Report of a Workshop

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INTERNATIONAL WORKSHOP ON AGRICULTURAL RESEARCH MANAGEMENT

isnar
International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, Netherlands on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting governments of developing countries to strengthen their agricultural research. It is a non-profit autonomous agency, international in character, and non-political in management, staffing and operations.

Of the 13 centers in the CGIAR network, ISNAR is the only one that focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on research policy, organization, and management issues, thus complementing the activities of other assistance agencies.

ISNAR has active advisory service, research, and training programs.

ISNAR is supported by a number of the members of CGIAR, an informal group of approximately 43 donors, including countries, development banks, international organizations, and foundations.

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INTERNATIONAL WORKSHOP ON AGRICULTURAL RESEARCH MANAGEMENT

7 to 11 September 1987
The Hague, The Netherlands

isnar
International Service for National Agricultural Research

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PROGRAM

INTERNATIONAL WORKSHOP ON AGRICULTURAL RESEARCH MANAGEMENT

ISNAR, The Hague, Netherlands

September 7-11, 1987

Monday 7 September
THEME: ISSUES IN AGRICULTURAL RESEARCH POLICY AND PLANNING

08:30 - 09:00	Welcome and Introduction	**A. von der Osten**
09:00 - 10:30	Diagnosing Constraints in Agricultural Technology Management Systems	**H. Elliott/A. Rabufetti**
10:30 - 11:00	Break	
11:00 - 12:30	Strategic Planning for the System	**G. Rocheteau/I. Soumana**
12:30 - 13:30	Lunch offered by ISNAR	
13:30 - 15:30	Priority Setting in Agricultural Research	**E. Javier/G. Norton/ A. M. Macha**
15:30 - 16:00	Break	
16:00 - 18:00	Working Groups	

Tuesday 8 September
THEME: LINKAGE ISSUES IN RESEARCH ORGANIZATIONS

08:30 - 10:00	On-Farm Client-Oriented Research	**D. Merrill-Sands/ S. Kean/L. Singogo**
10:00 - 10:30	Break	
10:30 - 12:00	Research-Technology Transfer Linkages	**D. Kaimowitz/ U. Bilbesi/G. Montes-Llamas**
12:00 - 13:30	Lunch Break	
13:30 - 15:00	Networking	**R. Martinez-Nogueira/S. Bonilla**
15:00 - 15:30	Break	
15:30 - 17:30	Working Groups	
19:00	Dinner Hosted by ISNAR	

Wednesday 9 September
THEME: IMPROVING MANAGEMENT PROCESSES

08:30 - 10:00	Management Information Systems and Their Uses	**B.T. Mook/R. Valmayor**
10:00 - 10:30	Break	
10:30 - 12:00	Program Budgeting	**P. Marcotte/J. Sands**
12:00 - 13:30	Lunch Break	

13:30 - 15:00	Monitoring & Evaluation	**D. McLean/R.M. Acharya**
15:00 - 15:30	Break	
15:30 - 17:30	Working Groups	

Thursday 10 September

THEME I: MANAGEMENT OF HUMAN AND PHYSICAL RESOURCES

08:30 - 10:00	Human Resource Development and Management	**P. Bennell/R. Kellou**
10:00 - 10:30	Break	
10:30 - 12:00	Management of Physical Resources (Planning & Development)	**G. Hariri/A.R. Shehata**
	Agricultural Research Planning, Monitoring and Evaluation in Vietnam	**Nguyen Trong Hoan**
12:00 - 13:30	Lunch Break	

THEME II: ORGANIZING AGRICULTURAL RESEARCH IN LARGE NATIONAL SYSTEMS

13:30 - 15:00	The Case of The People's Republic of China	**H.K. Jain/F. Zhou**
15:00 - 15:30	Break	
15:30 - 17:30	Working Groups	

Friday 11 September

THEME: CONCLUSION AND AGENDA FOR ACTION

08:30 - 10:00	Presentation of Working Group Reports	
10:00 - 10:30	Break	
10:30 - 12:00	Continuation of Working Group Reports	
12:00 - 12:30	Closing	**A. von der Osten**
12:30	Departure; Meetings with ISNAR staff; or Field Trip	

OVERVIEW, DISCUSSION SUMMARY, AND CONCLUSIONS

INTRODUCTION

The workshop brought 29 participants from 27 countries together with ISNAR staff in a forum to discuss a range of issues facing them as directors of national agricultural research systems (NARS). It also enabled ISNAR to have a program consultation with its partners. This provides critical assessment and feedback on work which is done at ISNAR and in collaboration with NARS.

At last year's workshop (1986), in which ISNAR's strategy was discussed, the research directors present confirmed the validity of the 12 critical factors for strengthening NARS as identified by ISNAR. ISNAR's agreed medium-term plan is to focus, as a priority, on six of the critical factors falling into three broad areas: research policy, organization, and management. The six factors are: formulation of agricultural research policy - priority setting, resource allocation and long-term planning; structure and organization of systems; linkages between NARS, the technology transfer system and users; program formulation and program budgeting; monitoring and evaluation; development and management of human resources.

As ISNAR's Director General Alexander von der Osten explained, the workshop themes were selected to share ISNAR's current work on some of these critical factors with its partners in the NARS and to enable NARS leaders to exchange experiences among themselves.

The workshop sessions were grouped around five themes. Within each theme a number of topics were discussed, first with ISNAR presenting an overview of its experience or reporting work in progress and followed by presentation by NARS leaders giving the NARS' experience.

An essential part of the workshop was feedback from the participants to ISNAR's staff in both plenary and working group discussions on each topic. This feedback helps ISNAR to validate the conceptual framework of its work and improve the design of management tools for handling research policy, organization, and management in collaboration with the NARS.

In this overview and discussion summary we have very briefly outlined the papers and drawn together the points to emerge from the plenary and workshop discussions. This follows the form of the workshop and deals with each theme and topic in turn. Naturally, there was overlap in the discussions. In order to produce a more coherent report, the points made have been grouped under the topic to which they relate, even if they were made during discussion of a different topic. The conclusion examines the results of the workshop and highlights the recommendations for ISNAR's program of work.

The rest of this volume contains edited versions of the papers presented at the workshop, in which you will find more detailed discussion of the topics highlighted here.

THEME ONE - ISSUES IN AGRICULTURAL RESEARCH POLICY AND PLANNING

Diagnosing Constraints in Agricultural Technology Management Systems (ATMS)

Agricultural research takes place within social, economic, political, and historical settings, which differ from country to country. Each research system faces constraints related to the broader environment in that country. While measures to overcome these constraints must be tailored to each NARS, the approach to analyzing them can be systematic and used in many countries. The ATMS approach, discussed in Dr. Howard Elliott's paper, is a method for analyzing the

constraints facing a research system and for generating the information needed to evaluate alternative solutions.

Elliott focused on the first level of an ATMS analysis which provides a holistic view from three perspectives: functional, historical (events), and policy.

The functional analysis examines the objective of the system in terms of 13 key functions any ATM system must perform. These were illustrated by a case study in Panama. These functions can be related through a responsibility chart to different groups or organizations in the system and the mechanisms they use to carry out the functions. Examining responsibilities allows identificatiion of structural or procedural weakness in areas where contraints exist. Changes in structure or the mechanisms organizations use become alternatives for improvement.

The "events" analysis establishes a database of technological, institutional and policy changes in the system. By arranging events chronologically, and relating them to each other, the analysis brings out interactions between policy, institutional and technical changes. Once established, the database only needs to be updated.

The policy analysis examines policies that constrain the impact of the ATMS. Those amenable to change from within the system and those that have to be lived with until wider policy changes are made can be identified.

Elliott sees this analysis as useful in putting an agricultural research system into a broader policy environment. The method provides the diagnosis and information needed to generate alternative solutions which are useful in strategic planning, as well as in providing the necessary background for a detailed review of the NARS.

Uruguay

Dr. Armando Rabuffetti discussed the evolution of the Uruguayan research system in its broader policy environment and the current reorganization of agricultural research.

The Uruguayan research system is one of the older systems in Latin America and has gone through several periods of growth and recession. By the mid 1980s the system faced major limitations, and a major program to overcome these was begun, involving reorganization, human resources management and development, and developing support for research. Dr. Rabuffetti discussed how the program was being implemented, the importance given to the role of the producers, and the difficulties encountered. He discussed ISNAR's catalytic role, with regular visits from ISNAR staff helping to concentrate attention on the institutional reform, and stressed the need for continued contacts.

Discussion

ATMS Concept. Overall there was agreement that the ATMS concept was useful because it took a systems view, emphasized the broader environment, and led naturally to further investigations into certain linkages and functions of the NARS. It was recognized that study of this broader environment was not ISNAR's primary mandate area even though its impact on research must be understood. It was, therefore, a useful complement to ISNAR's primary focus on the organization and management of NARS, but it should not become a separate focus of attention.

