management procedures were severely complicated to the point of creating a situation of great tension due to the administrative infrastructure not being adequately prepared to manage the accelerated growth of resources coming from external financing.

At the beginning of the third stage, the marked austerity was a restrictive aspect, principally in basic resources due to the difficult financial situation of the Center. The mobility of experienced technical personnel with the multidisciplinary research focus is also noted. However, at the end of 1982 this situation came back to normality. The present technical, financial, and operational situation of CATIE is very healthy and is approaching great stability and normality.

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Brief Description of CATIE

The Tropical Agricultural Research and Training Center, CATIE, was founded June 1, 1973, by the terms of a contract signed between the Inter-American Institute for Cooperation on Agriculture, IICA and the Government of Costa Rica. It is a nonprofit civil association, scientific and educational in nature, established to promote and stimulate research and technical cooperation in animal, crop, and forestry production, to provide alternatives to meet the needs of the American tropics, especially in the countries of the Central American Isthmus and the Antilles.

CATIE's origin, however, goes back to the creation of IICA itself, when the Training and Research Center was established at Turrialba in 1942. Since its constitution, the Center has been strengthened by the following member countries: Panama, Nicaragua, Honduras, Guatemala, and the Dominican Republic.

The Center is located in the Turrialba valley, in the Atlantic watershed of Costa Rica at an elevation of 625 m above sea level, in a tropical area classified as moist premontane. The average annual rainfall is 2,600 mm, with February through April being the months having less rain generally. The average annual temperature is 22.5°C (72.0°F). The Center has 950 ha of land, and is located at a distance of 5 km from the city of Turrialba. It also has a 100 ha cocoa farm, known as La Lola, near Port Limon.

The main objectives of the Center are (1) to conduct research for generating technology that will solve the agricultural problems of the tropical areas of Central America and the Caribbean, to benefit mainly small-scale farmers; (2) to train professionals from Latin America and the Caribbean at different academic levels, in order to provide specialists required by the countries to strengthen their national institutions and their agricultural development programs; and (3) to provide technical cooperation services to the countries, especially those of Central America and the Caribbean, working with them to strengthen their national institutions and to assist them in executing their agricultural research, training, and development programs.

Three research departments (Crop Production, Animal Husbandry, and Natural Renewable Resources) and one support department (Development of Resources for Research and Training) allow the present outreach work of CATIE.

The priority for CATIE's orientation and focus on the small farm sector of the region was identified by the member countries in 1973 (3).

CATIE operates with a staff of professionals in different fields of agriculture (half of them expatriates). A good proportion of the budget is accounted for by specific agreements and projects financed by USAID, DDA, EEC, IBM, IDB, IDRC, IFAD, GTZ, ODA, UNU, Kellogg Foundation, and the Government of The Netherlands. IICA and the member governments provide the core budget.

At its headquarters in Turrialba, CATIE houses the oldest graduate school and one of the principal libraries in agriculture for Latin America.

CATIE develops most of its activities out of Turrialba at the country level and in strict interaction with the different national institutes.

3.4 Organization and Management of Farming Systems Research: Experiences from Nigeria

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Introduction

Nigeria has been facing serious food shortage problems for quite some time now (Abalu, 1980). These shortages are occurring as a result of high population growth rates, rising levels of income, and rapid urbanization in the face of stagnant agricultural productivity. Despite the display of conflicting policy signals by agricultural administrators in the country in the past, the federal and state governments now appear to appreciate the reality that small peasant Nigerian farmers, who have traditionally produced the bulk of the nation's food requirements, constitute the most effective means of meeting the agricultural needs of the country (Liman, 1982). The integrated rural development program currently being pursued in Nigeria with the assistance of the World Bank demonstrates the country's preference for achieving improvements in agricultural productivity through improvements of existing peasant systems of production rather than by replacing these systems. At least six pilot rural development projects have already been started in several locations in the country. Eventually, each of the 19 states is to have its own rural development pilot project which would ultimately be extended to cover the whole of each state (Abalu, 1982).

The persistence of food problems in the country despite this well-articulated rural development program is increasingly worrying Nigerian agricultural administrators. The national research institutes in the country are being blamed for failing to make an impact on the nation's agriculture. This is not to deny the fact that dramatic improvements in agricultural technologies have been achieved by almost all agricultural research institutes presently operating in the country. There is evidence to suggest that aspects of several improved technologies and recommendations that have been developed at some of Nigeria's national research institutes have indeed been adopted by some farmers in the country (Idachaba, 1980). The problem, however, is that very few farmers have been willing or even capable of following, in any significant manner, several of the technological packages that have been produced at these research institutes.

It is the recognition of this fact that prompted the Director of Agricultural Sciences of the Federal Ministry of Science and Technology recently to say that:

> ... for many years I have personally toyed with what may be termed a mad idea. I have wondered if it would not be wise for our scientists to reduce normal research for a year or two and concentrate their efforts on the problems of bridging the gap between experimental and farmers' yields. (Iyamabo, 1983).

Indeed, the commitment of the Federal Ministry of Science and Technology to the restructuring of the agricultural research institutes in the country to enable them to quickly bridge the technological gap between on-station and on-farm conditions has never been in doubt. What has been uncertain is the best way to go about organizing and managing this increasingly popular strategy.

In the rest of this paper, the organization of agricultural research institutes in Nigeria is examined and an attempt is made to describe experiences from efforts to organize and manage farming systems research in the country.

Agricultural Research in Nigeria

There are presently 16 national and 1 international agricultural research institutes operating in the country. Five of the national institutes are principally concerned with research on food crops, 4 with tree crops, 4 with livestock, and 3 with fisheries. The remaining two are charged with research on general services while the only international research institute in the country is concerned mostly with food crops. Table 1 provides a listing of the various research institutes in the

country, their research area, location, year of origin, and year of formal establishment.

Government Policy

Government policy on agricultural research in Nigeria views agriculture in its broadest sense to cover arable and tree crops, animal husbandry, forestry, fisheries, and related factors of agricultural production which include soil, water, and other environmental factors. The country's research policy guidelines for the development of its agriculture includes the following (Federal Ministry of Science and Technology, 1982):

* survey and determination of the potentials of the country's soil, water, plant, and animal resources;
* achievement of increased productivity of individual agricultural commodities -- arable and tree crops, livestock, forest trees, wildlife, fisheries - by breeding for increased yields, pest, and disease resistance, etc.;
* achievement of improved farming and production systems;
* improvement of the flow of technical information into agricultural production systems;
* improvement in preservation, storage, processing and packaging practices;
* enhancement of energy sources for agricultural production;
* mechanization of all possible stages of production, harvesting, and processing consistent with the socioeconomic and cultural development of the people;
* development of manpower at the vocational, technical, and professional levels and in identified specialized areas.

Each of the research institutes has been provided with a set of statutes which define its functions. However, these statutes generally fail to set priorities for the institutes. They also fail to reflect the fact that a major objective of agricultural research is not only to increase agricultural production, but also to ensure that the vast majority of farmers are able to adopt the recommendations that are being generated in these research institutes.

Several of the recommendations emanating from research institutes in the country have simply not been adopted. Many reasons have been advocated as to why Nigerian farmers are not readily adopting these recommendations. Some have argued that the farmers themselves are at fault. The psychological argument that is usually used here puts the blame on the inability of the farmer to appreciate what is good for him; hence his resistance to change. Others have attributed the blame to gross inefficiency in the operation of state and federal extension systems. Restricted access by farmers to credit and other material means of production has also received its fair share of the blame.

While these arguments may have been valid at some time and place, they do not provide adequate explanations for the general ineffectiveness of agricultural research in the country. For example, the arguments do not explain why even the poorest and the most tradition-bound farmers in the country are adopting certain aspects of available technologies while rejecting others. A good example here is the relatively more widespread adoption of improved maize in northern Nigeria but not improved millet or sorghum.

A less frequently heard, but perhaps more plausible, explanation for the lack of effectiveness of agricultural research institutes in the country is the strong possibility that misdirected research efforts in these institutes may have led to recommended technologies that are simply not appropriate for Nigerian farmers. Yet this explanation is perhaps the only one that can provide a realistic and, hence, effective basis for improving the effectiveness of agricultural research in the country.

Fortunately, the Federal Ministry of Science and Technology is now strongly committed to the development of a research organization that would enhance the level of adoption by farmers of recommendations emanating from national research institutes. To this end, the ministry has taken the following actions:

* In 1981, it directed that all research institutions concerned with food production should evolve a farming systems research program.
* In 1982, it organized a training workshop on farming systems research.
* In 1983, it created a national coordinator for farming systems research in the country.

The ministry is now clearly desirous of an agricultural research strategy that would refocus and reorient research specifically towards bridging the gap between agricultural performance under experimental conditions and under farmer's conditions. This strategy, while benefiting from past experiences and efforts, is nonetheless expected to alter previous research approaches and processes in favor of developing integrated packages of agricultural technologies in time and space for the peasant farmers of Nigeria. Farming systems research has considerable potential for providing the needed impetus in this direction.

It could be said that the three principal elements that

Table 1. National Research Institutes in Nigeria.

Institutes	Station Headquarters	Year of Origin	Year of Formal Establishment
Food Crops			
Institute for Agricultural Research (IAR)	Samaru, Kaduna State	1922	1962
National Cereals Research Institute (NCRI)	Ibadan, Oyo State	1975	1975
National Root Crops Research Institute (NRCRI)	Umudike, Imo State	1923	1975
National Institute for Horticultural Research (NIHORT)	Idi-Ishin, Oyo State	1975	1975
Institute of Agricultural Research & Training (IAR&T)	Ibadan, Oyo State	1956	1962
Tree Crops			
Cocoa Research Institute of Nigeria (CRIN)	Gambari, Oyo State	1944	1964
Nigerian Institute for Oil Palm Research (NIFOR)	Benin, Bendel State	1939	1964
Rubber Research Institute of Nigeria (RRIN)	Iyanomo, Bendel State	n.a.*	1975
Forestry Research Institute of Nigeria (FRIN)	Ibadan, Oyo State		1975
Livestock			
National Veterinary Research Institute (NVRI)	Vom, Plateau State	1924	1975
National Animal Production Research Institute (NAPRI)	Shika, Kaduna State	1927	1975
Nigerian Institute for Trypanosomiasis Research (NITR)	Kaduna, Kaduna State	1947	1975
Leather Research Institute of Nigeria (LRIN)	Zaria, Kaduna State	1964	1975
Fisheries			
Lake Chad Research Institute (LCRI)	Maiduguri, Borno State	1960	1975
Kainji Lake Research Institute (KLRI)	New Bussa, Kwara State	n.a.*	1975
Nigerian Institute for Oceanography and Marine Research (NIOMR)	Lagos, Federal Territory	1975	1975
General Services			
Agricultural Extension and Research Liaison Services (AERLS)	Samaru, Kaduna State	1922	1975
Nigerian Stored Products Research Institute (NSPRI)	Lagos, Federal Territory	n.a.*	n.a.*

* information not available.

Source: Adapted from Idachaba, F. S. 1980. „Agricultural Research Policy in Nigeria." International Food Policy Research Report Number 17. Washington, D.C.

distinguish farming systems research from traditional agricultural research are that (Rohrbach, 1980):

* it involves an explicit attempt to understand the farm, the farmer, and the farm environment as a complex system of interdependent parts;
* it initiates the research process with an attempt to determine research priorities on the basis of an analysis of the characteristics of representative target farmers and target villages;
* it permits the entire process of research, including the analysis of the farming systems, the technology development and testing, and the verification of the results to be carried out by interdisciplinary teams of social and biological scientists.

The need for a farming systems research strategy has been prompted by the fact that new technologies developed so far in the country have not made far-reaching impact. For the expected impact to be made, new methodologies must be designed that would lead to the development of improved agricultural technologies that are appropriate to the needs and circumstances of the majority of farmers in the country.

Farming Systems Research in Nigeria

Although the interest of the federal Ministry of Science and Technology in farming systems research has only recently surfaced, and some national research institutes in the country are only now being exposed to it, the concept itself is not new in Nigeria. As early as 1958, researchers at the Institute for Agricultural Research at Samaru, Zaria had shown concern for the low response of farmers in northern Nigeria to the adoption of many of the recommendations that were emanating from the institute's work. They argued that the advice that was being given by the research division on how to produce the highest possible yield per acre of a particular crop "cannot and must not be interpreted as defining how best that particular crop may be fitted into the existing pattern of peasant agriculture" (Gisborne, et al. 1958).

Farming systems research is theoretically viewed as concerned with the interrelations of all the interacting components which make up the farming systems in the country: the land itself and the structure of farms and yields imposed on it, the climatic and soil fertility influences which operate, the labor resource and how it is used, the capital available for farm improvement, and the relationships with input delivery and marketing services (Fisher et al. 1982). In practice, however, this is far too vague, and farming systems researchers in the country are increasingly becoming aware of the need to focus on identifying the constraints which operate in the farming systems and testing technologies which might alleviate them. In this regard, the following processes suggested by Fisher and Lagoke (1982) might be said to be relevant for the Nigerian context:

* Identify the constraints operating to limit output of a particular farming system, usually represented by a target area of size not greater than a local government area.
* Evaluate, on the basis of existing information, possible technologies which might overcome the most important constraint(s), not so much from the viewpoint of their biological or technical efficiency but from the viewpoint of whether or not they are appropriate for use by the farmers who exist in the target area.
* Test, usually on farmers' fields, the technologies which appear to be appropriate and then either:
  * reject them and try something else,
  * modify them and try again,
  * accept them and propose the necessary institutional action to facilitate their adoption (extension, input delivery, marketing).
* Monitor the adoption process and either:
  * continue to modify the technology as necessary,
  * be prepared to try something else if, despite the on-farm testing, the technology is not widely adopted,
  * identify and propose solutions for the next most important constraint if the technology is being adopted.

The approach differs from conventional crop improvement strategies in that it begins with an assessment of what would most benefit the whole farming system rather than aiming to improve a predetermined crop with the system. The approach is also more farmer oriented.

Organizational and Management Problems

In this section, we examine some of the organizational and management problems that have confronted those national agricultural research institutes in Nigeria that have attempted to evolve a farming systems research program. While the scope of the discussion is national in content, the emphasis is on the Institute for Agricultural Research at Samaru, since this institute is among the very few in the country that can be said to have a functioning farming systems research program. However, the organizational and management problems faced by other research institutes in their own attempts to develop a farming systems research program or perspective are also discussed.

Reorganizational problems

Research in national agricultural research institutes in Nigeria has traditionally been divided along disciplinary lines. This has posed several problems whenever attempts have been made to reorganize existing structures in research institutes to capture a farming systems research perspective or to develop a full-fledged farming systems research program. Because of these disciplinary divisions, one reorganizational issue that immediately comes up is whether a separate farming systems program is to be pursued or whether a farming systems perspective or approach to research is to be incorporated into the ongoing research process (Conroy, 1983).

Because of the relatively self-contained nature of existing departments in national research institutes, several of these institutes have opted for the creation of a new department to direct farming systems work outside existing departments. Although it is too early to judge, this type of arrangement has a number of drawbacks. First of all, it does not fit in well with existing structures and functions of research departments. Second, this lack of fit is likely to prevent the development of the desirable linkages among research scientists of different disciplines.

The alternative that immediately suggests itself here is the creation of a farming systems unit within an existing department. The problem with this alternative is that such a unit is likely to be overly identified with the department in which it is embedded, thus losing its neutrality.

The problem of where to house the farming systems research unit has not been a particularly serious one for the Institute for Agricultural Research at Samaru. At Samaru, the administration of research is organized along departmental lines, while the implementation of research is organized along commodity lines. The present organizational structure of the institute is presented in Figure 1.

It was possible to create a farming systems research program that cut across departments and programs. This is not to say that well-entrenched staff in the commodity-based programs and the discipline-based departments did not feel threatened by this supposed attempt to venture into their established territories.