A systems perspective helped create an awareness of the importance of not overemphasizing any one part of the system, so that this developed beyond the point at which other parts could support it. An example was given of a proposal for a major extension project which would have gone far beyond the NARS' research capacity to support it with new technology to transfer.

The discussants emphasized the need to attack the limiting factors in the ATMS first. If a technology transfer network is hampered by a lack of technology, then the first priority must be to make the technology-generating system function.

There is, everywhere, the problem of defining and building an ATMS in reality, since the three technology subsystems - users, generators and transfer agents - are seldom properly linked in a coherent system.

Resource Requirements. There was concern that a complete ATMS approach required analysis of many problems and the skilled manpower for doing so. It needed to be kept going and updated. It also needed to be integrated into the national structures so that they would gain commitment to the results of the analysis. The ATMS approach is suited for use by a national study team or, if carried out by outside agencies, should include nationals to enable a holistic picture to be obtained and help build commitment to any recommendations it might make.

Impact. There was also concern about its practical impact on NARS managers. One impact claimed was

that clear analysis of the constraints could help in dialogue with policy makers about research and also with donors. It should also generate information which enables a range of alternative proposals to be developed and evaluated.

ATMS Methodology. Most discussion about the methodology focused on the functional analysis. The consensus was that focusing on functions was useful, since functions were more permanent than organizations. In practice, however, structures often have to be accepted as given and any improvements designed to be made within the existing structure.

Responsibility charts were accepted as a systematic way of recording information and studying the role of key organizations in the system. The 13 key functions used in them were considered adequate to describe a generic ATMS. Some were obviously outside the influence of research *per se*, but it was recognized that some parts of the broader ATMS must have influence on even these. Coordination is essential for the performance of several functions, including setting goals for the agricultural sector, executing research, organizing donor involvement, and taking into account the needs of farmers in planning and technology generation.

The historical perspective could be given through an events analysis or chronology. It was recognized that this could be a complex task, given the wide range of historical information, especially in large or old systems. It can help in analyzing relations and identifying points to watch. However, it must be used with care and must avoid too firm conclusions. Once created, the database may save staff time if used as a briefing tool for visiting evaluation or project-design teams and, as such, a NARS might find it worthwhile establishing one itself.

NARS' Link to Policy. In discussion, it was stressed that NARS influence on policy making is weak. Research was felt to have the expertise to comment on system-wide issues and influence policy but needed to explore appropriate means to do so. NARS must interact with policy making but usually in a consultative or informative, rather than participatory, role. NARS leaders must decide how much staff time and resources to give for providing information and advice to policy makers at the expense of research.

Finance and Aid. Four critical issues in finance and aid were identified in the discussion: the absorptive capacity of NARS for aid and technical assistance; the sustainability of systems supported by donors; the nature and conditions of donor support; the need to generate national support.

Strategic Planning for the System

As the ATMS approach makes clear, a NARS operates in a broader policy environment. This environment is complex, changing, and difficult to forecast. Strategic planning is a method developed initially for industrial enterprises influenced by a changing environment in which the future was difficult to forecast but important to predict with some degree of confidence.

In its work with NARS, ISNAR may become involved in assisting with a strategic planning exercise. Strategic planning as a process is also on ISNAR's research agenda to see how it can be developed further and adapted for NARS. Dr. Guy Rocheteau's paper is an initial reflection on this work and does not present a model ready for use in any given country.

In strategic planning, the future stems from a conscious desire to achieve a certain position, a "profound scenario". It is a process in which there is an initial diagnosis, evaluation of alternative scenarios, and development of an action plan to reach the preferred scenario. The scenarios of future conditions are based on rational choices related to desired objectives. Usually, there are two main approaches to action, one involving reorganization, the other mobilization of resources.

Rocheteau discussed five stages in strategic planning. First, organizing the planning, assigning responsibilities, time scale, etc.; second, a strategic diagnosis, describing and analyzing the present position; third, formulating the long-term objectives, i.e., the desired scenarios; fourth, developing strategies to go from the present to the planned position; and, finally, implementing the plan through short-term action plans.

Niger

In Niger, as Dr. Idrissa Soumana explained, an attempt has been made to apply strategic planning to the NARS. A National Institute for Agricultural Research was set up in 1975 to direct the NARS. It developed to include six research departments and various research stations, mainly in the west of the country.

A Niger team has gone through a series of strategic planning steps with ISNAR to produce a long-term plan with targets, and is now working on various short-term

implementation stages. Some measure of reorganization, with new bodies created to oversee research and a restructuring of the research system, has been carried out, as well as attempts to mobilize existing resources more effectively

Discussion

Niger. With respect to reorganization, some participants felt that the three levels of council, board, and committee, which were introduced, seemed much more complex than what it replaced. Others wondered how the university, regions, producers, and donors were involved in the research process.

Dr. Soumana pointed out that the planning system fitted the specific conditions in Niger, met the need to involve various parties, ensured a voice for research at the highest levels, and avoided the rigidities involved in a departmental structure by using a program approach. In determining research needs, the process started in the regions by drawing upon village and district-level organizations, and this involvement of relevant organizations and people continued up to the national level. Research expresses its needs to the Ministry of Planning, which contacts donors who discuss with the Ministry any project of interest.

Value of strategic planning. In discussing SP, there was a strongly expressed, generally agreed view that farmers' needs must be represented in the planning process. This poses practical problems of how to get the participation of producers or a fair representation of their views, something participants wanted specific advice about, as they had found it difficult to achieve.

Strategic planning was seen as a powerful tool:

- to enhance research coordination at a national level;
- to ensure that research institutions are not diverted entirely by short-term operational issues;
- to improve the image and credibility of the NARS among its clients and at governmental level; as such it is an asset for NARS in fund raising;
- to ensure continuity of research programs since a clear plan gives NARS bargaining power, with governments and donors, to defend the agreed programs;
- to improve efficiency in research monitoring and evaluation;
- to ensure that not only technical but also socio-economic factors are taken into account in research programming;
- to improve links between the research and the transfer of technology processes.

Limitations and enabling conditions. Two limitations in strategic planning were noted. First, the amount and quality of information collection, processing, storage, and retrieval required. If these requirements are not met, planning objectives and recommendations for change may be inaccurate, erroneous, or irrelevant. Since small NARS, in particular, have limited resources to gather the information required, this may be a particular limitation for them. Second, in some countries, governments are not deeply committed to strategic planning.

Two dangers in strategic planning were also mentioned: an excessive formality in the procedures, and bureaucratization of the process. These were not felt to be impediments if three enabling conditions were met:

1. Seeing strategic planning as part of a continuing process, integrating planning, programming, and evaluation procedures. The strategic plan has to be reanalyzed continually.

2. Complementing the long-term strategic plan by a short-term action plan. This reduces the uncertainties inherent in long-term planning statements.

3. Ensuring that those who have to implement the plan participate in its preparation.

Small countries. There was some discussion about whether there was a difference between strategic planning in small and large countries. It was felt that while there might be differences in attitude to strategic planning, the nature of strategic planning as a process seems to be similar in both cases.

Universities. In planning for a rational use of all research resources in a country, the issue of harmonizing research proposals from the universities and research institutes stimulated considerable discussion. In Algeria, for example, guidance is given to people doing master's and doctoral theses in choosing their topics so they fit into the areas planned for national research. While the need for greater synergy between universities and research institutes was agreed, it was felt that often universities either focus on more basic or purely didactic research than research institutes. This can be seen as complementary to the institutes' work. Where funding for research goes via the institutes, then they can draw in contributions from the universities. A strategic plan must consider the structural and operational issues in

bringing universities and research institutes closer together.

Recommendations. It was recommended that ISNAR do more work on the applicability and the necessary adaptation of strategic planning methodologies in developing countries' NARS and that research managers increase their own knowledge of strategic planning.

Priority Setting in Agricultural Research

Within an overall plan, NARS need to establish priorities for research. The need for improved priority-setting procedures and various methodologies was examined in Dr. George Norton's paper. He discussed four types of procedure: use of weighted criteria models, benefit-cost (expected economic surplus) analysis, mathematical programming, and simulation modelling. He focused on the first two as having the best potential use in developing countries and looked at work done in the Dominican Republic, Ecuador, and Uruguay in 1986-87 with weighted criteria models, and in Peru in 1985 with the expected economic surplus analysis

ISNAR worked with the directors of three systems to establish the goals, key criteria, and put weights on them. A spreadsheet program in a microcomputer wa used to analyze the initial results, and in an interactive way policy makers were given the chance to re-examine the weights they assigned to different criteria. Here, Norton warned against the temptation to add in criteria without really considering their meaning for research, which may occur because of the ease of manipulating data with the computer. Such methods cannot be applied in a mechanical way.