Indeed, the large number of crops that this new program had to accommodate, together with the logical implication that hitherto existing service-oriented research programs (such as mechanization, soil and crop environment, science and technology, and irrigation) could be more appropriately consolidated within it, created an uneasy feeling among several biological researchers who feared that a giant territory-grabbing monster was created.

In the end, skilled diplomacy, coupled with exhaustive communication among and between research scientists, finally convinced most researchers that the idea should be given a trial. As a gesture of goodwill to the crop-based research programs, a decision was taken to house an on-farm research subprogram in each commodity-based program. This had the additional advantage of not only providing program leaders of the commodity-based programs with direct control over on-farm research of crops of interest to their programs, it also provided a direct linkage between the crop-based programs and the farming systems research program.

Although this organizational arrangement is not yet completely sorted out, it is expected that on-farm studies housed in the crop-based programs will engage more in "upstream" or "perspective" farming systems research while the farming systems research program proper will involve more "downstream" or "interactive" farming systems work. The on-farm studies in the crop-based programs will emphasize the development of prototype crop technologies which will facilitate major shifts in the potential productivity of the major farming systems found in the sphere of influence of the institute. In the meantime the main farming systems research program should focus on immediate solutions for specific local situations and conditions on the basis of an understanding of the farming systems and their constraints.

Organizational and Management Issues

There are several management and organizational issues which must be successfully resolved in order for farming systems research to be effectively organized in a research institute in Nigeria. These are discussed below.

Team work

A farming systems research program necessarily requires a team approach with each member of the team contributing to the improvement of the farming systems by concentrating on a different facet of the same problem, while being supported by other members of the team on a broad front. Experience, however, has shown that the establishment of a cooperative working arrangement between social and biological scientists can be quite difficult and complex. Because of the strong disciplinary nature of existing research processes at national research

institutes, the tendency has been for the various disciplines to be isolated from each other. This, in turn, has deepened disciplinary barriers, led to a situation where furtherance of the disciplines took on a more important role than solving farmers' problems, and prevented simultaneous attacks on the major facets of the relevant constraints within the farming system in an area.

Consequently, the development of a cooperative process of working interaction between the various groups of scientists represented in each institute would be difficult unless each group made a concerted effort to understand each other's disciplinary perspective. It must, however, be pointed out that the successful establishment of a cooperative working arrangement between the social and biological scientists depends strongly on an initial recognition by the biological scientists of the importance of sociocultural and economic considerations to the usefulness of their own work. In addition, since academic training in the rich and agriculturally successful industrialized countries is entirely along disciplinary lines, it may be difficult to convince research workers in Nigeria or in most other national research institutes located in developing countries of the validity of work in different disciplines (Conroy, 1983). Furthermore, in most Nigerian academic institutions as in most academic circles in the world, the amount of published work determines a scientist's reputation to a large extent. Since interdisciplinary work is not so publishable, it may be difficult to convince researchers of its value in promoting their upward mobility (IAR, 1982). Given the present entrenched disciplinary bias in most national research institutes in the country, the creation of the necessary team spirit among researchers to support a successful farming systems research process may turn out to be a very difficult task.

The issue is perhaps not of serious concern at this point to economists and other social scientists who can point to an increasingly large number of their colleagues who "have made it" by persisting as farming systems practitioners. However, very few farming systems research studies are capable of generating response surfaces that can be published by the biological scientists in "reputable" journals. Consequently, academic rewards accruable from interdisciplinary team work are at best doubtful at present.

Rewards and recognition

Having established the doubtfulness of academic rewards to be gained from farming systems research, it is pertinent to inquire about the possibility of other forms of rewards for members of the research team.

The financial structure of national research institutes in the country makes no provisions whatever for financial rewards that are commensurate with the hardships that are encountered by farming systems research practitioners in the course of their work. While staff working for international research centers or those being sponsored by well-endowed funding organizations can normally expect to receive huge allowances which go a long way toward making up for the many inconveniences suffered in the field, researchers working for inadequately funded national research institutes must make do with such discomforts as sleeping two or three in a bed in rundown facilities so as to conserve their meager allowances, eating poorly in mediocre restaurants since these are usually the only places they can afford, and drinking water of questionable quality. The point being emphasized here is that farming systems research can only be successfully carried out by researchers in national research institutes who are genuinely dedicated to solving the farm problems of farmers and who are themselves dissatisfied with existing research processes. These are the kind of researchers who usually find intrinsic enjoyment in their research efforts quite apart from monetary benefits. This fact notwithstanding, it would not be asking too much if sufficient allowances were provided to such researchers so that they are not forced to spend more on their upkeep in the field than they would have had to if they had remained in their research stations.

Funding

The commitment of Nigeria's federal Ministry of Science and Technology to the development of farming systems research programs in all national agricultural research institutes has been clearly established. What is not yet clear is whether the ministry is prepared to back this commitment with the necessary degree of financial support. This question takes on particular significance since the operating cost of field research is usually quite high. A genuine farming systems project requires considerable logistical support in the form of improved seed, fertilizer, herbicides, insecticides, fungicides, and extension support. It also involves quite a bit of travelling by research scientists between different research villages. The total costs for this type of research would of necessity be higher than those for traditional on-station research. A farming systems program thus would necessarily require new

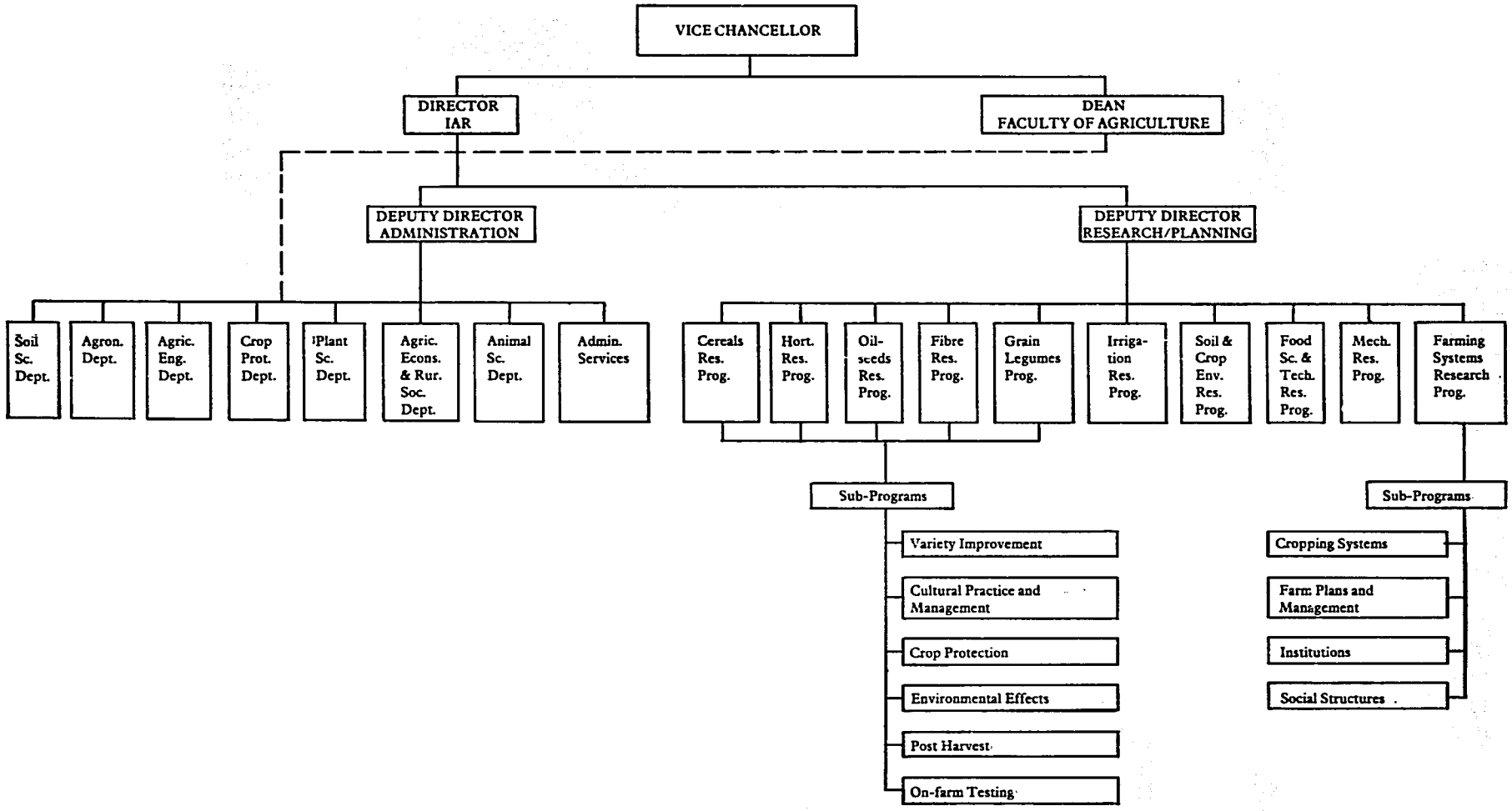

Figure 1. Administration and Research Organization at the Institute for Agricultural Research (IAR), Samaru, Zaria.

investments in field vehicles for transport to widely dispersed farms which are frequently located along different access roads. It would also require large acquisition of needed agricultural inputs as well as a large variety of research personnel.

Given the tight financial position in which many national research institutes have been operating in recent years, the question must be asked whether the funds needed for a successful program can be diverted from departmental and crop-based programs or whether new sources of funding should be found. It is quite clear that the lack of monetary support could significantly hinder the establishment of a viable farming systems rsearch program. There is a real danger that following in the directives from the ministry, considerable efforts would be spent planning and organizing farming systems research programs in national research institutes without these efforts actually resulting in researchers getting out to the field due to logistical constraints in the form of travel, night allowances, etc.

Scope and focus

The issue of the appropriate scope and focus on farming systems research institutes in the country needs to be resolved. The component parts of a full-fledged farming systems research program are many and complex, and a truly holistic approach that aims at taking into account all the important interrelations would be beyond the means of most research institutes. On the other hand, the advantage of a wider research perspective lies in the greater possibility for exploiting the interdependencies within the system under the influence of a national research institute.

With regards to focus, the choice is between a concentration on a few selected technologies or enterprises which are considered to be of major significance to the farming systems in an area (e.g., specific crops) and a wider mandate that covers the systematic problems involved in the development and adaptation of all the crop technologies under the jurisdiction of an institute. The advantage of a wider scope lies in the fact that it permits the maintenance of each institute's responsibility for a wide variety of crops, and it presents a better chance to exploit the systematic complementarities and interdependencies of the farming system. On the other hand, the narrower research focus has the advantage of being more manageable and within the limits of the resources available to these institutes.

Relationships with national development programs

Since each institute's objectives have been established within policy guidelines of the government, it is desirable for the objectives of the farming systems research program of each institute to be aligned with those of the agricultural development process already in motion.

It would be difficult to successfully introduce wide-ranging improvements in technologies or in the farming systems in the country without operational national or state agricultural support services. There is, therefore, a need to establish a cooperative relationship between national, state, and local government agricultural development efforts and the farming systems programs. This relationship is necessary, not only to accelerate the impact of the work of national research institutes, but also as a means of providing logistical support in the form of seed, fertilizer, herbicides, fungicides, extension advice, etc., to farming systems research efforts at national institutes.

Unfortunately, the present relationship between development projects in the country and research efforts in national institutes leaves much to be desired. The development projects are administered by the Ministry of Agriculture with the assistance of the World Bank. In-house squabbles between staff of the ministry and the Bank, the latter being determined to maintain the scope of its control, have prevented the administrators of these projects from speaking with one voice. For example, while the Federal Agricultural Coordinating Unit (FACU) of the World Bank-assisted projects is busy developing farming systems research linkages between national research institutes and the projects, the monitoring arm of the projects (Agricultural Projects Monitoring and Evaluation Unit, APMEPU) is at the same time engaging consultants to help it build a farming systems research capability in its new generation projects. Naturally, the Federal Ministry of Science and Technology, which in any case has been left in the dark by both FACU and APMEPU, is unable to do much. The end result is stalemate and lack of progress.

For this pathetic situation to be improved, the Ministry of Agriculture would need to curb the territorial ambitions of its warring parties, clearly define their roles and functions, and establish formal communication links with the Ministry of Science and Technology, which in turn would coordinate the needed farming systems research process in all the national research institutes under its jurisdiction.

It is obvious that the information flowing from this kind of a coordinated farming systems research network in the country, when systematically shared with administrators of the development projects, would greatly increase the effectiveness of efforts to

develop and disseminate new technologies from national institutes to farmers in their respective areas.

Conclusion

A vast amount of agricultural research has been carried out in Nigerian agricultural research institutes to generate new technologies and practices that would increase the output on farms and improve the welfare of farmers. Most of these research institutes have been quite successful in demonstrating that it is technically possible to grow very high yields of the locally important crops using good varieties, fertilizers, protection chemicals, and high plant populations (Fisher, et al, 1982). However, the impact that these research institutes have so far made on the agricultural development of the country has been limited. Despite all the efforts of the institutes, farmer practices still lag seriously behind those obtained at the research institutes.

There is now a growing concern in the country about this gap, and the Nigerian government is determined to reduce or eliminate it. There is also a growing interest in farming systems research as the best way of achieving this objective. The conviction is spreading that farming systems research processes should be established in all national research institutes in the country as a means of bridging the gap between agricultural performances at research centers and those on farmers' fields.

These research institutes are being encouraged to reorganize their existing research processes so as to create a research capacity able to develop new technologies which can be readily adopted by Nigerian farmers.

Many organizational and management problems are bound to arise as a result of these efforts. Experiences from institutes such as the Institute for Agricultural Research at Samaru, which has made a concerted effort to establish a farming system research program, as well as those from other institutes in the country which are in the process of attempting the task, point to several formidable organizational and management problems which can be expected to occur, including those related to interdisciplinary research, funding, and linkages. The most crucial question, however, is likely to be whether the government's commitment to farming systems research as the best way of improving the relevance of research work at its national research institutes can be translated into action by way of administrative and financial support, or whether the commitment is really just a fad which, like all fads, will die a natural death.

There is a real danger that the organizational and management problems to be encountered in the process of developing a farming systems research capability in national research institutes may, if not properly addressed, result in researchers engaging onlv in academic exchanges without any possibility of getting out into the field to demonstrate the potential of this innovative research process. True, farming systems research cannot be a panacea for all problems of agricultural development in the country. It can, however, provide an opportunity for farmers to articulate their felt needs, thus making research and technology development more appropriate. Teams of interdisciplinary scientists go out into farmers' fields to identify common farm problems and constraints. Hypotheses for technical research are then formed. Solutions are then designed and tested. In this way, the research results are useful, relevant, and adoptable because the researchers and the farmers are all working together.

This sounds very straightforward and simple. However, there are many critical organizational and management problems which could turn this simple but innovative research process into an academic exercise.

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3.5 ICTA Production-oriented Research

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Introduction

For any nation to win the fight against hunger and malnutrition and to acquire self sufficiency in food production, it is necessary to develop a concerted effort on the part of scientists, planners, administrators, and farmers alike.

Guatemala, up to 1980, had been a net importer of maize, beans, rice, and wheat, the staples of the country. With the exception of wheat, where a production limit has been set, this situation has now changed, due mainly to the efforts of the government which, in 1970, took the necessary steps to reorganize the Ministry of Agriculture, establishing the Public Agricultural Sector, on the basis of a coordinated, decentralized, and regionalized service sector.

Of special significance in this reorganization was the establishment, with the technical aid of the Rockefeller Foundation, of the Institute of Agricultural Science and Technology (ICTA: Instituto de Ciencia y Tecnología Agrícolas), to meet not only the production goals on basic grains set up by the government in the National Development Plan, but also to stimulate rural development.