ISNAR plans to refine the existing work, test it in some case studies, and develop a computer program and manual for use by NARS which would be supplemented by training.

A Practitioner's Perspective

Dr. Emil Javier, drawing from his experience in the Philippines, approached the task of priority setting as a practitioner. He proposed the joint drafting of agricultural development objectives with the Ministry of Agriculture (MOA) which describe the Ministry's current to medium-term targets in more or less operational terms. These statements, through which the research community may influence the MOA's priorities, can provide the common basis for planning, organizing, and implementing research and extension.

He discussed various ways of setting research priorities and expressed a strong preference for using commodities, because they appear best suited for linking the research agenda to national development goals. However, since not all development objectives relate to commodities *per se*, there must be a parallel set of priorities for non-commodity concerns.

Ultimately, priorities must be related to projects, activities, and resources. Priority setting simply orders research activities in a list of descending importance but does not translate itself automatically to resource allocation recommendations. It says where priorities lie, but does not say how much and how fast one should spend in the area. Unfortunately, there is little guidance available on this aspect in the literature.

The practioner's bias came up clearly when Dr. Javier introduced the notion of organizational priorities as a set of institutional concerns parallel to the program priorities. Program priorities are concerned with long-term, strategic subject-matter decisions, while organizational priorities have to do with tactical aspects of running the organization and institutional strategies for survival. Both, however, are essential.

Tanzanian Experience

Dr. A. Macha described livestock research in Tanzania and discussed how priorities in livestock research policy had shifted from dealing with epidemic diseases to animal nutrition. However, there was no rigorous system for setting priorities.

After the Tanzania Livestock Research Institute was set up in 1980, it analyzed and reviewed past results, and drew up a five-year research program. It was handicapped by the lack of a clear national policy on research, a lack of consensus about what should be done, by frequent changes in policy and personnel, and a lack of basic infrastructure to sustain basic livestock research.

A further fundamental problem was the lack of inputs by the livestock owners. If these were available, researchers could recommend packages from existing knowledge. Thus priority setting has to take place within constraints imposed by the system.

Discussion

There was considerable discussion about various

influences on research priority setting, as well as about the methodology itself.

National goals. The central influence must be national goals. Many countries had chosen food self-sufficiency as a national goal but had not achieved it. Participants discussed various reasons for this:

- Too often priorities were set but not matched by the allocation of resources to carry them through.
- Priority was not given to research, with many governments saying it is important but not giving sufficient funding to support their words.
- The priorities have not been correct for the given system. There may be a lot of technology available but not the inputs at the farm level to use it.
- To have self-sufficiency as a priority does not clearly define research priorities. It is too vague. The question is, priority for whom?

It was explained that in the three ISNAR case studies discussed, food self-suffiency was not included as a separate goal or criterion. Since the criterion of comparative advantage assumes that self-sufficiency was not wanted for its own sake but to improve the nutritional status of the population, self-sufficiency is included within the other criteria. To introduce it separately would lead to double counting.

External influences. Another important influence on priorities and the allocation of resources can be the effect of donors and international organizations, like the international agricultural research centers(IARCs). Each one promotes research on the commodities of interest to itself. ISNAR was asked how it could help resist this so that NARS can coordinate their research priorities. It was suggested that one way is for countries to set their own priorities first. These can be used to alert donors and IARCs to national needs and in planning a proper division of labor between the national and international institutes. Setting out the criteria for working out priorities is also good, as it helps to be more precise about the basis for taking decisions. In setting the priorities, participation of policy makers in weighting different objectives is critical.

Small farmers. There was much concern about the needs of small farmers and how they entered the priority-setting process. Participants felt the presentations did not appear to stress the need to make sure they were involved.

It was explained that in the three case studies, concern for small producers was one of the *main criteria* and that the relative weight given to this criterion should reflect the importance that the research planners give this issue. In fact, where farmers are not organized to participate in a priority-setting process, the explicit inclusion of their interests in a formal approach may help to give them the representation they lack.

Knowledge and information requirements. Some participants highlighted a problem for researchers choosing priorities or a research topic, especially in young countries, which lacks knowledge of the field in which the researcher has to work, and about what research has been done elsewhere. A researcher's prior training and not his knowledge of farmers' problems is too often the guide in choosing a research problem.

For NARS, lack of dependable data is a limitation in setting priorities. Quite obviously, whether one goes through a formal or informal route in priority setting, the outcome can only be as good as the information on which it is based.

Complexity and flexibility. There was some concern that the formalized priority-setting methods described seem to make setting priorities more complicated. All participants stressed the need for simplicity. However, it appeared that they were prepared to accept that making the process of setting priorities more formal and systematic is a step in the right direction. It forces researchers to assess more critically their own work and also serves as a convenient tool for demonstrating intellectual rigor, thereby generating respect from other professionals in the planning and finance ministries and elsewhere.

One participant suggested approaching priority setting as a set of decisions which could be treated in a hierarchical manner. Some decisions are made at higher levels of aggregation by higher levels of authority and others are treated as downstream decisions, made at lower levels of organization but within the framework of the broader decisions. Generally, however, prioties involve both bottom-up and top-down decisions.

An organizational necessity that needs to be reflected in the priority-setting exercise is provision for sufficient flexibility to allow research organizations to respond to changing conditions which were unforeseen when the priorities were set.

Linking priorities with resource allocation. It was hoped that ISNAR could devote some effort to examining how marked priorities are or can be linked to resource

allocation. In the eventual allocation of resources, the capacity of certain activities to effectively absorb resources must also be taken into account.

ISNAR's plans. The participants supported ISNAR's plan to develop a set of methodologies requiring different levels of sophistication to enable NARS to adopt the methodology that suits their needs and capabilities.

THEME TWO - LINKAGE ISSUES IN RESEARCH ORGANIZATIONS

On-Farm Client-Oriented Research (OFCOR)

OFCOR is a research strategy that links research with farmers. In this strategy, problem diagnosis and the design and development of technology occur at the farm level. Many countries and organizations have evolved different approaches and institutional arrangements to do this. In January 1986, ISNAR began work on OFCOR in order to understand the critical policy, organizational, and managerial factors relevant to implementing, integrating, and sustaining OFCOR within a NARS.

In reviewing the work in progress, Dr. Deborah Merrill-Sands examined seven functions OFCOR could perform when integrated into a NARS and ISNAR's attempt to synthesize the experience of various NARS with OFCOR. Nine case studies, three each from Latin America, Africa, and Asia, have been undertaken with national researchers from the countries involved responsible for developing each study.

The aim is to produce, first, practical guidelines and training materials for research managers about organizing and managing OFCOR; second, analytical papers synthesizing the lessons that can be drawn from the case studies; and, finally, the case studies themselves as independent contributions to knowledge. What is clear from the case studies so far is that the biggest problem in developing the linkages is the need for them to be intensively managed.

Zambian experience

Mr. Stuart Kean and Mr. Lingston Singogo reported on two aspects of the Zambia case study. Mr. Kean discussed the linkages between station-based and on-farm researchers and Mr. Singogo the linkage between on-farm research and extension. In Zambia a special adaptive research planning team, with provincial sub-teams, has been set up to deal with on-farm research. It links with both the extension staff and the commodity and specialist research teams based in the research institutes. They described how the relationships between each of these had developed, the managerial problems, and how some of these were being resolved.

Discussion

The discussion focused on some issues relevant to integrating OFCOR in NARS.

Specialized versus generalized implementation of OFCOR functions. No firm conclusion emerged from the discussion about whether OFCOR, as a research strategy, should be implemented by a specialized OFCOR team/unit or whether it should be a strategy which is adopted by the whole research institute. However, most participants agreed that the desired long-term objective should be to have OFCOR integrated within NARS as a general approach to research, with most scientists carrying out both on-station and on-farm research. Where there is institutional instability, however, it might be more effective to have a specific organizational unit with assigned OFCOR functions.

Integration of on-farm and on-station research. The participants cautioned against making a strong distinction between on-farm and on-station research. They should be closely integrated to stimulate a two-way flow of information. Information from on-farm research should be a critical input into priority setting and planning of station-based research.

Appropriate functions for on-farm and on-station research. There was a general consensus that the feedback function of on-farm to on-station research was of primary importance and the salient feature of OFCOR. In practice, the feedback function normally evolves out of the testing function. The functions might best be planned in a stepwise manner.

It was also argued that on-farm research should play a feedback role to policy makers as well.

Appropriate time frame for implementing OFCOR. It was noted that too often OFCOR has been promoted as a research strategy which will deliver quick results. This is a serious misconception, especially in those areas where there is limited relevant technology "on-the-shelf". The perpetuation of "false promises" and subsequent

disillusionment has been an important factor inhibiting the successful integration of OFCOR as a complementary research strategy in NARS.

Human resource needs. The participants discussed the disciplines and professional level of staff required for OFCOR. The general conclusion was that when a team approach is used to implement OFCOR, the team should be kept small - agricultural economist, agronomist, and perhaps animal scientist - but be able to draw on specialists in other disciplines as needed. This would require support from senior research managers, who must also give attention to team building, since good teamwork does not happen spontaneously. It requires management.

Although senior scientists should know farmers' circumstances, they are not likely to be permanently outposted as field staff. Consequently, they must devise mechanisms to provide technical support and supervision for outposted junior staff, as well as adequate incentives and compensation for some of the hardships, such as professional isolation and difficult living conditions.

Commitment from research management. There was general agreement that the successful integration of OFCOR, whether as a generalized or specialized complementary research strategy, requires the commitment of senior research managers. This can be a problem where there is a rapid turnover of senior-level managers.

ISNAR's approach. The participants endorsed ISNAR's approach to developing guidelines for the organization and management of OFCOR within NARS as having the potential to develop recommendations relevant to a wide range of countries. The products from the study were expected to be useful to NARS leaders and to address priority needs. Participants felt it was better not to imply such a strong separation between on-farm and on-station research. It was felt that the presentions had put too much emphasis on a structural separation between on-station and on-farm research as an issue. The attempt to define the appropriate functions of these and advise on the appropriate place of on-farm research within the research process was strongly supported.

Research-Technology Transfer Linkages

On 1987, ISNAR initiated a three-year research project on research-technology transfer linkages as a direct result of the concern of research managers at the management workshop in 1986 about ways to improve research's links with technology transfer. Dr. David Kaimowitz outlined the planned research and progress so far.

The study includes a literature review, issues papers, case studies from six countries in Latin America, Africa, and Asia, and secondary studies on specific issues. In each phase there will be collaboration with NARS.

As with the OFCOR project, the aim is to advance understanding and produce diagnostic tools to help identify problems and policy guidelines for research managers on how to resolve problems. The results will be disseminated through project documents, conferences, ISNAR's advisory service, and training materials.

The term "technology transfer" rather than "research-extension" was chosen deliberately because extension services are not the only institutions involved in technology transfer, and they have other functions besides technology transfer. The linkages will be examined from i) an institutional or structural point of view - who will do what, with what, under what authority, and with what incentives - and ii) a functional viewpoint - examining the activities required to bridge the gap between technology generation and transfer.

The institutional linkages will be examined at an ATMS, specific institution, and individual research or technology transfer worker level. In general, linkage problems appear to fall into four main types: structural/organizational; motivational/incentive; resources; communications.

Jordanian experience

Dr. Usama Bilbesi outlined how, in Jordan, the government changed extension from a general rural development focus to an agricultural one, linked this to research and then later to development project implementation. This was achieved through the expansion of the Department of Research and Extension into a National Center for Agricultural Research and the Transfer of Technology and grouping this with project implementation through the creation of a Department of Projects. This department has considerable powers which cut across several ministries, more flexible administration, and a revolving fund to serve as financier for research and transfer of technology projects.

Discussion

There was a wide-ranging discussion which reflected the concern of the participants that research results must reach farmers.

Learning from the experience of others. Several participants referred to the need to learn from the experience of neighboring countries; while others referred to difficulties faced earlier by various now-developed countries, how they had resolved them, and how the developing countries could learn from such experience.

Linkages are part of a broader ATMS. The discussion illustrated that linkages are part of a broader ATMS. Pricing policy and other agricultural policies strongly affect technology adoption and, hence, the effectiveness of the technology transfer system, and this, in turn, affects the linkages between research and technology transfer. The existence of an effective infrastructure for input distribution and product marketing is also crucial. The possibility of effectively using a wide variety of research results will be limited if there is no strong national system for credit, seed, agrochemicals and agricultural machinery production and distribution. These concerns reflect the need for a systems approach.

The need for regulation. One important function in this broader system identified in the discussion was regulation. It is an essential function which can help safeguard farmers' interests by preventing poorly tested results from being transferred. In one country, for example, research released a rice variety which greatly improved yields, but later proved to be quite susceptible to disease problems and put in jeopardy the country's entire rice crop. Since then, researchers have learned that participation by extension and producers is necessary before making any final recommendations. In another country, they set up a steering committee to try to regulate what technologies are transferred and by whom, to protect the producers' interests.

Input, feedback, and participation. Within the overall ATMS the need for contact between the different parts was emphasized. National policy makers set general research priorities, but within these, researchers must work jointly with farmers and extension workers in determining specific problems to be investigated. Otherwise, participants noted, the research may be irrelevant. It is also important to recognize that the producers also generate technology. Farmers are empirical researchers, but so far only lipservice is paid to this reality rather than seeing how to build on it.

Extension workers can more easily evaluate producers' problems if they live with the producers and are in constant contact with them. It was said that extension services, as well as research, must learn to identify and evaluate producers' problems and to organize their programs accordingly. Testing technology on farmers' fields helps link farmers, extension, and research together. Another way to bring them together in some countries is use of pilot farms for adaptive research, validating research results, and demonstrating them to farmers. One participant reported how in his system, in order to try to improve the research-extension linkage, they offered researchers special training and then let them serve as extension staff. They could then easily talk to researchers, they spoke the same language, and this helped the linkage a lot.

Credibility. Extension workers need to be credible to their clientele. Several factors which influence this credibility were discussed. Most extension workers have no specific training in extension. In colleges and universities the curricula are biased toward research-oriented work, yet their graduates go into extension as well as research. Thus extension workers are at a disadvantage and are less credible to the clientele. Extension workers are also often younger than the producers, with little practical farming experience, and this reduces credibility. Rural-urban migration has an effect too, as it leaves the elderly in villages: they are more difficult to change and are more difficult for young extension workers to deal with.

Communication. There was concern that agricultural research results do not end up in the library, but with the producers. Communication channels should not just operate in closed systems, through committees, formal contacts and reporting, but also through open systems, in which the results of research, technology-transfer experience and farmers' experience are widely broadcast so other researchers, technology transfer workers and farmers may self-select anything they are interested in from the information disseminated. This requires mechanisms and budgets to ensure that information is disseminated widely.

Structure and organization. Research, extension, and farmers must be conceived as part of one integrated system rather than compartmentalized. Often there is no formal point for contact between research and extension. Such a point needs to be institutionalized. This does not imply, however, that research and extension have to be in the same organization.

It was agreed that appropriate linkage mechanisms for

technology transfer will vary, depending on the type of technology, type of product, and characteristics of the producers and industries involved.

Boundaries. No consensus was reached about whether research's mandate is only to generate technology or whether it has some responsibility for transfer and eventual utilization. Whatever the decision, the roles of research and extension should be clearly defined, showing areas for which they have joint responsibility, and the specific responsibilities of each. An important area of joint responsibility is in following up the technologies produced to see whether they are adopted or not and how they perform.

Coordination. Sufficient opportunities and forums for coordination are needed, and the presentation appeared to underestimate the need for this. Using an illustration from the Indian experience, one participant noted that it is preferable for research to work through extension, rather than going around it, even if the extension system is weak. Otherwise, the result will inevitably be a great deal of competition between the two systems, with both systems individually being weaker than a coordinated system would be.

Motivation and incentives. Incentives are used to promote relevant research and technology transfer in several countries. In Vietnam, for example, researchers and research institutions contract with state farms and production cooperatives to provide new technology and are paid and promoted depending on the results. The participants noted, however, that giving researchers incentives based on immediate results could be a two-edged sword because good research generally requires a long-term effort.

One reason for the apparent success of single-crop commodity systems is their integrated approach, but another is that the parastatals and private firms responsible for these systems often give greater incentives to their personnel.

Professionalization of extension. Kaimowitz's paper seemed to imply that attempts to "over-professionalize" the extension service could lead to them being less able to communicate with farmers. However, the participants argued that for extension and research to be effective, both have to be professional. The disparity in professional levels between research and extension make effective linkages between the two very difficult. Researchers have more education and many more opportunities for scholarships provided by donors. In fact, it may be more difficult to be a good extensionist than a good researcher, because the extensionist must bridge the gap between researchers' values, language, and techniques and those of poor farmers. He or she must combine good technical and social skills. This requires professional people.

Non-technology-transfer functions of extension services. There was no consensus about whether extension doing non-technology-transfer activities impedes technology transfer or not. Some participants reported cases where it impeded extension, while others gave cases where it had positive effects, because these other activities made a favorable impression on farmers.