Other lines of activity were established: horticultural crops for export and local consumption, deciduous fruit production, and a program to raise the levels of meat and milk production.

ICTA Organization

The production of small grains and other food commodities is in the hands of small- and medium-sized farmers, an important sector lacking resources, having a low level of education and technology, and consequently generating marginal yields.

To be able to cope with the problem of generating adequate technology for specific conditions, ICTA developed an integrated, multidisciplinary system that functions at the regional or subregional level. The traditional organization of the department was changed to a system of national commodity programs focused upon farming systems and oriented toward production.

ICTA is governed by a Board of Directors presided over by the Minister of Agriculture.

The General Manager is responsible to the Board for the operational procedures of the institute, which is organized into three main units:

* Administrative and financial services,
* Programming unit, and
* Technical unit of production.

All of the scientific and technical work is carried out within the technical unit. Two distinct working groups are recognized: (1) commodity production programs, and (2) support disciplines.

The programs assume primary responsibility for generating production technology, and in this endeavor the discipline provides support activities. At the national level, the coordinators of programs and disciplines can form a technical coordinating committee, presided over by the director of the technical unit, which reviews results, coordinates activities, and approves recommendations.

At the regional level, all coordinators of programs and disciplines who have projects in the region form a coordinating and advisory committee amounting to an integrated and multidisciplinary regional team. It is at this level that the majority of the technical work is conducted.

The Integrated, Multidisciplinary System

The work of the regional team – namely, the generation, validation, and promotion of technology – is divided into five broadly defined activities:

* Agrosocioeconomic studies
* Breeding work
* Farm trials
* Farmers' tests
* Evaluation

The initial generation of technology is carried on at the experiment stations, where a great deal of emphasis is put into developing new varieties or hybrids of the different crops adapted to specific site conditions.

Some agronomic data is obtained at the research centers, but the most useful information regarding agronomic practices or variety tests come from farm trials, which also include economic evaluation of these practices. The next step is the establishment of farmers' tests where the farmer becomes the prime evaluator of the technology generated by ICTA. The purpose is to get much more realistic information on how the practice or the technology will work when managed by the small farmer, and particularly to get a much better estimate of the risk factor. In the year following the farmers' tests, ICTA again becomes the evaluator. If a high proportion of the farmers put the technology into practice on over 50% of their land, it can be considered well accepted, and it is promoted as a technology that will be readily received. ICTA works for all farmers of Guatemala, but the small farmer is considered the principal client.

The technological system devised by ICTA to generate and validate adequate technology for the small farmer just described has already proven its merit. ICTA was inaugurated in May 1973, and in the short span of eight years its contributions to Guatemala agriculture had made the country self-sufficient in the production of staple foods needed to adequately feed its population.

Main Achievements

The intitial emphasis of ICTA's work has been to conduct research on the traditional cropping patterns, either for polyculture or monoculture. More than 70 varieties or hybrids of maize, beans, rice, wheat, sorghum, sesame, and potatoes with superior agronomic characteristics, higher yield potential, and higher nutritive value have been developed and are now widely grown. Also, some new agronomic and milk production systems requiring intensive labor use have been developed for the small farmer, along with marketing schemes to channel their production. Following is a resume of the main results.

Maize

In 1976, ICTA's varieties or hybrids were planted on about 20,000 ha. In 1982, the area planted had been increased to about 128,800 ha (455,000 ha is the total planted in the coastal area), which meant an extra increase of about 128,000 tons of grain valued at US$ 22,500,000. For the sake of comparison, the 1982 ICTA fiscal year budget was about US$ 4.2 million and the maize program budget for this same year was US$ 250,000. Thousands of small farmers who formerly had to purchase maize for family consumption are currently self-sufficient and so is the country now, despite droughts, flood, and social disorders that have taken place during this same period.

The most recent and major contribution has been the development of Nutricta, an improved corn variety with a balanced lysine and tryptophane content that renders its nutritive value as high as 90% the nutritive value of milk.

If we were to consider only its social benefits, this sole achievement justifies the time, effort, and financial resources invested in research.

Beans

The major problem ICTA faced at the start was the virus mosaic BGVM, which had reduced bean production by 40% and caused bean prices to go up more than 300% over a short period. For most Guatemalans, the combination of corn and beans constitutes the main source of protein; because of the BGMV problem, a significant portion of the rural population had dramatically decreased bean consumption with a corresponding negative consequence in their nutritional status.

Actually, the country is self-sufficient in the production of beans, and farmers are producing enough even for the market.

Furthermore, the improved varieties are currently being utilized either commercially or as sources of resistance in several national programs -- to mention a few: Argentina, Colombia, Venezuela, Cuba, Nicaragua, and Mexico.

Rice

Currently about 70% of the total rice area is planted with ICTA's varieties, and importation of rice seed dropped 45% from 1981 to 1982. It is expected that there will not be any importation in 1983 nor in the near foreseeable future.

To find out the real impact of the new varieties at small farmer levels, ICTA conducted a farm-record study in an important though small farming area. In 1977, rice yields in that community were 0.526 t/ha, and farmers were getting a net income of minus US$ 11.32/ha. An improved variety of rice was introduced in the area along with some simple agronomic innovations. Three years later, the same sample of small farmers were getting 3.25 t/ha and a net income of US$ 484.00/ha.

Sorghum

There are two important sorghum-producing areas in the country, each facing different problems. In the southeast where droughts are common and the fertility level is low, farmers have late maturing, disease susceptible varieties, and yields are low. On the Pacific coast, sorghum is grown commercially for the feed industry.

In the southern coastal region, often corn and beans plantings fail because of lack of rain at a critical stage of growth, and sorghum becomes the insurance crop.

The introduction of edible, early, and high-yielding varieties has benefited a population of nearly 90,000 small farmers, who can resort to eating sorghum should their corn crop fail on account of severe droughts.

For the commercial sorghum-growing area on the Pacific coast, a new hybrid has just been released that shows better agronomic characteristics and yields than the hybrids currently imported.

Wheat

This crop is planted in the highlands, mostly by Indian small farmers, as a cash crop. About 250,000 inhabitants have benefited from an improved wheat production technology. Yields are now about three times as high, and costs of production have been reduced by about 30%.

Sesame

A very important cash crop for the small farmer on the Pacific coast, sesame either is exported for oil extraction or utilized in the manufacture of baby food because of its good quality and high protein content. Blanquina, a highly prized variety, is highly susceptible to stem and root rot and yields only 0.5 t/ha. It has been replaced by two disease-resistant varieties yielding over 1 t/ha.

Potatoes

Potato is a very important crop in the highlands with some 50,000 small farmers involved in its production. It is grown as a component of a very complex farming system, and it has different roles: staple food, cash crop, and feed crop.

ICTA has released improved technology that reduces costs up to 50% and increases net income by about 200% to 250%. Part of this technology involves simple storage facilities that enable farmers to store the potato crop for a three-month period with minimum loss in weight or through rot. Economic and social implications for some 250,000 people seem to be significant.

It is not considered necessary to discuss at this time other important ICTA accomplishments, which include: horticultural production for export, meat and milk production in the tropics, efforts to make the country self-sufficient in apples and grapes, and more.

Seed production

In 1973, the production of seed was negligible, and most seed was imported from the United States and other nearby countries.

As a result of ICTA's activities and its commitment to the seed industry, a National Seed Production Association has been formed with 23 members actively participating in the trade. There are three seed processing plants privately owned, where formerly there was only one. A seed law is ready for enactment and 3,200 tons of certified seed were made available to the farmers in 1983. These are quite impressive figures considering the short time which has elapsed since ICTA came into being. These achievements have occurred in spite of shortages of personnel and budgeting difficulties which have forced ICTA to terminate or curtail some activities.

How Was This Done?

This very pertinent question brings us to the central theme of this meeting: organization and management

issues which have been found useful in the application of this type of research.

A number of factors were involved in the development of ICTA and its programs, but perhaps, the two most important considerations were government support and international support.

Government support

National governments are the prime factors in food production and rural development, and it is incumbent upon scientists to help those making political decisions to rationalize demographic and food production programs.

At the time of ICTA formation, some of the top officials of the Ministry of Agriculture as highly qualified technicians were rather conscious of the decisive role that research could play in the improvement of the country's agriculture.

Concomitant factors to the institutionalization of research, with initital impetus on basic grains oriented to small- and medium-sized farmers, were the formation of a Public Agricultural Sector to provide services on marketing, credit, and technical assistance, along with the regionalization concept that helped to orient the first research activities.

International support

Even before the formation of ICTA, strong ties were established with CIAT, CIMMYT, and CIP, whose help was necessary to develop not only new technologies now of common use by farmers, but to develop institutional capacity through advice and help whenever it was deemed necessary and through personnel training. These ties created a two-way relationship, showing that international cooperation can be helpful to strengthen national programs and also to widen the scope of work of the international centers.

ICTA has also received support from the Rockefeller Foundation, USAID, BID (Inter-American Development Bank), the Swiss and Taiwan governments, and from two Central American regional organizations: INCAP (Central American Institute for Nutrition) and CATIE (Agronomic Center for Research and Training).

The strategies of ICTA

There is definitely the need to establish well-defined policies and strategies of research work. At times it may only be necessary to reach an agreement on what is required from a research program. However, a safer procedure is to require a written project where all lines of activity are clearly defined. ICTA employs the following strategies.

Leadership selection

The leaders at the different levels of the institute must have leadership qualities and experience in agricultural research and be convinced of the necessity of a farming research approach. The selection is always based on technical criteria. Participation of international agencies could be very helpful.

Autonomy

Depending on national policies, this aspect varies from country to country. An autonomous research institution is able to avoid bureaucracy and speed up efficiency.

Everything is organized and works under a scientific and technical framework. Scientists are reminded at all times that generation of technology must be always production-oriented according to the objectives of the institution.

National commodity programs

It has been ICTA's experience almost from the beginning that seed is the most easily accepted technology on the part of the farmers. And yet, the adoption of genetic materials developed by the programs depends to a high degree on a series of interrelationships of supply and demand, of socioeconomic factors at times deeply rooted in tradition, of the prevailing cropping systems, etc.

Program coordinators in their breeding endeavor must be on the alert at all times for the implication of these socioeconomic factors on their work and also keep an eye on those aspects of national policies on farmers' problems that may eventually affect adoption of their varieties.

Support disciplines

The strategies set up by ICTA to develop and strengthen the country's seed industry are a good example of the role of a support discipline. Seed producers are allowed to make free use of genetic seed for the production of registered or certified seed. The involvement of private initiative and the establishment of price incentives along the production-marketing chain, coupled with assistance to the seed producers in the processing, storing, and

marketing phases, have made it possible for the end-product of research to be available to the farmers when needed.

Efficient use of resources

Human and economic resources are efficiently used. Prioritization is crucial in order to concentrate resources on a very few activities. Otherwise, resources become diluted and efficiency decreases.

Physical infrastructure

ICTA has a stringent policy against luxury. Buildings, laboratories, offices, greenhouses, equipment, machinery, etc., are kept at the necessary minimum. Most of the work is on-farm research, and investments are mostly in vehicles, fuel, and other means of mobility.

Flexible and simple administration

Excessive bureaucratization is detrimental; so administrative personnel have to be kept at a minimum. ICTA has one Ph.D., 27 at the master's degree level, 120 university graduates from the University of San Carlos de Guatemala, and 34 paraprofessionals. Administrative personnel (17%) must be kept at a minimum.

Foreign personnel

All the weak areas where expertise is lacking, could be reinforced by foreign scientists. In the meantime, national personnel should be trained locally or abroad. ICTA's policy has been to apply the same norms and regulations to local personnel and foreigners alike. "Advisers" with special status are not beneficial.

Training

This is a key issue, as programs and projects are carried out by human beings and not by the plans themselves. At least two main types of training are needed:

* Academic training in foreign universities at the graduate level.
* Discipline- or production-oriented courses where trainees can learn about farming systems philosophy and methodology. This training can be done at an international center or at the local level.

Incentives

Very often national agencies in less developed countries are not able to provide economic incentives. However, it is strategically important to search for other incentives for personnel. Interest, initiative, responsibility, creativity, and stability can be fostered with such incentives as training, aid for publications, meetings, conferences, etc.

A well-established program to pursue postgraduate studies should increase the institution and national scientific capability and at the same time make research more attractive.

Bottom-up decisions

Technical decisions must be based on farmers' needs and desires, and not on what the technician thinks could be a useful or usable technology. It is important to involve the farmers in the process of generation and validation of technology. A lot can be learned from them, and decisions should be taken as a team rather than individually.

Planning and evaluation

Based on farmers' real needs, planning and evaluation must be carried out by a team rather than by individuals.

Personnel stability and continuity

An institution may have excellent programs and yet their execution will depend entirely on the capabilities of its personnel. Stability and continuity allow experience and evolution. Research results are not obtained overnight; it takes a lot of effort and time, and it is a learning process. Keeping the same personnel as long as possible could help to speed up this process.

Simple options for farmers

The technology being generated must be as simple as possible. Farmers should be able to manage the technology without too much supervision, so that they can make their own evaluation. If it is useful, it can be easily adapted and extended. Because technology transfer is part of the same process, extension methodologies must follow the same principle of simplicity.

Summary

The results obtained with a new production-oriented research dimension have been presented. The two main factors for its establishment were the decision of the government to speed up production through

research and the technical help, mainly from international centers, other specialized agencies, and friendly governments.

The strategies followed show that the model is simple and easy to adopt; no drastic changes in the existing organization are required. However, the decision to bring change into existing institutions, or to create new ones, will depend on the prevailing atmosphere.

Definitely, production-oriented research can go a long way in helping the nations to overcome food shortages.

The decision must be made now. Tomorrow may be too late.

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3.6 Experience in Organization and Management of Research with a Farming Systems Perspective in Panama

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Introduction

The need to accelerate the process of generation and transfer of appropriate technologies is the challenge currently faced by most agricultural research organizations in developing countries. This challenge is underlined by the urgent need of those countries to substantially increase agricultural development, and it pushes researchers to find mechanisms and methods to incorporate the perspective of the farmers' environment and behavior into research in order to attain quick results. The challenge is also strengthened when resource constraints constitute a barrier to proper implementation and growth of farm-oriented research programs. The adequate planning, administration, and management of such agricultural research programs is thus one of the most difficult tasks encountered by research institutions in developing countries.

We are convinced that a farming systems research program must be set up from its initial stage in such a way as to provide rapid answers to properly identified problems, along with low-cost, minimum-risk technological alternatives aimed at increasing productivity and improving the standard of living of farmers and rural communities. The organization and management of such research programs should bear those objectives in mind, and therefore mechanisms and methods to accomplish them need to be considered when analyzing experiences in the implementation of farming systems research programs.

Our experience with farming systems research in Panama has provided us valuable and useful information during the last five years. On the basis of such experience, the Instituto de Investigación Agropecuaria de Panamá (the Agricultural Research Institute: IDIAP) has designed strategies and made adjustments in its organization in order to increase its efficiency in the implementation of this type of program.

Although IDIAP is presently working in eight priority areas in the Republic of Panama, and about 60% of the research action is performed in small- and medium-sized farmers' plots, our most successful experience comes from the Caisan area, a location of about 10,000 ha with some 300 farmers who cultivate predominantly maize and beans in rotation every year. The area is located in the western part of the country where the annual average rainfall is 4,000 mm, and the temperature ranges from 18°C in the dry season to 22°C in the rainy season.

After four years of conducting on-farm research in Caisan, IDIAP – with the technical assistance and collaboration of CIMMYT and working with a restricted systems approach (focusing on priority crops and concentrating on the most promising research opportunities in terms of their potential for increasing productivity and income for target farmers) – developed technological alternatives for the maize crop that were adopted by up to 80% of the farmers (Arauz and Martinez 1983). (Technological alternatives developed in Caisan are based on appropriate weed control, planting in rows, higher density planting, no fertilizer usage, and zero or minimum tillage.)