Factors promoting success. Participants discussed many factors promoting successful technology transfer. First, the appropriateness and timing of technology transfer influence adoption. In Niger, for example, fungicide use was quickly adopted because it fitted in well with traditional seed-cleansing rites designed to bring good luck and ward away evil spirits.

Transferring technology was said to be easier for commercial crops with stable markets, particularly export crops, than for subsistence crops or crops with uncertain markets. This is because many innovations are embodied in inputs which must be bought, and there are no funds for use in subsistence crops; and with unstable markets there may be great risks that the producer will not recoup his/her investment. Several participants, however, felt that if the overall system and infrastructure were well organized it was possible to transfer technology just as well for subsistence crops as for cash crops. One participant explained how in his country they did not try to transfer integrated technology packages. Research tried to know needs of the farmer, learn from him/her, and apply technologies step by step.

Networking

Networks among researchers and research systems are one way of helping bring about communication, collaboration, and the integration of efforts in research. ISNAR, as Dr. Roberto Martinez-Nogueira explained, is working to clarify, conceptually, the components and varieties of networks, develop case studies to show what the problems and constraints are, and develop methodologies and tools for managing, monitoring, and evaluating networks.

He discussed the criteria for setting network boundaries, and the purposes of networks. Networks serve both *explicit* purposes, like improving the effectiveness and

productivity of research, and *implicit* or latent purposes, like showing institutional legitimacy and trying to secure additional resources for NARS.

Network activities seem to deal with either research inputs and outputs, or the research process. In each type of network, common needs have to be identified so that activities of mutual benefit may be developed. He discussed a number of conditions for integration into a network and for operating networks. A range of structures exists and he discussed four alternatives for the central core of a network, and three different network models, as well as posing a number of open questions about how NARS relate to networks. The objective of ISNAR's work is to see how networks contribute to strengthening national agricultural research.

Chilean experience

Chile's experience with three national and six international networks since 1964 was described by Dr. Sergio Bonilla. He discussed the development stages and conditions determining their efficiency. They had observed five development stages. First, "gestation"; second, "acquaintance and information gathering"; third, "joint study and analysis of common problems and methodologies"; fourth, "coordinated research"; and, fifth, "collaborative research". They had found it easier to implement international than national networks, and they found that certain products had practically no networking, e.g., horticultural crops and animal production.

Discussion

One participant was skeptical about the likelihood of a group of weak countries becoming stronger through networking. If the network structure meant some countries left research to others because they were too weak to do it, then he doubted if they would ever become stronger.

Definition. For the discussion, networks were defined as "all voluntary associations among autonomous institutions to carry out activities of common interest". Four consequences of this definition were stressed:

1. Persuasion, rather than authority, prevails in such arrangements.
2. Autonomy means an ability to decide about network membership, to take part in policy making in the network, and about funding.
3. Common interest should be understood broadly.
4. The interests of NARS should overlap with those of other participants, especially the international centers and the funding institutions. If not, the viability of the network is in jeopardy.

Network characteristics. Given the definition, the participants agreed upon a number of network characteristics:

- Networks follow a development path over time. Initiative may pass to the stronger national systems from the international centers and donors. Some participants were concerned about how NARS can get more support from these institutions to strengthen this process.

- Networks that deliver products have certainly contributed to the development of the scientific and technological capabilities of NARS. Those set up for mutual support to members are important in obtaining a better use of resources according to agreed objectives and priorities, complementing national efforts.

- There are regional differences in the nature and evolution of networks. Some of the more complex networks in Latin America are based on equal partners with sufficient capabilities to engage in mutual support through various forms of collaboration in regional collaborative programs. Some African experiences are consciously the result of a strategy of strengthening one national system to enlarge its capacity to play a more significant role at a regional level. This gives rise to a greater concentration of resources for research on commodities or problem areas in certain NARS, with other members of the network acting as recipients.

- Larger systems, with greater scientific and technological capabilities, are able to participate in more demanding types of networks, with activities centered in more upstream research.

Participation in networks. Researchers, farmers, research administrators, and policy makers differ in their appreciation of the benefits of the participation in networks. Systematic evaluations are needed to assist decision-making about network participation.

The growing multiplicity of networks raises the question of balance. A lack of balance in the growth of networks and the topics covered can create imbalances in the NARS by giving support to one crop but not another. Some participants wanted guidance about how they should decide whether or not to participate in networks since it takes resources to do so. It was suggested that

better strategic planning and programming of national research would help, so that national priorities could be distinguished from regional ones.

Network experiences. International networks were felt to work better than networks within a country because they often had more experience and funding. For national networks there was a lack of experience, means, and insufficient understanding of the contribution of being in a network.

It was reported that the Chilean experience was that there had been a greater spirit of cooperation when working with neighboring countries than when working with other institutions within Chile.

At first, networks have difficulties functioning because of the lack of accumulated learning, and because of the process of mutual adjustment that takes place among participants. A young institution in a network must feel that it participates in it, at all levels, but this is often not the case and so their membership becomes a token.

As the capacity of the participating NARS increases, the perception of the network changes, even though it may have constant effectiveness and efficiency. This results in growing demands on the results and impacts of participation in the network.

The effectiveness of the networks appears to be associated with their structure and management. The risk of bureaucratization should be avoided to maintain a network's flexibility and adaptive capacity in the face of new demands, conditions, and challenges. Any question of ideal size is a relative thing, depending upon the circumstances

Since networks cross national boundaries, special attention was paid in many countries to the relationship between the type of commodity, its competitiveness in world markets, and the risks of sharing information and genetic materials, all of which are deterrents to participation in networks.

ISNAR's work. The attempt to formalize a conceptual framework for studying networks was accepted as a useful effort. It helps classify the variety of situations encountered and to highlight some of the issues related to network participation by institutions with different resources and capabilities.

Participants wanted methods and instruments for evaluating the benefits of participation from the perspective of the participating institution, as well as from that of the users of the technology. These should also provide evidence for national policy makers for use in obtaining their support.

Recommendations. The working group made seven recommendations:

1. Systematic studies should be carried out on the contributions of networks to the development of national scientific and technological capabilities, as well as of their organizational and managerial requirements for effectiveness and efficiency.

2. The results of these studies should be given to international institutions, donors, and national systems, plus analytical instruments to evaluate the appropriateness of establishing new networks, and so avoid unnecessary proliferation, and identify those more effective in developing national capacities so they may be given full support.

3. NARS should take the initiative, evaluating their contributions to networks and the benefits of participation.

4. Network participation should not be a substitute for national efforts; rather, it offers the opportunity for better use of national resources and concentration of activities on national priorities.

5. Network participation needs support from policy makers and farmers' organizations. For this, the benefits of participation in networks should be available and disseminated.

6. Participation in networks should strengthen NARS and fit national priorities and not simply be based on the availability of resources for participation in networks backed by international funds.

7. Network evaluations should be comparative and offer new insights for the design or revision of networks.

THEME THREE - IMPROVING MANAGEMENT PROCESSES

Management Information Systems and their Uses

Every organization has some kind of management information system (MIS). An MIS is important because it provides the information upon which management decisions are made. In discussing MIS, Dr. Byron Mook

stressed the need to separate the idea of an MIS from the tools with which it is implemented.

Four types of information are common in a research MIS: about program content, personnel, finance, and facilities. Procedurally, an MIS involves the collection, movement, management, and use of information. The key point, though, is how the information is used. Normally, this is in planning, monitoring, and evaluation of programs, personnel, finances, and facilities.

Mook described ISNAR's work in Indonesia and some sample outputs. Three main design considerations in developing an MIS have emerged from this: be flexible in objectives, content, uses, and users; start small; encourage multiple uses and users. The constraints in developing an MIS come from the attitudes of people involved who may not understand, be interested in or want an MIS, and from the staff and technological resources that may be required . The use of microcomputers can make the storage, retrieval, and manipulation of information easier and is certainly desirable in large systems but is not necessarily required.

Philippines experience

The Philippine Council for Agriculture and Resources Research and Development(PCARRD) is the national research planning, coordinating, and monitoring agency for agricultural research in the Philippines. Dr. Ramon Valmayor described the background to PCARRD and its activities in research information systems.

In PCARRD the MIS provides information to support system management and researchers in doing research. The Management Information Services Unit was established in 1977 to develop the council's information systems. To date it has established seven data bases or data banks: research management information for research program planning and monitoring; research information databank on completed projects and research literature; equipment infrastructure inventory; manpower; financial management; publications; administrative support.

They plan to create specialist databases and extend access to some databases to the regions. Dr. Valmayor suggested that ISNAR might consider undertaking a program with NARS in which those enjoying similar conditions might exchange technologies and provide training.

Discussion

Tools required. Several participants were concerned about the tools required, although one pointed out that establishing a proper method for organizing the information needed in a NARS was the fundamental requirement. However, in an MIS the speed of information retrieval is important, and most countries, it was felt, could benefit from the use of microcomputers. Certainly, the participants wanted to benefit from the experience of ISNAR and other countries with MIS.

It was suggested that the use of computers was not an "either/or" question but that there would be a mixture of methods. Caution was needed when starting off with the use of computers. Often the software was not easy to get right at the start, there was a danger of swamping the MIS with unnecessary information simply because there were microcomputers to put it on, and that there were seldom enough resources to put microcomputers everywhere in the system. Introduction of a microcomputer-based system, it was suggested, is easier when there is a paper-based system already in place.

Cost. Organizing an MIS or other information flows has costs; however, it was felt that these would be more than recouped by the improved functioning of the NARS in management of programs, personnel, and fiscal and physical resources.

Developing and strengthening MIS. The consensus was that the process of strengthening MIS had three parts. First, the exposure of national research leaders to the potentials and requirements of MIS. This needs considerable attention, since most leaders are not familiar with MIS. Two ways to do this were discussed:

1. ISNAR-supported conferences and training, at both the international and national levels;

2. written descriptions of national experiences with MISs, either as formal ISNAR publications or more informal ISNAR training materials.

The second part of the process is planning the content, structure, and development of MISs. Participants saw two ways in which specific operational plans might be developed:

1. through intensive case-study workshops, similar to the one ISNAR supported in The Gambia;

2. through a combination of case studies and workshops in the country concerned, similar to what ISNAR has done in Indonesia.

Whichever approach is adopted, participants stressed that existing management information and databases should be used to the maximum extent possible. Many countries already have substantial amounts of relevant information available, so that all that needs to be done is to re-package it (on computers or manually) to make the NARS more effective.

Third, there is implementation. Once again, two points were made:

1. The development and strengthening of an MIS is a labor-intensive process. A NARS may request ISNAR to suggest general guidelines and to monitor progress - but the details of information collection, data management, and use must be the responsibility of national personnel.

2. The development and strengthening of an MIS is a continuing, long-term process. In a relatively large NARS, leaders must plan on at least three years, and probably 5-10, before an MIS can be fully operational and effectively used for research planning, monitoring, and evaluation.

Program Budgetting

The goal of a program budgeting system (PBS) is to align research activities with available resources. Dr. Paul Marcotte, in presenting a synthesis of ISNAR's in-house work in progress, discussed where the PBS fitted in a NARS. He outlined 10 distinctive features of program budgeting, grouped into three types of activities: program formulation, budgeting, and monitoring and evaluation. These steps require different skills, yet must be integrated into a coherent process.

Using a rational-decision model, he discussed who was responsible for decisions about these different activities in a NARS. Several outputs are expected: time allocations of scientists, financial budget breakdowns, personnel costs, and direct operating costs. ISNAR has produced some demonstration software growing out of work in Morocco, and Marcotte showed the kinds of outputs this had produced. However, it was stressed that this was only of operational use in the country for which it was designed. For other countries, it could serve as a demonstration of the value and difficulties of such systems.

The Gambia: a comment on the approach

Dr. John Sands discussed the demonstration software in more detail and the differences between it and a complete PBS. He outlined, first, how the software had been used in a PBS workshop in The Gambia to explain the concepts involved; second, the observations of the participants about the type of adaptation needed to implement a PBS in The Gambia; third, the initiation of work on this; and, finally, the lessons ISNAR drew from its work on PBS.

Discussion

PBS in use. There was some concern from one participant about the theoretical nature of the presentations; he was anxious to have more specific guidance and a model or format for budgeting that might be applicable at the research institute level. It was noted that the PBS described seemed to require a lot of detailed information from researchers about how they spend both their time and money on each project. Collecting this may well be beyond the capacity of many systems. One participant described how, when they had tried to introduce a PBS, the forms had been poorly or incorrectly completed. Some scientists resented such questioning, seeing it as a regulatory activity and as an attempt to deny them funds. It was suggested by others that the opposite might also be true and that by developing clear program budgets scientists could better defend their positions. This is especially true where a central department has the upper hand in budgeting and there is a need for NARS to sell their case to the central decision makers.

Although The Gambia is quite atypical, as a small country with abundant aid resources, it was understood that what had been learned there could and would be tested elsewhere. ISNAR was continuing work on developing demonstration tools for PBS. An essential component of the demonstration was an understanding of the principles involved. The demand from countries for such tools is very high, but it was stressed that any model needs to address only the basic principles and must be simple to use.

Tools and skills required. There was discussion about whether or not computers were necessary. The consensus was that in those areas where there were either physical problems (like unreliable electricity supply) or expertise gaps, a simple manual system could provide adequate information. If a manual system is operational and adequate, then it can be computerized later.

Once a computer-based system is set up, then the question arises of whether it will be easily maintainable as the staff who set it up are lost. Attrition among computer specialists is high. In general, the participants felt that the system should be as reliable as possible. Several things could assure this reliability: i) it should be as simple as possible, built up from local, commercially available software, thereby assuring local expertise and no dependency on consultants; ii) as many people as possible within the system, i.e., scientists, users, managers, etc., should be trained so that the system operations are not dependent upon one or two people; and iii) it should include extensive documentation so that it could be used with a minimum of computer skills.

Linking PBS to annual research activities. One participant suggested that it was better to talk of program formulation and budgeting together rather than as two separate entities. If this was done, then the programs had to have time limits and must be evaluated along the way for what was happening.

Another suggested that such a process uses information from the top down as directives, and from the bottom up as proposals. Thus, it is partially hierarchical for management, and partially collegial for scientists. The key to facilitating the combination of these two is an interdisciplinary committee, including the scientists and groups such as farmers, making priority decisions on the proposals that should be funded. Characteristics such as quality of experimental design would be deferred to the scientists, as they were the technical experts, while characteristics such as relevance were committee issues.

ISNAR's role. ISNAR feels that the development of PBS software by ISNAR for NARS is not a good idea or a responsible way to attempt to solve PBS problems. If ISNAR develops software it makes the NARS dependent upon ISNAR or other outside consultants for problem solving. ISNAR does not have sufficient staff to provide this service. The consensus was that ISNAR could help with the framework or the concept of PBS and with demonstration software. However, it cannot transfer a turnkey PBS, as each country is unique in its internal information and managerial needs. ISNAR's assistance would focus on the concept, but not computer programming backstopping. Specific applications should be developed locally, with local expertise and equipment and with ISNAR guidance if deemed essential.

Monitoring and Evaluation

There is often a tension between those who manage research and those who do it. Research is risk taking, and management can be seen as inhibiting. This tension is perhaps most marked in monitoring and evaluation(M/E), which poses a challenge to research managers, according to Ms. Diana McLean. In her paper she examined the relationship of monitoring and evaluation in NARS and various evaluation criteria. She pointed out that ISNAR was taking an evolutionary approach to developing M/E materials. The philosophy in producing these is simplicity and practicality.

Four main types of M/E activity were discussed. These, in order of priority for work by ISNAR are: monitoring and ongoing evaluation, which involves data collection and analysis of important factors during implementation; *ex-ante* evaluation, which analyzes the potential impact before implementation; *ex-post* evaluation, which assesses performance immediately after the activity is completed; and, impact evaluation, which determines the extent to which an activity addressed larger development goals.

She also used a rational decision model, as described by Marcotte, to examine the levels at which these are carried out and discussed in more detail ISNAR's work on monitoring and evaluating ongoing research programs.

Indian experience

Dr. R. M. Acharya discussed the organization and implementation of research evaluation and monitoring in India and the role the Indian Council of Agricultural Research (ICAR) plays. There is a national evaluation system related to the five-year plans. The institutes within ICAR also have an internal monitoring and evaluation system. He examined the type and method of evaluation, use made of the findings, reviewed ICAR's performance in M/E, and some weaknesses in the evaluation system.

Discussion

Structure. While some discussants favored setting up an external specialized unit for M/E, others felt that there were advantages in having an internal central unit composed predominantly of people with past research experience. The "policeman" role of an M/E unit should be avoided. It was agreed that each country must consider the size and complexity of its system to determine where the M/E unit should be attached and what type of unit would be necessary.

Types of M/E. It is important to see *ex-ante* and *ex-post* evaluation as a coupled activity. It was suggested that

ex-ante evaluation sometimes tries, through exaggerated predictions of, say, yield gains or rates of adoption, to convince policy makers to allocate resources to an activity. This then sets projects up for ultimate failure when these over-optimistic projections have not been met. *Ex-ante* evaluation should more correctly estimate potential impact, establish the baseline, and set realistic but specific targets for an activity.