The adoption of these alternatives, as well as of those generated for the bean crop, has resulted in the doubling of yields for both crops and lowered production costs. The following discussion on organization and management of farming systems research will be based mostly on the Caisan experience, the first one established, but also on other area-focused research programs being planned or implemented at present in Panama.

Research Planning Strategies

Farming systems research and the production process

The organization and management of a farming systems research program depend upon the strategies, objectives, and goals of the program. As the objectives are accomplished, the organization needs to be adjusted in order to increase its adequacy to the structure of a regional agricultural or rural development process. Research plays a significant role, but it is only part of agricultural development. Therefore, we cannot and should not limit ourselves to developing technologies for production, if at the same time we do not contribute to holding tightly the different links conforming to the agricultural production chain. In this sense, an effective organization implies having an adequate operational structure, a well-structured program, and efficient mechanisms for relating with other organizations in the agricultural sector.

The systems approach is essentially an ecological approach where man constitutes the center of the studies of the ecosystems and the biosphere. Therefore, an ample, multidisciplinary, integrated approach is needed in farming systems research, in which not only agronomists, biologists, and economists participate, but ecologists, sociologists, and anthropologists as well. The development of appropriate technologies should then – besides removing man from his inefficiency, ignorance, and poverty – contribute to self-realization in his cultural, social, and ecological environment. We believe that this humanistic part must be a major concern of any rural development program.

Area characterization

Proper characterization of an area or region in which farming systems research will be implemented is not an easy task. Knowledge of social and cultural variables, besides the agroeconomic ones, is important.

However, we should not take too long in diagnosing these variables, at least in the early stages. We have experienced cases where it took almost one year to characterize and analyze the data from an area or region before field research started. This is not convenient for a research institution, especially when scarcity of resources is a limiting factor, and the country's agriculture demands rapid answers to the problems faced. However, when an adequate land resource plan is lacking, making it difficult to determine the best possible use of land from both the agronomic and ecological points of view, it may be hard to initiate long-term efforts in designing and implementing farming systems research projects. Work with existing systems or modifications of them must be done gradually, because any changes must take into consideration the most appropriate means of use and management of natural resources, with both the farmers' needs and the country's agricultural development needs in mind. This is a difficult task requiring a clear governmental orientation and definition of agricultural policies. It is possible that reality exerts pressure to take immediate action, making us overlook the country's main developmental objectives and goals. But how can we cope with these overall objectives and goals and the urgent needs of farmers located in areas suitable only for them to subsist but not make a significant contribution to the country's agricultural development? If we can develop systems for subsistence farmers to increase the quantity and quality of their food production, along with cash crops to raise their income, we will probably make a good contribution to their social and economic welfare. This brings up the question of what type of agricultural technology we should develop. The Government of Panama has recently imparted instructions to separate programs aimed at a commercial production from those oriented towards the social welfare of the poor.

From a sociocultural standpoint, different types of farmers have different attitudes and expectations; so it is important to identify correctly their problems as they see them. An anthropological study conducted in a region of Panama (Heckadon, 1983) revealed five different types of farmers, all involved in the production process: big, medium, small, subsistence, and landless farmers. A farming systems research approach should treat each type differently. From a biological point of view, the greatest difficulty will be encountered in solving the problems of the subsistence farmers. One has to differentiate between a research effort oriented towards commercial production and a socially oriented research effort aimed at improving nutrition, changing habits, and improving production methods to ameliorate social structures.

A restricted systems approach

Once priority areas and farmers are identified, depending upon national agricultural development plans (e.g., Caisan, Panama), the area-focused research should concentrate on priority crops and problems. This type of restricted systems approach was utilized in Caisan, and in part it is probably responsible for the success of the program.

Characterization of the area from an agroeconomic point of view through exploratory and formal surveys did not take more than two months and permitted, without exceeding the normal resource allocation for the area, a quick pin-pointing of technological alternatives with a high percentage of adoption by farmers.

Rapid identification of promising variables for research, starting with the development of simple alternatives (one variable at a time) beneficial to all or most of the farmers, was the key point in the Caisan program. However, we realize that Caisan is predominantly a region of small- and medium-sized farmers involved in commercial production of maize and beans in a rotation system. The approach utilized there might have to be modified in other areas and with other types of farmers.

Choice of collaborating farmers

Some considerations have proved to be highly desirable to the success of farming systems research. We have found a direct relationship between degree of adoption of technological alternatives and concentration of farmers in an area or region. When farmers are rather concentrated, we can increase the number of collaborators with experimental plots with not much distance between them. The identification of farm leaders with sufficient motivation to accept innovations and capable of influencing other farmers of the community is highly desirable. In planning a research strategy, it is important to realize that technological changes are gradual, and therefore specific problems should be solved step by step. Our experience indicates that farmers adopt new technologies quickly when they participate in the research process and not when delivered a technological package generated altogether in one particular site.

Adjustments in the program

As the Caisan program advanced, some adjustments were made in its organization and management. To the original team of agronomists and economists (with CIMMYT's support), other specialists working at a national level were incorporated to some degree into the program. This was the case with plant breeders, pathologists, and soil scientists. For example, a simple plant breeding project had to be incorporated into the program to lower the height of the native maize variety (usually over 3.5 m), which made it very susceptible to lodging. In spite of the fact that other shorter varieties had been tried in the area, they had not been accepted by the farmers, mainly because they were not sufficiently resistant to the characteristic excessive humidity of the area (Martinez and Arauz, 1983).

Similar approaches are being implemented in other regions of Panama. In Los Santos, located in the central part of the country, a research team composed of an agronomist, an economist, and a recently added plant protection specialist, was formed early this year, with the technical and financial aid of CATIE, Turrialba, Costa Rica. The team is doing a farming systems research program aimed at generation and technology transfer, including most cropping systems of the area. Again, the agroeconomic approach prevails in this area as well as in the other eight priority areas in which IDIAP is working in Panama.

Monitoring of farming systems research is conducted within IDIAP through periodic dynamic surveys and economic evaluation of the technological alternatives adopted by the farmers. In the performance and analysis of dynamic surveys, economists play the most important role. These surveys have revealed very important information, although the informal and frequent contact with the farmers helps us to identify quickly most of the problems which arise. Some of these problems will be discussed in another section of this paper. The important issue here is that monitoring is not only essential for evaluation of the program, but also to make the necessary adjustments in the planning, organization, and management of a farming systems research program. The experiences so far and the need to start research programs with other farm communities in Panama – such as subsistence hill-side farmers and Indian communities – have encouraged us to incorporate sociologists into the farming systems research scheme. At present we are conducting a sociocultural survey to complement the agroeconomic information obtained in one of the areas in which on-farm research is taking place. This kind of survey may have its limitations since the amount of information required by sociologists is usually fairly extensive, and in some areas we cannot, for different reasons, take too much of a farmer's time to collect the information needed.

Organization and Internal Structure

Organization and resource allocation

Strategies go beyond the research planning process. Implementation of a farming systems research program needs a strategy that may affect the logical program structure itself, especially where funding for research is provided by the government through the national budget and is thus highly dependent on

the political support (Trigo and Piñeiro, 1982). Program structure in this case needs to be oriented not only towards increasing the efficiency of research action but also towards facilitating acquisition of resources. Thus, IDIAP has maintained an organization by product lines and disciplines at the national level. However, these groupings are cut across by regional research programs, whose basic operational unit is the area-specific, on-farm research project. This type of organization has contributed, because of a better understanding of the program at high governmental levels, to significant increases in IDIAP's budget, although it has the disadvantage of hindering the integration of research scientists working at a national level into multidisciplinary teams required in the farming systems approach.

Every effort must be made by a research institution to obtain operating funds for this kind of research. As a part of the strategy, one must take every opportunity to give wide publicity to any significant research achievement. When economic figures are shown, the importance of research is well understood. This public awareness action must be carefully organized, since for many institutions it may make the difference between respectability and being ignored, between having more operating funds and not being considered for budget increases. This battle for recognition is one that needs to be fought continuously.

Adjustments in the internal structure

While farming systems research is being carried out and more areas are covered, the internal structure of the organization needs to evolve; reorganizations must take place from time to time. The management of on-farm research activities becomes more complex, involving more personnel requiring greater technical supervision. A national farming systems program demands a decentralized style of management to provide the logistical and financial support required by increased off-station field operations (Martinez and Arauz, 1982). IDIAP has already moved in this direction, decentralizing management and operating funds to three regional research centers. Institutionalization of farming systems research demands other structural changes that are being analyzed by IDIAP directing staff. A national coordinator for farming systems research will be appointed soon. It also seems advisable to have economists and sociologists within the frame of technical departments dealing with on-farm, area-focused research – not as members of the Departments of Planning and Technology Transfer as they are in IDIAP at present.

Management of Resources

Competence and commitment

Man is the most valuable resource of any research institution. Because of the nature of farming systems research, it is frequently believed that subprofessional people with deficient academic training are all that is needed to carry on the essential part of on-farm research (Laird, 1980). On the contrary, many of the problems to be faced represent a greater challenge for a researcher than most studies carried out within experiment stations, and it takes more than just a normal or specialized academic training to actually be able to formulate and implement a sound farming systems research program. The generation, transfer, and adoption of new technologies by farmers are all part of the same process which requires a special commitment from the scientist if quick results are to be achieved. It is true that multidisciplinary teams are essential in the systems approach, but their motivation and willingness to have a thorough knowledge of the farmers' circumstances are valuable prerequisites for the success of the program. Each member of the team will be more competent if he achieves a general understanding of agricultural development as a process (Mosher, 1981), of the problems, limitations, and existing policies to improve agricultural production and protect the natural resources.

Training

In the Caisan program, the team was oriented in the above mentioned direction. Training of researchers in farming systems methodology at international centers has contributed to the improvement of the capabilities of the area research teams. An essential part of the training is done within the institution through frequent seminars, courses, workshops, and staff meetings, not only in methodological aspects but in projecting institutional policy and setting standards and priorities. Some actions have also been taken for expanding and sharpening administrative skills, since we believe an institution functions better if all members of its staff understand the administrative process (Mosher, 1981).

Location of the research staff

The efficiency of a farming system research program is greatly improved when the members of the research team live in the area during week days. Laborers and research assistants should preferably be natives of the area. Because Caisan and other area-specific research programs are quite distant

from main cities or towns and good living conditions are scarce, IDIAP built research subcenters in three of the areas to accommodate offices, dormitories, and storage facilities for the members of the research teams. These facilities undoubtedly contribute to rationing operating costs, quite frequently limited in developing country research organizations. The responsibility of specialists and investigators, not living in the area but collaborating or participating in area research projects, should be clearly defined through calendars of regular visits. Their participation should be integrated and effective and not just limited to giving advice to the resident staff.

Incentives

We believe that resident team scientists should receive an additional stipend for living in areas far away from their homes and for encouraging them to dedicate some time out of normal working hours to strengthening their relationships with the farmers of the area. On-farm research should evolve from area research actions towards institutionalization as they prove to be successful in terms of impact on productivity and income of target farmers. This evolution of the programs will strengthen the area research team and contribute to recognition of the scientific effort required in this type of research.

The Caisan program was considered for an important institutional incentive this year. One of three recognition awards given to IDIAP scientists was granted to the team leader of the Caisan program. This reward may catch the attention of some research specialists working in experiment stations who are still reluctant to participate actively in farming systems projects. Nevertheless, their participation in on-farm research does not mean that strengthening of station-based research is not an important element for generating a continuous flow of improved technological components (Martinez and Arauz, 1983), a necessary complement of farming systems research.

Operating funds

A proper management of funds to assure a quick mechanism for control and disbursement of operational expenditures is necessary in the implementation of area-focused research. A small operating fund should be handled in the area to cover unforeseen expenses. The team leader of the area should be responsible for this administrative duty. IDIAP's decentralization of funds at the regional level has contributed to increasing the efficiency of operation of area research programs.

Program Implementation and Evaluation

Research and extension coordination

The diagnostic stage should lead us to the proper establishment of experimental plots with collaborating farmers. Ecological and conservation aspects should not be neglected in the design and implementation of a farming systems program. This is a prime consideration when working with hillside and sloping-land farms. Ecological considerations should induce us to incorporate integrated pest management practices as well. As technological alternatives are developed, extension workers should assume clear responsibilities in the technology verification and demonstration stages. When extension is not a component of the research institution, as in IDIAP's case, this may present some difficulties. However, every effort should be made to coordinate actions with the organization responsible for the extension programs in the area. Such coordination is important because dissemination of results must be done as soon as possible, especially when innovative practices are urgently needed to achieve a quick impact in the production patterns of the area.

Monitoring and evaluation of the program

Frequent supervision and evaluation of the research program, in terms of the impact on the production process, is needed in order to make the necessary adjustments in both the institutional and program organization. A preliminary survey in Caisan revealed a paternalistic attitude by IDIAP towards the farmers and indicated some resentment by farmers when IDIAP started to move part of its limited resources to nearby areas. This, of course, would not have happened if the sample of collaborating farmers had been changed every year (which was not the case in Caisan) and if an adequate participation of extension workers had been acquired during the research and verification process. The survey revealed also the reluctance of farmers to continue growing beans in rotation with maize. This situation arose because of several months delay in paying the farmers for their products sold to the Institute of Agricultural Marketing, a government organization which provides this service to commercial farmers. At the same time, the Bank of Agricultural Development, a state institution giving credit to farmers, charges interest for the loans not closed on time. This is a clear indication of the need for a closer interinstitutional coordination, as will be discussed in a subsequent section.

On the other hand, an economic evaluation of the Caisan program was conducted in 1982, with the help of CIMMYT's economic program. In less than four years, even assuming no further adoption of new technologies after 1982, the social returns were much greater than the amount invested by IDIAP. The rate of return, using the most conservative figures, was 188%, clearly exceeding the opportunity cost of capital (Martinez and Arauz, 1982). Such figures had been used by IDIAP to promote the validity of this type of research before government officers with decision power.

Meetings and workshops of the directing staff of IDIAP have been held to review, discuss, and evaluate farming systems research actions. A workshop took place early this year with the collaboration of CIMMYT. At this time, most IDIAP directors and department heads at national and regional levels were exposed for two days to an intensive discussion of the Caisan program in relation to organizational, managerial, and technical issues arising from the field experiences in on-farm research. Difficulties in the organization of the program were intensively discussed and institutional adjustments were considered.

Support programs

The need for integrating support programs such as soils and plant protection into the farming systems scheme is being considered currently by IDIAP directing staff. Extrapolation of results from one area to another comparable in soils and climate is possible, provided proper characterization of these components is achieved. As long as technological alternatives do not imply an increase in costs, we foresee a way to accelerate dissemination of results with a multiplying effect of the area-focused research programs. A national plant protection program concentrating on integrated pest management will eventually be incorporated into the farming systems research scheme.

Inter-institutional Coordination

The need for inter-organizational links

Linkages with other organizations of the agricultural sector, private or public, are vital to the research institution's survival, as well as to its success in introducing changes in the society that supports it (Bumgardner, et al, 1971). Without appropriate inter-institutional coordination, the generation of technology process would not be able to make the necessary impact on agricultural development.