The subsequent *ex-post* evaluation, whether or not truly post-project, should take place after sufficient time has elapsed to have met some of the planned objectives. This might be every 3-5 years or longer, depending upon the type of project undertaken. This level of evaluation looks at relevance, effectiveness, and efficiency issues.

Impact evaluation was considered important to NARS for relating information to policy makers, as it could have a major influence on resource allocation. It was explained that ISNAR is putting less emphasis on impact evaluation because it is less useful as a management technique than the other types of evaluation, and there is much work on this by other organizations.

In ongoing evaluation, it is important to recognize both the formal and informal processes which exist. It is also important to stress evaluation of how effectively the concerns of farmers are incorporated into ongoing research programs. This implies not only methods for contacting or involving farmers, but also methods for evaluating how much researchers use their recommendations in programming.

Personnel performance. It was suggested that ISNAR should also offer assistance on personnel performance evaluation. All discussants agreed that issues of reward and motivation were fundamental to the success of the research system. If teamwork and work with farmers is important, an alternative to scientific publications as one of the main criteria for promotion should be proposed. It was agreed that national systems require different criteria for personnel evaluation, depending on the emphasis placed on different types of research (e.g., basic vs. adaptive) and that on extension.

Standards. There was some discussion about the standards used to evaluate the technical merit of a research project itself. A methodology for M/E in research has to deal with complexities such as:

1. In adaptive research it was often preferable to have many simple trials, each of comparatively low precision but providing a measure of variation over locations and seasons, than a few individually precise experiments. The fact that individual simple trials may not give significant results does not detract from the value of the information they give as a group.

2. Various factors may need to be considered when setting evaluation criteria, such as whether or not research is problem oriented, the rate of adoption, farmer response, etc.

Training. Training is crucial and should begin as soon as possible, but few opportunities exist currently for training in M/E as used in research. It is important to offer appropriate training in different aspects of M/E to different levels of management. Field testing methods as they are developed is extremely important.

Effort required. National research managers must determine what level of effort is necessary and cost effective in adopting M/E activities and other management tools. ISNAR's assistance was sought in proposing which of these are most important, presuming that managers cannot do everything; at least not initially. ISNAR should suggest the costs associated with putting these various management structures and mechanisms in place.

National systems also need techniques for evaluating international and regional organizations and networks in which they participate or which are operating in their countries, e.g., regional commodity networks.

ISNAR's approach. Overall, the discussants considered the topic of M/E to be of priority importance. ISNAR's approach to developing M/E materials in steps was endorsed, with its initial emphasis on M/E of ongoing research. They suggested that ISNAR concentrate its efforts on developing materials and in offering training at the various levels of management as soon as possible. Field testing methods as they are developed is also important.

THEME FOUR - MANAGEMENT OF HUMAN AND PHYSICAL RESOURCES

Human Resources Development and Management

Human resource needs must be determined in advance. This is a planning and management function which requires knowledge, skills, and appropriate attitudes in NARS managers. In his oral presentation, Dr. Paul Bennell followed these assertions with 10 propositions

about human resource development and management designed to stimulate discussion. He identified three types of skills needed for management competency: administrative; technical, subject-related; and interpersonal. Bennell discussed the interpersonal skills that human resources management is most concerned with: those skills needed in directing people, including motivating, communicating, leading, coaching and appraising performance, handling organizational power and politics, and managing conflict.

He noted that most managers spend too much time on technical and not enough on interpersonal aspects of management. It was recognized that the ratio of the different requirements for management varies with the level of management involved. In his written presentation, he described ISNAR's work on human resource planning and analysis.

Algerian experience

Before discussing human resources in Algeria, Dr. R. Kellou described the agricultural and research background of the country. He outlined the present staffing in the research system and the distribution of these. He also discussed the training needs and how there was no formal human resources planning. He suggested that ISNAR should establish a methodology for use by each NARS in assessing its needs and should give guidance on how to bring about close collaboration between agricultural research and higher education.

Discussion

Human resources planning. There was almost unanimous agreement that the development of long- and medium-term human resource plans are essential and that these should be directly integrated with program planning as a whole. The importance of developing and maintaining a comprehensive human resource information system was stressed. While this would obviously focus on the human resource stocks and flows within the NARS, it is also desirable to collect information selectively on conditions in relevant national labor markets.

Lack of control over recruitment by NARS was identified as a key constraint frustrating the implementation of human resource plans. The overall supply and demand for personnel varies tremendously from one country to another. It seems that in some countries there is a growing problem of an excess supply of university graduates in agriculture and science. In contrast, many NARS face shortages of sufficiently well-trained technicians and other middle-level personnel. Where the system is expected to provide employment for all graduates, the lack of control over hiring leads to an inappropriate mix of expertise.

In other countries, staff attrition, its magnitude and causes, needs to be carefullly analyzed. Where it is likely to remain a persistent problem, NARS must recognize that they will need continuing recruitment and large, expensive, and long-term training programs.

Human resources development. The discussants concluded that the development of research personnel is strongly influenced by the type and quality of recruits. Most are young and inexperienced, usually fresh from formal training programs. The degree of competition for different types of personnel required in a NARS will affect recruitment.

There was considerable discussion about training. It appears that training policies and procedures for professional staff are fairly well formalized and developed in most agricultural research organizations, but that postgraduate training is still a major preoccupation. More attention also needs to be given to training technicians.

Everyone agreed that management training is of great importance. It was suggested that NARS make use of locally available sources of management training, but some participants felt that public administration programs are often too general about most areas of management and administration. It was agreed that ISNAR has an important role to play in sensitizing agricultural research managers to key issues in management areas relevant to research, so that they are in a better position to seek appropriate advice and assistance from local management-training institutions and, where necessary, overseas institutions. In its training program ISNAR can help local institutions to develop a capacity in training for agricultural research management. This will largely be through work with selected individuals rather than institution building *per se*.

Human resources utilization. A wide variety of issues was discussed, including: financial incentives for obtaining additional training (particularly at the postgraduate level); rewards for service in remote locations; the need to maintain equity between research and extension personnel, especially when they belong to the same organization; insufficient control by research management over the promotion process; and the need for appropriate advancement criteria.

Participants recognized that improving the conditions of service of agricultural research personnel may sometimes depend on the ability of senior managers to negotiate effectively with the relevant ministeries, most notably finance and public service, and other institutions. How successful they are will depend on the extent to which they can present convincing arguments to policy makers, recognizing that most other occupational groups in the public sector are also seeking improvements in their conditions of service. Where it is impossible to get a special status for researchers, other means of motivation are required.

Some participants felt that as research managers they had to spend so much time on administration that they had little if any time left, either for managing their staff or monitoring the research programs. One participant stressed the need to differentiate between management and administration. NARS managers were both agriculturists and managers who had a number of administrative tasks put on their shoulders. These tasks should be delegated to others. Concern was voiced about delegating technical tasks to non-scientists because they would lack scientific knowledge and might not understand the problem of research.

Management of Physical Resources

Researchers need appropriate physical resources to work with if they are to be productive. Dr. Ghazi Hariri discussed some guidelines for physical resources planning and development in his paper. Both a national plan for physical resources and planning and operation of them at the research station level is needed. He discussed the major constituents of physical resources: buildings, land, equipment and supplies; and the requirements of physical resources planning.

Several priority indicators to help establish the need for research stations were discussed, as well as a planning sequence. Four important areas to consider are 1) site development and use; 2) maintenance and repair; 3) supply and purchasing; and 4) personnel development. In planning physical resources he understood that it is vital to bear in mind the recurrent or operating costs as, over the lifetime of the resources, these generally far outweigh the initial capital costs. Finally, Dr. Hariri discussed the responsibilities of scientists, managers, operators, and policy makers in physical resources planning and development.

Egyptian experience

Dr. A. H. Shehata described the agricultural sector in Egypt and the historical development of research before turning to the present state of agricultural research and an overview of the NARS. He discussed the role, resources, and strategy of the Agricultural Research Center as well as the impact of agricultural research. The ARC training program, links with extension, information and documentation, and international and bilateral assistance, as well as a number of recommendations in these areas were also discussed.

Discussion

Egyptian system. There was considerable discussion about various aspects of the Egyptian system. One question concerned the strategy taken with respect to creating new physical resources to handle the research needed for the reclamation of new land, or working with existing resources. There is a new land technical development program in the latest Egyptian five-year research plan. The research requirements for this cut across many research institutes, and all those that have something to do with new land will be involved, as will two regional research station clusters. It was consciously decided not to create a new research institute. However, it is felt that not enough has been done to expand agriculture into new land, and either more support will have to be given to existing research institutes, or a new research institute will have to be set up.

Justification for research institutes. There was some general discussion about the rationale behind establishing new research stations, consolidating and/or rehabilitating existing research stations. One discussant suggested that too often attention focused on research institute facilities rather than the justification for the research institute itself.