Coordination with credit and marketing institutions, as well as with organizations providing services and inputs for agricultural production, is a dynamic process aimed at exerting influences, effecting changes in the other organizations with which one interacts, and facilitating institutional development. In our experience with the Caisan program, lack of adequate coordination with credit and marketing organizations constituted a serious drawback to our research efforts. It is necessary that a research institution take the leadership in establishing effective linkages with any organization influencing agricultural development. On the other hand, an interesting effect of farming systems research on the policy of mechanization has been observed in Caisan. A government organization provides farm machinery services in the country, and as a consequence of the introduction of zero or minimum tillage as a low-cost technological alternative, the farm machinery service for soil preparation is no longer in demand in the area. We hope that eventually appropriate machinery for non-tillage planting will appear as a replacement for the former technology. IDIAP has just designed and is building a prototype planter for non-tillage use in the Caisan area. It is quite common to find agricultural support services designed with the needs of the larger farmers in mind (Mosher, 1981). Farming systems research will undoubtedly introduce significant changes in this field. Technology generated for small farmers is usually better adapted to bigger farms than the other way around.

Frequent interactions with public or private advisory services to farmers are essential to the success of the program. Fields days, seminars, and meetings are tools to be handled successfully. When extension is not part of the research institution – as it is with IDIAP – and inter-institutional coordination faces some difficulties, farming systems researchers must participate actively in an extension process, otherwise research is meaningless.

Inter-institutional coordination is facilitated when integrated rural development programs are established in an area or region. An integration of institutional and inter-sectoral actions aimed at community development is the main objective of such programs. When research becomes part of them, greater advances might be expected in terms of adoption of improved technological alternatives with significant incidence on agricultural growth. One of these programs has been established in one of IDIAP's research priority areas. The importance of such programs becomes evident when we face situations like the one that took place in a community in Panama, where the inhabitants, mostly subsistence farmers, did not fully accept or participate

enthusiastically in any isolated governmental development program if their access road was not repaired and a bridge was not built. Clearly, new programs or projects generate new attitudes and expectations, and when innovations are not assimilated by a community, they are rejected: a work for sociologists and anthropologists (Taylor, 1982).

Farming Systems Research Programs and Agricultural Development Policies

Quite often governmental programs are implemented in an isolated way and in separated areas with no interrelationships between them, even where they complement each other. Lack of well-structured, long-term agricultural development policies and plans is perhaps the main cause for such deficient coordination. When a research institution has taken a certain degree of leadership within the agricultural sector, it becomes a moral duty for it to participate actively in the definition of agricultural policies and in leading inter-institutional coordination. Moreover, research to spur agricultural development should include research on national policies affecting agriculture (Mosher, 1982), as a necessary complement of rapidly increasing farming systems research programs.

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3.7 INIAP Production Research Programs as Agents of Generation and Transfer of Technology to Small Farmers in Ecuador

P. Espinosa[1], E. Moscardi[2], J. Palomino[3], and J. C. Delgado[4]

Introduction

The National Agricultural Research Institute (INIAP) is responsible for the organization and execution of a national research system to improve agricultural productivity in Ecuador. To achieve this objective, INIAP has seven experiment stations and three regional centers located in the three natural regions of the country: the Coastal Region, the Highlands, and the Eastern or Amazon Region.

At its founding in 1962, a structural frame was established with several research programs and departments. The research programs were organized by individual crops or groups of related crops (e.g., small-grain cereals, maize, coffee, etc.) or animal species (swine, poultry, and livestock) and focused towards genetic improvement and development of production methodologies. Research departments (soils, entomology, plant pathology, etc.) were organized according to discipline in order to provide technical assistance to the different research programs within their respective areas of specialization. In general, their work was oriented towards the development of the so-called "technological packages." It was intended that the production of the different products under research would be improved with the application of these packages.

Until 1976, research was carried out at experiment stations and in regional field tests at farmers' plots under variable soil and climatic conditions, following patterns and models of experiment stations.

Generally, in order to assure proper management and success, these regional tests were located on so-called large farms, which are classified in this way mainly because of the farmer's economic situation and available facilities rather than because of the farm size.

The information finally obtained from these regional tests was put together in recommendation packages which, however, did not include the expected increase in production and productivity, mainly in the case of basic food crops which are grown mostly by small farmers. To overcome this situation, INIAP established a new research program named Crop Production Research Program (PIP) to verify and clarify the results obtained in the experimental stations and in the regional tests, in order to adjust them to the farmer's production systems and, in addition, to use this method to transfer the technology generated.

Therefore, since 1976, INIAP has introduced the PIP as a new institutional strategy to articulate better the supply and the demand for agricultural technologies. It is a production-applied research program based on a multidisciplinary approach, involving social sciences closely linked to biological sciences.

The main characteristic of this methodology is that the work performed by the experimental station researchers is complemented by production research carried out under prevalent farmer conditions; thus, the farmer is an active participant, also responsible in the process of generation of agricultural technology.

PIP's activities are particularly focused on small farmers, who have remained practically out of the influence of modern technological innovations.

To date, PIP operates in 11 different areas of the country, supported technically and administratively by the nearest INIAP Experimental Stations (Figure 1 and Table 1).

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[3] Staff member, INIAP Production Research Program
[4] Director General, INIAP

Ecuador

Production Research Programs
Research Stations

1. Carchi
2. Imbabura
3. Cayambe
4. Salcedo
5. Quimiag-Penipe
6. Loja Sur
7. Quininde Malimpia Nueve Jerusalem
8. Puerto Ila-Chone
9. Balzar
10. Manabi
11. Napo

Figure 1. Location of Production Stations and Production Research Programs (PIP) at INIAP.

Table 1. INIAP Production Research Programs (PIP).

Name and Location	Support Station	Crops Sources of Research
In Execution		
PIP Carchi	Santa Catalina	Potato
PIP Imbabura	Santa Catalina	Corn-Bean-Green pea
PIP Cayamba	Santa Catalina	Potato-Wheat
PIP Manabi Zona Zeca	Portoviejo	Corn-Castor bean-Squash
PIP Balzar	Pichilingue	Corn-Yucca
PIP Napo	Payamino	Grass and Legumes Fodder
PIP Quimiag-Penipe*	Santa Catalina	Corn-Bean-Green pea
PIP Puerto Ila-Chone*	Portoviejo y Pichilingue	Coffee-Cocoa-Corn
PIP Loja Sur*	Boliche y Pichilingue	Corn-Peanut-Yucca
PIP Quinde-Malimpia-Neuva Jerusalem*	Santa Domingo y Pichilingue	Coffee-Cocoa-Corn
PIP Salcedo*	Santa Catalina	Corn-Bean-Barley, Pastures
Projected		
PIP Jipijapa	Portoviejo, Pichilingue	Coffee-Swine raising-Corn-Beans
PIP Valle del Rio Portoviejo	Portoviejo	Herbs and Grain legumes
PIP Daule-Peripa	Boliche	Coffee-Cocoa-Corn-Bean-Banana
PIP Tres Postes	Boliche	Rice-Corn-Cocoa-Coffee-Banana
PIP Puellaro	Santa Catalina	Smaller animals, Herbs and Grain legumes
PIP Austro	C.E. Austro y	Corn-Bean-Wheat-Barley-Potato
PIP San Gabriel	Santa Catalina	Dairy Cattle

* PIP located under Integral Rural Development Projects.

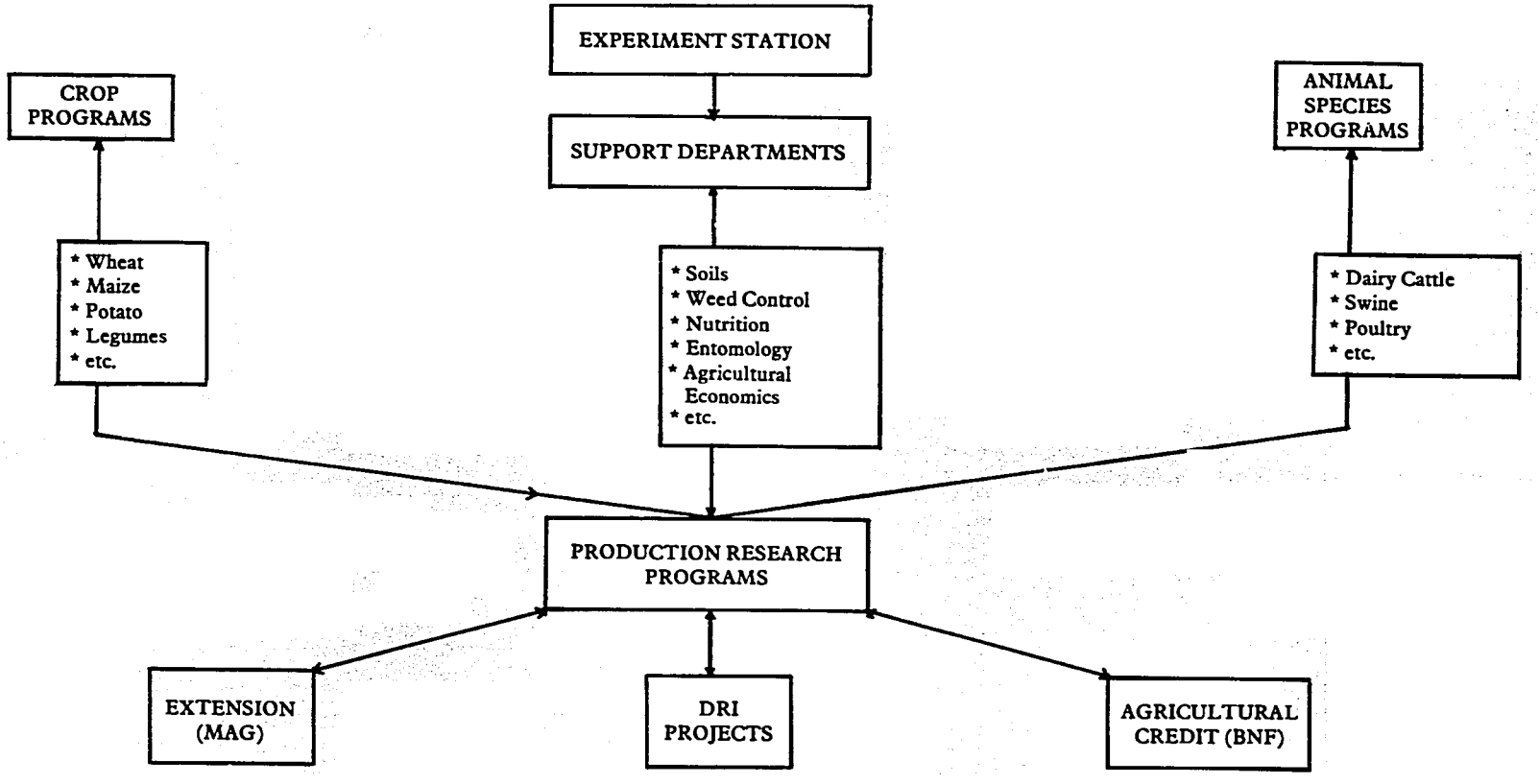

Figure 2. Relationships and location of Crop Production Research Programs (PIP) within the structure of INIAP experiment stations, with governmental services of extension and credit, and with Integral Rural Development Programs.

Figure 2 shows the relationships and the location of the PIPs within the typical structure of INIAP's experiment stations and their ties with the Agricultural Extension Service of the Ministry of Agriculture and Livestock (MAG), with the Integral Rural Development Projects (PDRI) coordinated by the General Secretariat of Rural Development and with the credit programs of the National Development Bank (BNF).

PIP methodology includes the extension agent in the final stage of the generation process of technological alternatives, to introduce him to the process through his own experience. The articulation between the PIP and the extension service is better assured in those areas where DRI projects operate, because the executing units have integrated extension agents as well as PIP researchers.

Objectives

The objectives of the Production Research Program are

* To select and to test technological components which are being generated by the programs and departments of the experiment stations for their immediate adaptation and adjustment to the production systems and socioeconomic conditions of the small farmer.
* To formulate technological alternatives submitted to an economic validation which can be available for its verification and for further transfer by the agricultural extension and credit services.
* To orient the extension agents to work in programs devoted to increasing production.
* To train Ecuadorian technicians from several institutions in research and extension within the methodology adapted for the small farmer.
* To provide feedback information to guide research being conducted at experiment stations towards the development of new technological components – as an answer to the possibilities and limitations being detected at the level of farmers of a given region.

Methodology

Focus and strategy

The PIP is the institutional tool designed for identification, generation, and transfer of technological alternatives adequate for small farmers.

The PIP's work is the essential complement to the innovative research being conducted by experiment stations to assure that the technology offered is adequate for production systems and farmers in each work area. On the other hand, while working in close relationship with extension agents, PIP keeps a constant eye on farmers' reactions to technological alternatives being introduced. This provides permanent feedback to the process of generation and transfer.

The PIP operates in specific areas where one or two INIAP technicians live and work. They are trained in procedures oriented toward generation and transfer of technology at the farm level. Their basic responsibilities are to collect information regarding the factors (limitations and opportunities) which could influence the generation and transfer of technology, to plan and to execute on-farm experiments, and to formulate tentative recommendations based on the results obtained.

As mentioned, the focus of PIP's work is on applied research in production systems. Even though the initial experimental work takes into account one or two agricultural activities – or an association or mixture of crops in this instance – other activities are examined (including those producing income outside the farm) jointly with possible interactions within the system components, considering, at the same time, the consequences for other components. Available technology supply, social objectives, and priorities of the farmer determine the point from which the work should be initiated.

PIP's work is basically focused toward the fundamental clientele of small producers. It looks for technological alternatives for increasing production, bearing in mind budget limitations and farmers' rejection of economic risks characteristic of this type of farmer. This philosophy leads to a careful study of production systems to identify flexibilities and to analyze possibilities for introduction of innovations which allow a more efficient use of available resources.

Most of PIP's work is performed at the farms and in contact with farmers. This permits elaboration of the requirements for new technologies to come from the farmers themselves and then be transmitted to experiment stations, which should generate adaptable technological alternatives.

Strategies of the process

Four stages have been outlined to cover the process of generation and transfer of appropriate technology to small farmers, through which the proposed objectives are expected to be achieved. These stages or components, in turn, serve as a reference framework for execution procedures shown later on.

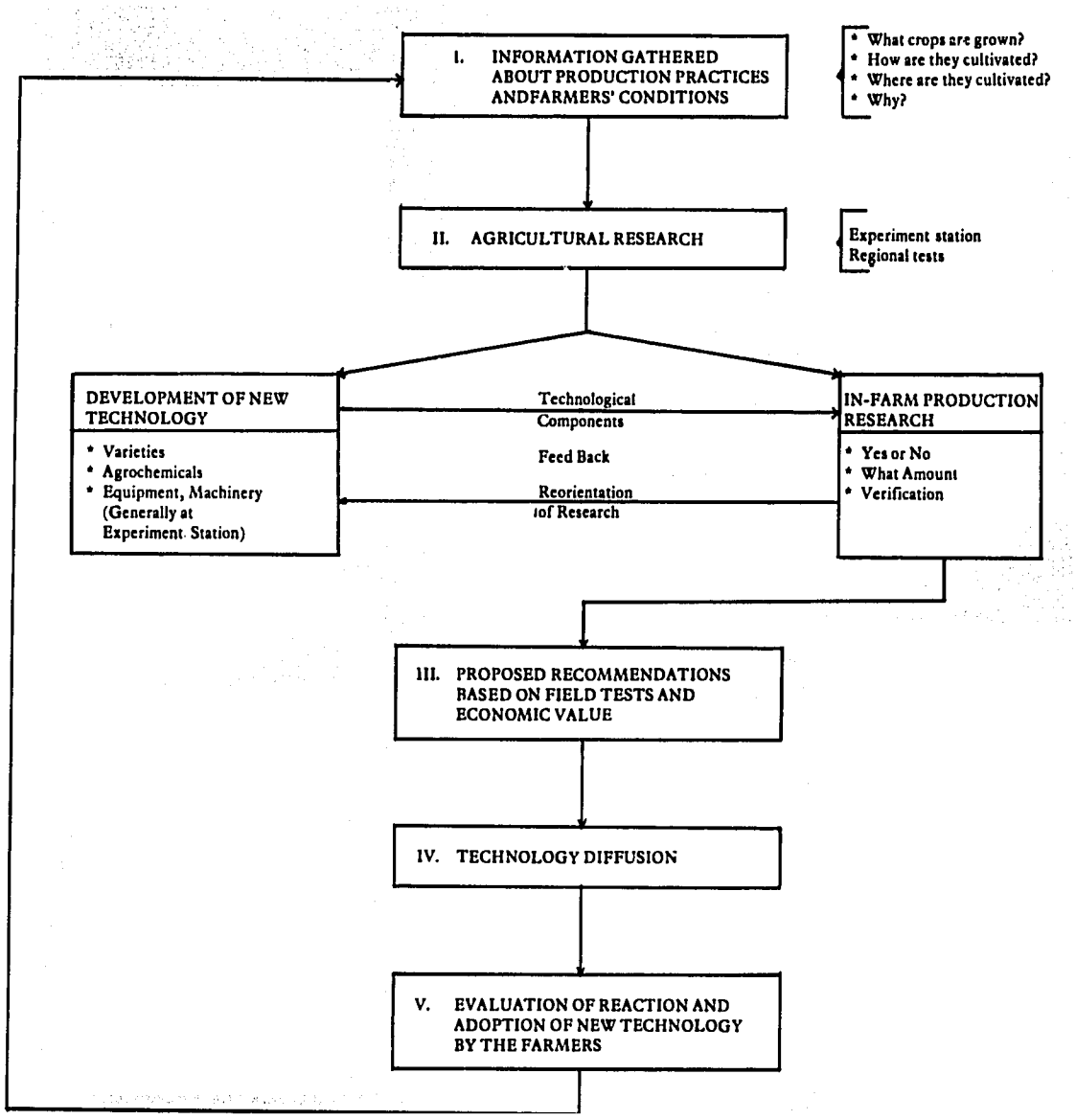

Figure 3. Adaptable Research Procedures for Generation of Technological Alternatives.

Descriptive stage. The production system is examined to determine its flexibility, its most important limitations, and possible strategies for solutions. Representative farmers are selected, and the most common practices and agroeconomic conditions are established and grouped tentatively into "mains of recommendations" (groups of farmers of similar conditions who are in a position to generate and diffuse, more or less, the same technological recommendations).

Diagnosis stage. The following factors are established: rationality of common cultural practices, main problems, opportunities offered by the system, and pre-selection of technological components. The elements taken as possible solutions are compared with the technologies available at experiment stations. In other words, the need for new technologies is identified and research lines are defined.

Experimentation stage. Probable solutions outlined during the diagnosis stage and available at experiment stations are evaluated through field tests at representative farms. This stage of production research is focused on acquiring knowledge, by practical experience, of the ability of available alternative technologies to produce acceptable and productive changes in the existing production system.

Diffusion stage. Alternative technology considered acceptable is extensively promoted through demonstrations, field days, etc. This stage is used also to evaluate the reaction and adoption of technology by farmers, using samples of a larger size.

Procedures. In summary, the procedures used by PIPs to achieve the above-mentioned objectives are the following:

* Definition of work areas by domains of recommendation, adjusted according to the information gathered from surveys and tests.

* Random sampling of farmers (formal surveys) within the domains to identify their goals and the scope of relevant agroeconomic conditions to increase productivity.

* Utilization of data provided by the sample – and in subsequent years by the tests – to evaluate appropriate technological alternatives and to establish the scope of farmer conditions under which the evaluation tests will be carried out. (Farmer conditions are understood as including all those factors which influence farmers' decisions about technology to be used for production of a crop, such as farmers' goals, natural environment, economic conditions, and resources.)

* On-farm tests to gather information about the yield of selected treatments in each area of work. Basically, the tests are of three types: (1) yes or no; (2) what amount; and (3) technology verification. In the first two cases, the field experiments are multifactorial and are aimed at developing adequate levels of input use; in verification tests, the information obtained from the other tests is combined as a basis to recommend different alternatives to the farmer. This is a dynamic process which makes it possible, through a trial-and-error test carried out by the farmer, to make recommendations to the farmers for improvement of their production system.

* Concurrent with on-farm experiments, other studies are carried out on characteristics of input markets (agrochemicals), agricultural credit, etc., and factors (transportation, field prices) which may affect or limit the adoption of alternatives to be recommended.

* Economic evaluation of alternative technologies analyzing data gathered from the tests, surveys, and market studies.

Figure 3 summarizes the sequence of PIP activities and their articulation with the development of new technology, generally undertaken first by experiment stations.

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3.8 Framework for Organization and Management of Agricultural Research with a Farming Systems Perspective

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This paper is intended as a bridging exercise between the plenary sessions on country case studies and separate discussion groups on aspects of organization and management The views expressed are not necessarily those of ISNAR.

Introduction

Most countries have a national agricultural research system – for better or worse. Few have given much thought as to how to incorporate "farming systems research" into the established system. One of our main tasks is to see if there are some basic elements of organization and management that can be adapted to particular systems so as to bring a better farming systems perspective into the process of technology generation. What evolutionary modifications can be made to the existing system so that the distinctive contribution of farming systems perspective can be brought to bear to improve the research system? Or is revolutionary change needed?

ISNAR has had to face a similar issue more generally: what basic elements of organization and management are needed to enable all aspects and methodologies of agricultural research to make their distinctive contributions efficiently and harmoniously in the national system? Many of the research methodologies are better known and recognized than those in farming systems research and, therefore, more readily incorporated, but the essence of the problem is similar.

To provide some common basis for an approach that would be relevant to systems of such disparate countries as the Solomon Islands and Indonesia, ISNAR has had to develop some general concepts of what should be the role and nature of a national agricultural research system in developing countries. These might help as a framework for our subsequent discussion. In particular, some functions of a national agricultural research system seem to be essential, no matter the size of the country or the strength of the research service. The mechanisms for carrying out these functions will vary considerably from country to country depending on the conditions of the countries.

Bringing a Farming Systems Perspective into the Functions of a National Agricultural Research System

Assuming that the main role of a national agricultural research system is to support national agricultural development in planning and production, there appear to be three main duties (the third group, the research community, usually receives adequate attention and it is not included in the diagram):

* To make available to the government, in an appropriately interpreted form, key elements of information on which effective agricultural policies and reliable development plans can be based.

* To make available to the producers, through appropriate channels, detailed management, biological, and economic information on which they can base their crop and livestock production patterns. Such information must be based on adaptive research at the producers' level of management.

* To develop and maintain a group of well-trained, competent scientists in active research positions, capable of sustaining and interpreting national and international scientific advances for the benefit of national development.

These three main duties also define the three main groups of clients for the research system: the policy makers, planners, and development agencies; the primary producers; and the researchers – on the world scene, colleagues and peers, and the researcher himself. One important task of research management is to achieve an appropriate balance of research effort

among these clients, and there must be effective instruments to bring this about.

A farming systems perspective in the research system will clearly have a great contribution to make in what sort of information is channeled to the producer, especially to smaller, unsophisticated farmers. However, research resources are allocated by government, and it may not be interested in smaller farmers. It is up to the research service to ensure that the government has good information on which to base its policies.

Cycle of Functions

Starting with the major clients to be served, the main research functions can be represented simplistically (Figure 1), in a cycle that begins with the needs of the clients and ends in feeding information back to the clients.

Identify research priorities

The cycle starts and finishes with the major national clients of the research system, the policy makers, planners, and development agencies, and the primary producers. Their prime needs for information and better technology determine the key research priorities.

Not all needs can be dealt with, and hard choices must be made. There is need for a forum in which different interests can be presented. It is important that a sound "farming system perspective" be brought to bear at this point in the research planning process to ensure that criteria particularly appropriate to the requirements of producers are included, and that their genuine interests are skillfully interpreted and reflected in defining priorities for research and institutional development. At this point, major decisions are made on the strategic allocation of resources for research, leading to a plan for research, and this is fundamentally a "top-down" process stemming from national goals and objectives.

Develop research program

The formulation of the research program is a very different process, and a different organization is required to carry out this function. It is essentially a bottom-up process. The national agricultural research program comes from the aggregation of commodity, departmental, and station programs, which come from approved suggestions of individual researchers for experiments or studies. It is important that researchers be well aware of the priorities in the research plan, but the emergent research program will depend particularly on the technical knowledge, creativity, and motivation of the researchers trained in various disciplines. The research program is also derived from balancing the needs for better information and technology with the personnel and facilities available (or likely to be available) and the potential for success in supplying and applying the needed information or technology. This process clearly needs a mechanism for interdisciplinary review – as near as possible to the grass-roots level of program formulation so that a broad value system can be applied to proposal, approval, and selection of projects.

If a farming systems research perspective is to influence the generation of new technology, it is at this grass-roots point of program formulation that it must make itself felt, and the organization must be accommodating enough to permit this impact: for instance, at a formally constituted interdisciplinary body to conduct a review of research proposals at an early stage, scientists from a farming systems research group can act as scientifically well-informed proxies for the producers, and bring to bear a value judgment at a stage in research preparation when it is still easy to make changes. It is relatively easy for management (if it wishes) to give such a body power to exercise some control, for example, formal approval by a majority before transmission of a proposal. The meetings of such a body are also useful for the interchange of relevant research findings and the basis for argument and justification for programs (and policies) at higher levels. In some circumstances, it might be valuable to include extension staff, or it may be better to have separate sessions on trials in which they have direct involvement.

Assess and develop manpower

A third function of the research system is to ensure that there are appropriate personnel to devise and carry out the research program. This is a large and complex operation involving recruitment of a suitable balance of staff in different disciplines, appropriate staff development programs, and the provision of a research environment to encourage research efforts and retain well-trained staff – including a scheme of service which adequately rewards research performance. The introduction of new methodologies involving unfamiliar disciplines, or new uses of old disciplines, gives rise to trouble in recruitment because it is not widely apparent what contribution the methodology can make. It takes some time before the approach is common enough for recognition as a relevant "discipline" to qualify its exponents for appropriate rewards.

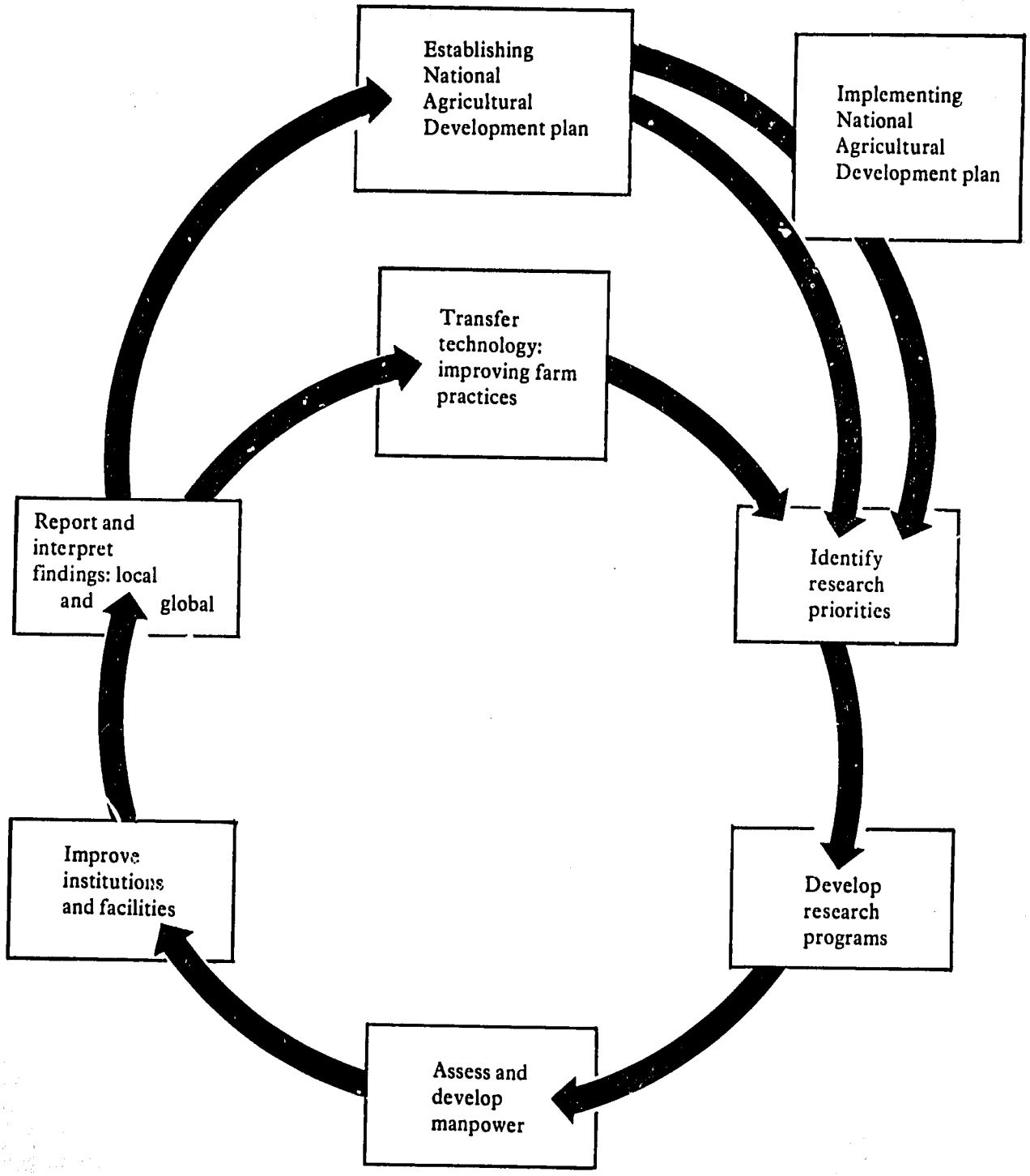

Figure 1. Planning for implementation of national agricultural research

There are "research" schemes of service in a few countries that reward research performance in addition to administrative responsibilities, but a reward system outside narrow disciplinary values is still difficult to achieve. The move towards integrated crop research in a team has been going on for some time, but team achievement in improvement of crop productivity is still hardly recognized as a basis for promotion. Farming systems research is broader still and even more divorced from disciplinary recognition.

It may prove to be necessary to strive for some specific recognition of the approach in order to give a focus for recruitment, training reward, and promotion. The mechanisms to bring this about must fit into a conceptual framework that gives researchers a chance to work. Central to the farming systems perspective is the need to use a value system based on the needs of the farmer as the main client. Thus the "good" technology created, or the "good" object and outcome of an experiment, is not to be based on its scientific or knowledge-generating excellence, or even that of crop production efficiency. This is likely to require a profound shift of emphasis in research management, and a considerable degree of firmness by management to keep the thrust of research work towards the farmer's interests – or rather to maintain a judicious balance among farmer's, government's and researcher's interests (because the balance is usually well away from the farmer's interests).

Improve institutions and facilities

Suitable research facilities are needed if well-trained research scientists are to be able to give a good return on the investment in personnel. The facilities usually include farms, research stations and equipment, and adequate current funding for continuity of a vigorous research program. The physical needs of traditional research methodologies are familiar to many administrators, but the distinctive needs and costs for farming systems research are not yet so well known.

Report and interpret local and global findings

In general, the research service is concerned with reporting its findings in an appropriate form to its major clients: the government planners, the producers, and the research community. There is a need for establishing appropriate (two-way) channels of communication to each of these groups. However, in the particular circumstances of this workshop, the internal communications channels within the research organization are clearly paramount. These are intimately linked to the creation of strong mechanisms for the formulation of the research program at an early stage by interdisciplinary review panels.

Monitoring and evaluation

The completion of the cycle in reporting the product of research activity back to clients is a key step in monitoring the progress and effectiveness of the research sector. Evaluation, like beauty, tends to reside in the eye of the beholder, the value system of the client. It is important for the research service to recognize its major clients and to ensure that the thrust of the research work and its outcome are expressed clearly to the clients in terms they appreciate. Contribution from a farming systems perspective in this respect is as valuable in assessing the end product as it is or was in formulating the research project.

Requirements of Organization to Incorporate a Farming Systems Perspective in Research towards Technology Generation

The requirements of a research organization to incorporate a farming systems perspective will depend to a certain extent on the objectives of the organization and on the methodology used for farming systems research. However, in general, the material facilities additional to those of a traditional research station would involve support for a core group of scientists for an exploratory or diagnostic survey of farmers' needs and more capacity for conducting on-farm trials. In disciplinary terms it usually implies an addition of social scientists.

This group must have intimate contact with the existing technical scientists to be able to deliver information to encourage them to work on key improvements to the agronomic system. It must also have good lines of communication to policy makers to encourage them to generate improvements in institutional arrangements. (And it will need to have good links to the delivery or extension system.)

In practice, this requires a shift in all of the main functions of the research system, beginning probably with an improvement in the articulation of the farmers' technical needs at the political level. It is important to have a voice at the strategic research planning stage (where government interests tend to dominate), and at the research program formulation stage (where researchers' interests tend to dominate). The recognition and evaluation of the team research work done for the farmers' good is of critical importance for the career satisfaction of scientists working with this thrust.

What sort of major structural arrangements might be appropriate for incorporation of farming systems

research? Several structures have been tried or proposed with varying degrees of promise. No comprehensive discussion is attempted.

Major difficulty arises here in that farming systems research addresses a wide operational field. We have concentrated on the contribution of a farming systems perspective/farming systems research on the generation of new technology – and its linkage with the technical research teams; but farming systems research is equally concerned with on-farm testing of developed technology and therefore closely linked with the technology delivery system and extension. Structural arrangements must at least take care of these two aspects of farming systems research.

Separate visibility and status come mainly from financial and administrative responsibility, but the main contribution of a farming systems perspective to technology generation is perhaps through the other line of control: responsibility for the content of the research program. Some of the structures proposed are included in the following list, but discussion is left to the groups:

* A separate division for farming systems research to work alongside existing divisions within a department responsible for agricultural research.

* A separate division within a department responsible for planning or economic research.

* A separate division within a department mainly responsible for extension and technology delivery.

* A separate unit or team within an agricultural research division.

* A farming systems research team made up from component staff recruited from different disciplines within a research division.

* No farming systems research team at all; instead a general strengthening of desirable component disciplines within the administrative system and a strong cross-discipline structure for determining the research program (on a commodity or farming systems basis).

* Radical alternatives: Traditional research structures could be abolished and replaced with entirely new systems. For instance, there could be regional development-oriented research teams centered on a farming systems research group with technical research units fulfilling service roles by feeding in new components, while additional testing teams followed up with adaptive trials.

4. Discussions

Agricultural Research with the Farmer in Close Focus

Is research with a farming systems perspective aimed at technology generation in the near term (4 to 5 years) the same as Farming Systems Research/On-Farm Research (FSR/OFR)? Participants at the workshop could not agree on an answer to this question in spite of the fact that the country and regional experiences described at the workshop were weighted toward FSR/OFR.

Although recognizing its benefits under certain circumstances, some participants considered FSR/OFR to be a premature and unwarranted attempt at rigidly delimiting a necessary and fruitful attitude: namely, the endorsement of interdisciplinary research judged in terms of its utility to farmers. Research with a farming systems perspective is held to imply (1) at the conceptual level, an emphasis on specific sets of farmers as well as a concern for immediacy, and (2) at the operational level, the use of interdisciplinary capacity for the development and use of diagnostic techniques for locating and ordering problems and solutions in terms of magnitude of payoff in the near term.

Those supporting FSR/OFR argued that though they would agree to a distinction between FSR "in the large" and FSR "in the small (FSR/OFR)," the latter is the only one which has proved itself. The FSR/OFR approach was described as well fixed and proven, capable of leading to significant productivity increments for small farmers in the near term. The poor performance and discontinuation of some FSR/OFR projects in Africa was attributed to factors beyond the control of the FSR/OFR teams and projects, factors of organization and mode of insertion into the national agricultural research systems (NARS).

While agreeing to discuss research with a farming systems perspective in terms of FSR/OFR, some participants pointed out that the differing perceptions on agricultural research do have significant consequences on how such research should be conducted and where it should be located.

Differences on those issues came together with differing perceptions on how client-oriented research should be organized within the research system. Some saw this research being undertaken by clearly identified entities, such as in Ecuador and Nigeria. Some saw these entities as a temporary arrangement, the start of a movement towards a format in which such work is undertaken exclusively by disciplinary, commodity, or regional teams. Some saw the work as better initiated through such teams, for example, Panama. Some saw the diagnostic aspects in the hands of an assigned team with experimentation done by a disciplinary or commodity team, which would consult with the diagnostic team.

Initiation of Research with a Farming Systems Perspective

The workshop could not reach any general conclusions concerning the necessary conditions for the initiation of a specific farming systems program. The cases presented did not show any pattern: IAR in Nigeria could not readily be compared with CATIE or IDIAP in Latin America. It was agreed that CATIE's development path to farming systems research, with its massive multifactorial trials, was a special case prompted by unique circumstances.

The participants noted that in most of the cases presented at least one international agricultural research center (IARC) provided support in the development of FSR/OFR. In some cases this support may also have coincided with financial and technical support from other sources. The question was raised whether regional organizations (such as CATIE), or institutes in developing countries could be encouraged to increase their technical help to

other developing country programs. Networking between FSR/OFR programs was deemed worthwhile, and questions were raised as to whether developing country institutions (national or regional) would be the ideal headquarters for organizing such networking.

The workshop agreed that independent or semiautonomous institutes or agencies could probably incorporate agricultural research with a marked systems perspective more easily than could institutions which are part of the governmental apparatus and thus subject to civil service and other regulations.

The operational costs of research with a farming systems perspective are considered to be anywhere between 50% and 100% higher than the cost of ordinary commodity research programs. Significant increases in funding, either through national or international channels, is imperative. The workshop participants agreed that in order to absorb cost increases and to minimize staff attrition and possible demoralization, FSR/OFR should be introduced gradually in any agricultural research system.

Organizational Location of Research with a Farming Systems Perspective

The workshop was unanimous in agreeing that a farming systems perspective should permeate the NARS of developing countries. The real question was perceived as where to locate an FSR/OFR program. The Institute for Agricultural Research at Samaru, Nigeria, demonstrates that it is possible to create a farming systems research program that cuts across departments and programs – particularly when the administration of research is organized along departmental lines, while research is implemented along commodity lines. In the case of crop-based research programs at Samaru, an on-farm research subprogram is housed under each commodity-based program. On the other hand, Panama's IDIAP has maintained an organization by production lines and disciplines at the national level; the basic operational unit in the regional research programs is the area-specific, on-farm research project cutting across these national groupings.

The placement of an FSR program in a particular NARS has important ramifications. In Nigeria, for example, it is expected that on-farm studies in crop-based programs would engage more in "upstream" research (albeit with a farming systems perspective), while the farming systems research program would engage more in "downstream" or interactive farming systems work.

The participants in the workshop agreed that it was essential that specific organizational and managerial steps be taken to insure close linkages between an FSR/OFR project team and scientists upstream.

This was important for the morale, prestige, and retention of the FSR/OFR team members and also for the quality of their work.

The location of an FSR/OFR team in a development project was discussed at length. It was generally agreed that there was much to recommend this location insofar as the organization of the integrated development project might compensate for the absence of adequate extension services. Problems were noted, however, in connection with locating an FSR/OFR team in such projects. One problem is the generally short-term nature of these projects (5 years) – the project might be on the verge of termination by the time FSR/OFR results are available. (There is apparent now some tendency in international development organizations to consider funding integrated or agricultural development projects of 10 to 20 years' duration.)

Another problem with the location of the FSR/OFR team in a development project has to do with the linkages between the team and back-up disciplinary or commodity line services located in the NARS or IARC. These linkages with the scientific capabilities of central or regional experiment stations are essential, but some questions do arise: Is the project FSR team seconded to the project by an FSR unit in the NARS? What should be the position of IARC FSR/OFR members secondary to the project? What would be their lines of communication and responsibility to the NARS?

The workshop participants took note of the fact that an IARC would not, in general, wish to work in any country without the collaboration of that NARS. The participants also agreed that some lines of authority and main lines of communication upstream and from the FSR/OFR team should be through the NARS. This should insure adequate linkages during the life of the project and the subsequent reincorporation of the FSR/OFR team members into the NARS.

Funding is an important factor to be considered in the location of an FSR capability. The apparent "hybrid" nature of the Panamanian system is a function of funding (it is easier to secure funding there if the organization of IDIAP remains on disciplinary lines). There was no consensus among the workshop participants on whether FSR/OFR should be located in clearly defined entities, as has been done in Ecuador and Nigeria.

Relationship FSR – Extension Service

The work group was unanimous in emphasizing the need to bring extension workers into the on-farm research approach for more efficient and acceptable agricultural technologies. It was pointed out by some participants that this involvement of agricultural extension workers formed an integral part of the FSR methodologies developed at CIMMYT, other IARCs, and by national research organizations in both developed and developing countries.

Agreement on this point did not, however, obscure the difference between the normative and the actual. The workshop participants felt that a distinction should be made between two questions, both of which are legitimate and require answers: What should the appropriate division be between research and extension functions in FSR work? What can one expect the optimal division to be between the research and extension functions in FSR work (in different countries, regions, or – to use FSR terminology at country level – recommendation domains)?

Several participants in the workshop agreed that there were marked differences in the quality of the extension services, in terms of both personnel and organization, among countries and regions. The quality of the extension services was generally considered poorer in Africa south of the Sahara than in most countries of Latin America. The question was raised, therefore, concerning the organizational problems presented by a functionally inadequate extension system.

It was generally recognized that the selection of a number of extension agents to work with the agricultural FSR team at the farm level (OFR) did not raise insurmountable problems. What was not clear, however, was how to ensure that the few extension agents assigned to collaborate with an FSR team would not become mere appendages of the FSR team. Discussions have been focused on the links between FSR teams and researchers oriented along commodity or disciplinary lines at (central or regional) research stations. Workshop participants believed that an equally important problem was the relationship between the extension agents working with FSR teams and the ordinary extension agents.

There was general agreement that, though the participation of extension agents in the on-farm research phase can help alleviate the load on the researchers by taking on monitoring or organizing roles, such load alleviation is not the primary justification. Extension agents working with an FSR team are meant to do more than help smooth working relationships with cooperating farmers and contribute to fine-tuning the packages being developed by FSR/OFR: They are meant also to link with other extension agents in order to insure the rapid testing, adaptation, and eventual use of the innovations proposed.

In the absence of an adequate extension system, should the research team assume responsibility for extension activities and, if so, to what extent? What would be the organizational and managerial implications?

The workshop participants took note of the fact that IARCs of the CGIAR system have been constrained by their mandates, their comparative advantages, and by their limited resources, to concentrate on research leading to the development of agricultural technologies, and to helping NARCs build up research manpower. Though a number of IARCs have agricultural production training courses, IARCs are not seen as having a comparative advantage in this area over the long run. So far the IARCs have little interest in extension and do not claim special expertise in this area. The question one participant raised was whether this fact implies that, when an IARC is involved in a collaborative FSR/OFR project with a NARS, will it not consider the capability of extension to help propagate the improved technological package? The literature and actual practice of FSR/OFR assumes that the extension agents involved, especially in the OFR stage, will be able "to keep one foot on the bridge and the other on solid land." He or she may not be able to do so and could end up being a de facto junior or peripheral member of the FSR/OFR team. What then? What are the organizational implications? Is one to expect in those cases where the extension system is weak that a highly desirable research product will find its way independently to the farmer-consumer? One participant contended that the improved packages of the Green Revolution found their way to the farmers in the absence of (and at times in spite of) the activities of the extension agents: that extension agents are not necessary, if the technological package is appropriate.

The workshop could not come to any consensus on these problems. It took note of the fact that FSR/OFR was developed when researchers realized that results were not always appropriate because farmers' circumstances had not been taken into consideration. This asymmetry between farmers' needs and the research products was blamed on the academic disciplinary or narrowly commodity-focused orientation of the reseachers, on the one hand, and on the lack of adequate data on farmers' circumstances, on the other hand. Correctly

or not, it was often felt by the agricultural reseachers that it was the job of extension to provide the data on farmers' circumstances.

The incorporation of social scientists in FSR/OFR strategy sprang from the realization that even the better agricultural extension agents in developing countries were not capable of developing adequate data on farmers' felt needs (subjective) and circumstances (objective). If FSR/OFR can in fact be said to be an imaginative, methodological, and organizational response to lacunae in both research and extension, should FSR/OFR in some cases develop an extension arm using modern mass media technologies, for example? What are the organizational implications? The workshop participants agreed that the topic deserved further investigation.

Incentives

The workshop participants took note of the fact that in none of the country cases presented were financial incentives used to recruit FSR team members. Salary scales were not adjusted upwards to take into account increased hardships stemming from living conditions, distance from urban centers, separation from families, longer working days.

Compensatory allowances were being provided in a number of cases: for example, 10% of salary in Panama and up to 50% in Ecuador, depending on geographical area and project. It was emphasized that those are not incentive payments but compensatory allowances. If those allowances were flat payments not requiring documentation of expenses actually incurred, and to the extent that the allowances were greater than actual expenditures, then a subsidy or incentive might be said to be implicit in the allowance system. Management should ensure the adequacy of the allowance to cover reasonable expenditures incurred by FSR team members as a function of their assignment. Furthermore, the possibility that the allowance could provide a proper mechanism through which an incentive element could be deliberately included should probably be investigated.

The workshop participants recognized that the question of compensation or incentives raised a number of problems, some severe. For example, to the extent that the researchers are part of the civil service system, the question of financial compensation cannot be divorced from that of equivalence for other groups, such as teachers, nuns, etc., in hardship posts. This problem of comparability of civil service remuneration can be avoided to the extent that the governmental research programs are located outside the civil service system, for example, in an independent institute.

Some participants strongly agreed that it would be a mistake to reduce incentives to purely financial one particularly when problems with civil service comparability and intraresearch organization resistance can render moot the institutionalization o such financial incentives. These participants emphasized that, without minimizing the importanc of reliable and prompt reimbursements for reasonable expenses incurred, incentives can take many forms. Some of these are the provision of adequate housing, schooling facilities, reliable transportation to urban centers for the families of researchers, prompt access to adequate medical care etc. Some of these nonmonetary incentives can be provided by management if it so wishes (such as transportation for families to urban centers or for other social functions). The workshop participants strongly recommended that managers of agricultural research systems should make a special effort to ascertain the factors which present and potential agricultural researchers weigh in deciding to join particular programs (for example, an FSR zone) which might increase their productivity.

Evaluation and Monitoring

The need to distinguish between the various forms of evaluation and monitoring was recognized from the outset.

Evaluation can be ex ante and ex post. Monitoring was seen ideally as a process of continuous collectior of data on the operation of the object being investigated. Cybernetically, this is the process of generating feedback leading to continuous fine-tuning for optimum operation. Evaluation may be concerned with the whole program or part of it. The evaluation may result in a reorientation of the entire program or of parts thereof.

Evaluation and monitoring could focus on at least three levels:

* Area teams.
* Institutional arrangements.
* Structures for policy determination.

It was agreed that the ex post evaluation should be given priority over ex ante evaluation. Although the ex ante evaluation stage (that is, determining feasibility in advance) of farming systems projects was seen as important, the consensus of the group was that (in view of the scarcity of human and financial resources) where general agreement exists

concerning the worth of the farming systems approach, ex post evaluation of programs and projects should be given priority.

An effective evaluation presupposes the existence of two conditions: (1) a clear statement of objectives and (2) a means of measuring their attainment in some way or another. Ex post evaluation is helped enormously when useful data have been gathered in a relatively continuous process of monitoring.

Ex post evaluation requires an evaluation of the relationships between inputs and outputs. The factors listed below were identified as elements of output (not an exhaustive list). Some factors might be quantified (marked with Q), while others may be measured only subjectively (marked with S).

In each case, prior decisions had to be made as to what elements would be most useful for the evaluation and then be fruitfully analyzed:

Output of farming systems research

Production/productivity	Q
Incomes of the people	Q
Employment of the people	Q
Human satisfactions	S
Social indicators, if available	Q
Public support for research	Q - S
Trained researchers and farmers	Q - S
Adjustments in methodologies	S
Cost of methodologies	Q
Information	Q - S
Clarification of policy alternatives	S
Impact on relations with other organizations	S
Ancillary factors	
Effect on research organization	S
Effect on FSR team	S

Inputs for farming systems research

Money	Q
Personnel	Q
Facilities	Q
Methodologies	S
Time of farmers	Q

It was repeatedly emphasized that evaluation may refer not only to the process of evaluation of a total program of farming systems research, but also to selected components. Thus, evaluation could be made of the economics, the human resources, the administrative, or other components of a farming systems program. Selection of a particular area for evaluation may or may not be prompted by a perceived weakness of that system component.

As indicated earlier, monitoring (the continuous evaluation of a system's operations) is an essential prerequisite for a thorough and maximally useful evaluation. Given its importance, responsibility should be clearly assigned for the monitoring task at different levels at which farming systems research might be undertaken.

Systematic evaluation should contribute significantly to increased efficiency of farming systems projects and programs. Only by continuous evaluation of the various components and feedback into the system can the farming systems perspective become an integral part of agricultural research programs in developing countries. The farming systems approach to agricultural research must be continually adapted and refined. Only by continuous monitoring and systematic evaluation of its components can cost efficiency be improved.

Decisions concerning the arrangements for carrying out evaluations is a management function. A number of possibilities or combinations already have been tried. These include

* Setting up an evaluation unit within the farming systems research unit.
* Evaluation from outside.
* Evaluation by those engaged, plus an outside input.

The preference of the work group members was for the third option, development of a task force composed of individuals from within the system, supplemented by outside members.

Policy Formulation and FSR

The workshop participants agreed that it was important for results of FSR projects to reach policy makers. Whether the communication of such results lead to positive changes in the short run, or long run, may depend on the realism of the policy changes recommended (and thus, indirectly, on the correctness of some of the assumptions made by the FSR team in developing its experimental parameters) and on other factors over which the FSR team cannot be expected to have any control. The necessity of informing policy makers was recognized.

Agricultural policy plans will be made with or without much appreciation of the farmers' problems, and it was considered better to have well-informed policy makers. Dr. Coulter's (World Bank) view is that FSR is a useful tool to help maximize returns on resources, either those currently available or those additional resources to which farmers can get access as a result of policy changes (recommended by FSR teams as a result of their investigations).

The ease with which such communications can be developed depends partly on the intensity and specificity of the interest which policy makers may have in FSR. Good communications seem to exist in a number of countries, such as Nigeria and Panama. The importance of giving any FSR success wide publicity (conferences, mass media, etc.) – rather than keeping the news a secret within the research section or ministry – was agreed upon by the workshop participants; some noted that it took an average of 4 or 5 years to get any results, by which time policy makers may have become impatient or may have given up hope altogether. The wide dissemination of research results, of data on the levels of productivity enhancement to be expected from recommended policy changes and of interim increased production data from the group of farmers targeted, is particularly important where funding and policy changes recommended depend on a broad range of ministries and organizations.

Some participants in the workshop argued that FSR generally – and certainly FSR/OFR – is aimed at the acquisition of practical knowledge that will lead to incremental increases in production, mostly within the broad parameters of resources available and of existing policy. Some felt that this definition of FSR was too restrictive and did not allow for the development of FSR as new farming systems developed. It was generally agreed that FSR/OFR was not concerned with national macroeconomic analyses, but was concerned with socioeconomic analyses at the farm level only to the extent that they may affect the development and acceptance of successful near-term alternative improved technologies.

Planning and Program Formulation

The workshop focused its discussion on the role and potential contribution of the farming systems perspective to the research planning and program development processes.

It was felt that a definition of the content and scope of this process was needed. The differences between planning and program formulation were stressed. Planning was considered to be related to the overall priority-setting process carried out at the top level of government and its institutions on the bases of broad social, economic, and political considerations and the country's resource potential. On the other hand, program development was seen as a bottom-up process through which the priority problem areas (coming from the plan) are translated into researchable questions and specific proposals. At the planning level, the essential interaction was seen as between top management and policy makers. Program development is a scientist-centered process. The quality of the resulting program will depend on the training and competence of the scientists and their comprehension of the problems of the clients of research.

Having these two processes properly executed is the first step for sound management of the research effort.

The FSR contributes to both levels. To higher planning, it brings a flow of reliable information concerning the farmers' conditions and potentials. It is with respect to program development that FSR becomes essential as a proxy for farmers in assessing the relevance of research proposals to their conditions and value systems. It permits the focusing of technology generation on the farmer. At the same time, it is instrumental for increasing the probability that research results are more useful in the generation of acceptable technology.

Another major contribution is through improving the transfer of research results to the delivery system (extension).

From the management point of view, two aspects become crucial for this contribution to planning and programming. One is the kind of capacities needed for FSR; the second is how this perspective is brought into the organization. The approach is basically interdisciplinary, requiring inputs from both the biological and the socioeconomic sciences.

This is perhaps one of the most important problems to solve, since few research systems have (or are large enough to afford) the number of economists or sociologists that may be needed. The discussion of these issues touched on several aspects, concentrating on whether these capacities should be brought into the research system as a separate effort, as a farming systems unit or program, or as part of regular research activities. The extent to which this can be done will depend on the resources and the size of the system; but it was agreed that, at a minimum, this capacity should be available at the level of each of the major operational units of the research system – whether commodity or regional/geographical groupings (commodity programs and research centers or stations).

Communication

There were few observations on how to raise the probability of effective communication among those undertaking on-farm research and those undertaking

other classes of research or – perhaps better – between those doing interdisciplinary research aimed at near-term recommendations and those engaged in research on components. Delgado reported to one discussion group about INIAP's investment in raising the probability of communication. Effective communication will require a significant commitment of resources.

Networking

The participants agreed that some attention should be given to the development of a network which could facilitate the exchange of experience and ideas as well as materials. Countries contemplating the organization of FSR/OFR work could benefit from discussions with those already involved. Visits of two or three weeks to the organizations with experience in research with a farming systems perspective might be recommended. There was a strong feeling among some participants that the base for this networking should be located in an institute, center, or NARS in a developing country. It was emphasized as well that the costs of networking would have to be defrayed by donor countries or an international organization such as World Bank.

Some participants emphasized that networking involved not only the sharing of information and materials, but making available training places for personnel from areas just starting FSR/OFR projects. There was some insistence that such mutual assistance between developing country institutions would be particularly appropriate, given the scarcity of training places in IARCs and the general unsuitability for FSR/OFR work of formal courses in developed country universities.

The value of networking was reinforced by discussions – reported under Human Resources Requirements in this chapter – of what suitable training might be and how it could be organized.

Human Resources Requirements

The workshop was unanimous in deciding that only in a few cases would a reorganization of a whole NARS take place around an FSR approach. In those rare cases, recommendations would have to take into consideration the constraints of the specific situation. The workshop decided to focus on situations where the viability and integrity of a NARS organization is not at stake, but where the problem is integration into the system of an FSR perspective and FSR/OFR teams.

The composition of an FSR/OFR team and the intensity of activities of its members will vary over the life cycle of the FSR/OFR project. The participants agreed that, as a rule of thumb, the team should include one social scientist for every three general agronomists/biological scientists; extension agents should be incorporated as soon as practicable, certainly by the time the OFR stage is reached. This rule-of-thumb ratio does not take into consideration the ex post evaluation stage demand on research personnel.

The participants agreed that the formal integration of support disciplines (such as, soil science and entomology) into FSR teams would make them unmanageable, even though it would help ease some of the current linkage difficulties by providing essential back-up disciplinary research inputs for FSR projects, especially as they are extended to new production areas. In other words, other disciplines will need to be represented in the core team as new regions involving animals, agroforestry, and horticulture become target areas.

Some participants emphasized the integrator/evaluator role that can be played by FSR in developing countries. It was agreed that the farmer in developed countries (usually better educated and informed than his developing country counterpart) performs the role of integrator/evaluator, as well as being the articulator of his needs. These roles must be filled by the researchers in developing countries, in this case by the FSR/OFR team. It was noted that in developed countries the private sector does a lot of integration in the process of developing inputs that are offered to farmers.

The basic attitudinal requirement for selection of personnel to be assigned to farming systems teams is open-mindedness and an ability to work as a team. The team members should be well trained in their own disciplines in order to maintain mutual respect and meet the challenge of the task. The team leader should have pronounced multidisciplinary know-how as well as the skills usually associated with leadership.

Experience in Latin America and elsewhere seems to suggest that the FSR/OFR teams are composed of relatively young and highly motivated individuals. It was suggested by some participants that the experience of Ecuador and Guatemala seems to indicate that hands-on training and the selection of young members with less than 5 years of station experience form the best combination. Other participants cautioned against the preponderance of young, relatively untrained and inexperienced

researchers in FSR/OFR teams. Irrespective of the question concerning the ability of these researchers to do a good job, managerial considerations are involved; FSR/OFR teams composed mainly of younger researchers may have problems gaining prestige and acceptance by older, more established researchers in disciplinary or commodity-oriented programs.

It was considered likely that incentive and other measures for such FSR/OFR teams might be resisted by other researchers, as these could threaten the continuation of differentials perceived to be legitimate and based on seniority or formal educational attainment. In the absence of adequate incentives and prestige for the FSR team, a problem of retention of experienced FSR/OFR team members may arise. The relative newness of farming systems research may explain why this has not been widely experienced as a problem. A carefully developed career plan, aimed at retention of experienced FSR/OFR team members, is essential if participation in FSR is not to be viewed as an unfortunate but transitory career phase. One effective management tool for keeping such individuals is the provision of frequent opportunities for additional training of both a formal and nonformal nature. Frequent short visits to regional and central stations, as well as regular visits by top administration and researchers to the FSR/OFR field locations, are important to facilitate integration and to develop the legitimacy of the FSR/OFR teams.

Considering the amount of farming systems activity, the workshop members felt that there was a large underinvestment in training at all levels. It was felt that an especially attractive leverage point would be a program for improving the agricultural sciences curriculum in the developing countries by helping them to incorporate an FSR perspective in their training.

Some participants felt that it might be particularly useful to target university professors who teach agricultural undergraduates in the developing countries. These professors would then incorporate the FSR/OFR methodology into the regular curriculum. In the formal educational program, every attempt should be made to have students conduct their research work in connection with FSR/OFR programs or projects. Participants felt that it would be more economical and effective to develop short, practical FSR/OFR courses in country (there are, in any case, few FSR training opportunities overseas at present, including those at IARCs), even if it means that an international team of trainers might have to be called on to supplement local resources.

5. Recommendations of Committee to Consider Conclusions from the Workshop

Conclusions

The workshop reaffirmed that the farming systems approach to research has a significant contribution to make to national agricultural research systems.

Every effort should be made to instill a farming systems perspective into the national research system, and research management should ensure the capacity to carry out farming systems research.

The main sets of activities described as farming systems research are diagnosis, priority determination, experimentation in relevant environments, monitoring and evaluation, and communication of interpreted conclusions to users.

Valuable experience has been gathered from existing operations for initiating farming systems research activities in other countries on a small scale: the pattern of growth depends on a learning process in local circumstances and the growth of capacity in personnel. Little guidance is currently available for launching farming systems research on a large scale.

There is an urgent requirement for applying rapid methodologies to lead to results for early impact with farmers.

Recommendations

It is recommended that the development of an international network be encouraged so as to benefit from sharing in the experiences of organization and operation of farming systems research in different countries.

Detailed information on costs of implementing farming systems research is needed as patterns of operating costs are not familiar to research administrators. It is recommended that a research project be set up to collect this information from different countries to enable more realistic budgets to be prepared.

Lack of personnel with training in farming systems research is a major handicap to expansion of a farming systems perspective. Maximum use should be made of training courses in farming systems research offered by institutions, but in-service, in-country training courses are very desirable. Linkages should be developed between practical research operations and educational institutions.

Point on Organization

Strong linkage mechanisms should be established between those carrying out farming systems research and the rest of the research system (for generation of better technology) and with the extension service (for rapid diffusion of results). A mechanism should be institutionalized within the research system to ensure multidisciplinary review of research proposals at the earliest stage of research program formulation.

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Annex 1

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Annex 2

ISNAR/CIMMYT WORKSHOP PROGRAM

Organization and Management of Research with a Farming Systems Perspective Aimed at Technology Generation
ISNAR Headquarters, The Hague, Netherlands
September 27-30, 1983

Monday, 26 September

	Arrival of participants at The Grand Hotel Central in The Hague
18.30-20.00	Cocktail – Grand Hotel Central – Cambridge Room – Mezzanine

Tuesday, 27 September

08.45-09.15	Welcoming Address by M. Dagg ISNAR
09.30-10.30	Recent views on the farming system research D. Winkelmann
10.30-10.45	Coffee break
10.45-11.45	Activities of Development Agencies in Support of Farming Systems Resarch at CATIE J. K. Coulter
11.45-12.45	Discussion Discussion leader: H. Davis Rapporteur: K. R. Kern
12.45-14.00	Lunch
14.00-15.00	Concepts and Implementation of Farming Systems Research at CATIE G. Paez, L. A. Navarro, C. F. Burgos, J. L. Saunders, and J. Arze
15.00-16.00	Organization and Management of Farming Systems Research: Experiences from Nigeria G. O. I. Abalu
16.00-16.15	Coffee break
16.15-17.15	Discussion Discussion leader: J. Mieman Rapporteur: M. Dagg

Wednesday, 28 September

08.45-09.45	Zambia country report: W. Chibasa*
09.45-10.45	Experience in Organization and Management of Research with a Farming Systems Perspective in Panama R. Tarté
10.45-11.00	Coffee break
11.00-12.00	ICTA Production Oriented Research A. Fumagalli
12.00-13.00	Discussion Discussion leader: D. Winkelmann Rapporteur: P. Bennell
13.00-14.00	Lunch
14.00-15.00	Ecuador country report: J. Delgado
15.00-16.00	Discussion Discussion leader: R. Waugh Rapporteur: M. J. Chang
16.00-16.15	Coffee break
16.15-17.15	Preparation for working groups: M. Dagg

Thursday, 29 September

08.45-12.45	Working groups Chairman: M. Dagg Discussions on requirements in organization and management of research with a farming systems perspective * Planning and program formulation * Human resources requirements

* In view of Dr. Chibasa's absence, this country report was not presented.

Thursday, 29 September (cont.)

	* Financial and other support requirements * Communications/Evaluation and monitoring
12.45-14.00	Lunch
	Chairman: J. K. Coulter Rapporteur: T. Weersma-Haworth
14.00-16.00	Presentation of group discussions and conclusions by rapporteurs of individual groups
16.00-16.15	Coffee break
16.15-17.15	Plenary discussions
19.00	Dinner offered by ISNAR

Friday, 30 September

08.45-10.45	Plenary discussions
10.45-11.00	Coffee break
11.00-12.30	Committee work
12.30-13.30	Lunch
	Chairman: J. K. Coulter Rapporteur: K. R. Kern
13.30-15.30	Workshop conclusions Chairman: M. Dagg Rapporteur: K. R. Kern
15.30	End of workshop