Location. Another discussion point concerned the appropriate location of physical resources and the siting of these to fit agro-ecological zones. Some countries in Africa, it was suggested, might consider setting up a regional network of research institutes to enable more cost-effective use to be made of investment in research.

Maintenance. It was agreed that NARS must make policy makers more aware of the need to allocate sufficient financial resources for operating and maintaining both local and donor-provided physical resources.

One requirement for building the capacity to maintain and repair physical resources is training for those who operate them. Another basic requirement is an inventory of physical resources. This would allow

managers to review the status of existing physical resources, and would be required for developing a national strategy for physical resources. Such a strategy, it was emphasized, should match research program implementation.

General recommendations. Overall, the participants agreed that each system needs to review, plan, and develop physical resources; adequate procedures should be developed for this purpose; and physical plant managers should be specially trained.

THEME FIVE - ORGANIZING AGRICULTURAL RESEARCH IN LARGE NATIONAL SYSTEMS

Structure and Organization in NARS

Dr. H. K. Jain gave an overall perspective of the changes that many of the larger countries have introduced into their NARS over the last 20 years. He discussed the creation of autonomous or semi-autonomous agricultural research councils or organizations to handle research and divided those created into three broad types: administering, coordinating, and funding. He discussed their ability to deal with six governance components, their potential to perform 11 research functions, and three lessons to be drawn from this experience.

Next, he examined the organization of research station networks by country size, resource base, type of station, and type of research. Finally he examined research station organization by mandate, linking goals to the type of organization best suited to meet them.

The People's Republic of China

There was then a presentation on a major NARS, that of the People's Republic of China.

There is an integrated NARS in China, with four different subsystems, as Ms. Fang Zhou described. One subsystem deals with basic research, another with applied research nationally, another with applied research at provincial and prefectural levels, and the fourth with university-affiliated research.

She discussed how these operated and managed research and the constraints in the present system. Research policy was outlined, as was a planned reform of the research system which would match the major rural reform also under way. Management had been recognized as a major weakness, and China would seek international cooperation in developing its capacity in this and other areas. Any development, however, had to fit into China's own environment and could not simply be copied from elsewhere.

Discussion

There was some more detailed discussion of how research operated in China as well as about a range of issues in large systems.

Decentralization. Although centralization of national research management for some important objectives and for economy in resource use is needed, large systems could become cumbersome with some inefficiencies and may need decentralization to respond more effectively to regional needs. It was noted that after about 30 years of central control of research in Argentina, there has recently been a decentralization of program and operational authority to the regional level, with Regional Boards with 50% farmer representation. Similarly in India, where research is already organized along federal and regional lines, there is a move towards less central control of operations in ICAR, while retaining central funding and coordination.

Size as a factor in efficiency and effectiveness. There was some speculation on what the optimum size of an efficient and effective research unit within a large system might be. Opinions from the participants ranged from 50 to 150 scientists for efficient management. Many countries have research units that are too small to be effective. More analysis of this issue is required.

They also thought that very large research systems were effective in making an impact, and relatively resilient in the face of funding difficulties simply because of size, but they were not necessarily efficient in their management. It was stressed that small systems cannot afford to be inefficient, since they can only have an impact in a limited number of commodities because of their limited resources in personnel and funding.

Learning from country experiences. Participants felt they could learn much from the positive elements of management systems in other developing countries, and these countries could pass on experiences to each other. The SADCC region has examples of several kinds of research structures, and there may be lessons from large country systems that could be valuable for regional research organizations.

Experience with research councils in the larger systems suggests that no autonomous or semi-autonomous research council without funding power was really listened to. However, it was noted that even small systems faced just as much difficulty as large systems in drawing dispersed research institutions together into a national entity: each institution wants to retain its independent authority. Participants felt that complete system reviews by ISNAR could help move governments to improve the structure where needed.

Autonomy. The general perception was that in recent years there has been a move toward greater autonomy for research from bureaucratic and financial structures. The discussants agreed that the target is to achieve greater administrative and financial autonomy for research organizations, but not at the expense of commitment to government priorities and programs of economic and social development. Too often, however, there is tight bureaucratic control over finance and administration and no national guidance for the research program. In Argentina, where decentralization is creating some fear that a vigorous regional board might exert too much pressure on the direction of research, the sensible membership of 50% government and university, and 50% farmers and users of research was considered an appropriate stabilizing factor. It was also stressed that the members of a board of an autonomous institution should be active and concerned users of research conclusions for development.

Duplication of research. Duplication is a common problem for large research systems. It is difficult to avoid, and some coordinating review boards can spend a lot of time checking to avoid duplication, rather than checking positively that programs are highly relevant and urgent. Participants felt that donors and IARCs may give rise to some of the duplication. One positive approach to duplication of experiments has been to organize formal national coordinated research programs on common problems with a well-defined, concrete plan. Sometimes in a large system it is necessary to arrange sectoral or commodity reviews, taking in all research institutes concerned, so that a well-coordinated program is reached in an internal networking process. A focused and clearly defined national program can facilitate dealings with donors.

CONCLUSION

In his closing remarks, ISNAR's Director General Alexander von der Osten expressed his satisfaction with the workshop. There was good, intensive interaction, and ISNAR had received the feedback it hoped for. He noted that the meeting confirmed the need for practical management tools and guidelines, suitably adapted to the needs and circumstances of different NARS. For ISNAR to produce these it had to concentrate its efforts on a selected number of management topics. Here the priorities selected by ISNAR had been reconfirmed at the meeting.

The working methods had been supported, too, along with the idea of starting small and building up gradually, while refining the techniques. It was clear that working in isolation is unproductive, said von der Osten. ISNAR needs to collaborate with future users of its products in joint efforts in the design, adaptation, and testing of management tools - just as farmer involvement in technology design is the key to success in agricultural research.

He recognized that ISNAR's work on the various topics was at differing stages of advancement, reflecting the state of the art. Some was still at the level of developing the conceptual understanding of the problem, while some was well on the way to producing the desired guidelines and management tools in specific areas.

The feedback from the participants was very useful in giving guidance and suggestions for future efforts. Many important points were recommended, including:

1. Support for the ATMS approach as giving a broader picture of the NARS environment; recommendation that it should not become a separate ISNAR thrust, but rather remain as a support to the review of NARS work, where the policy environment is a major constraint on the system.

2. ISNAR should do further work on the applicability and necessary adaptation of strategic planning methodologies for NARS.

3. ISNAR should continue work on how priority setting and resource allocation could be linked in methodology and process, and should produce a set of methodologies for use in different circumstances.

4. ISNAR should continue the work on developing guidelines for institutionalizing OFCOR.

5. The network research should produce methods and instruments for evaluating the benefits of network participation, for both the participants and users of technology, and should highlight benefits for use in gaining support from policy makers.

6. ISNAR should consider helping to arrange a program for inter-country experience and technology exchange in development of MIS.

7. ISNAR should clarify the concept of PBS and develop well-documented, simple, easy-to-use demonstration software for PBS, but should leave the local development and application in specific countries to the staff of the NARS.

8. ISNAR should develop the guidelines for ongoing M/E and offer training at various levels of management as soon as possible.

9. ISNAR should help local training institutions develop a capacity in training for agricultural research management, initially at the level of individual staff members who can collaborate with ISNAR.

Overall, the emphasis was on producing tools that were practical, simple to use, and requiring as little specialized manpower as possible.

All the points made and recommendations will be considered carefully by ISNAR as it reviews its own program and plans its work program.

DIAGNOSING CONSTRAINTS IN AGRICULTURAL TECHNOLOGY MANAGEMENT SYSTEMS

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I. INTRODUCTION

ISNAR's goal, as expressed in its strategy statement, is "to assist developing countries to improve the effectiveness and the efficiency of their agricultural research systems through enhanced capacity in the areas of research policy, organization, and management."[1] This means that ISNAR's primary focus must be the national agricultural research system (NARS), but its systems approach leads it on occasion to place the NARS within a broader environment -- the agricultural technology management system (ATMS). The objective of this paper is:

a) to present a conceptual framework for identifying opportunities to improve agricultural technology management systems;[2]

b) to describe certain tools that have been used to assist in identifying such opportunities and choosing among them;

c) to relate this analysis to commonly used frameworks for strategic planning at the system level.

II. SOME SYSTEM CONCEPTS

Churchman[3] defines a system as a "set of parts coordinated to accomplish a set of goals." He identifies basic considerations that the scientist must keep in mind when thinking about the meaning of a system:

a) the total system objectives and, more specifically, the performance measures of the whole system;

b) the system's environment: its fixed constraints;

c) the resources of the system;

d) the components of the system, their activities, goals and measures of performance;

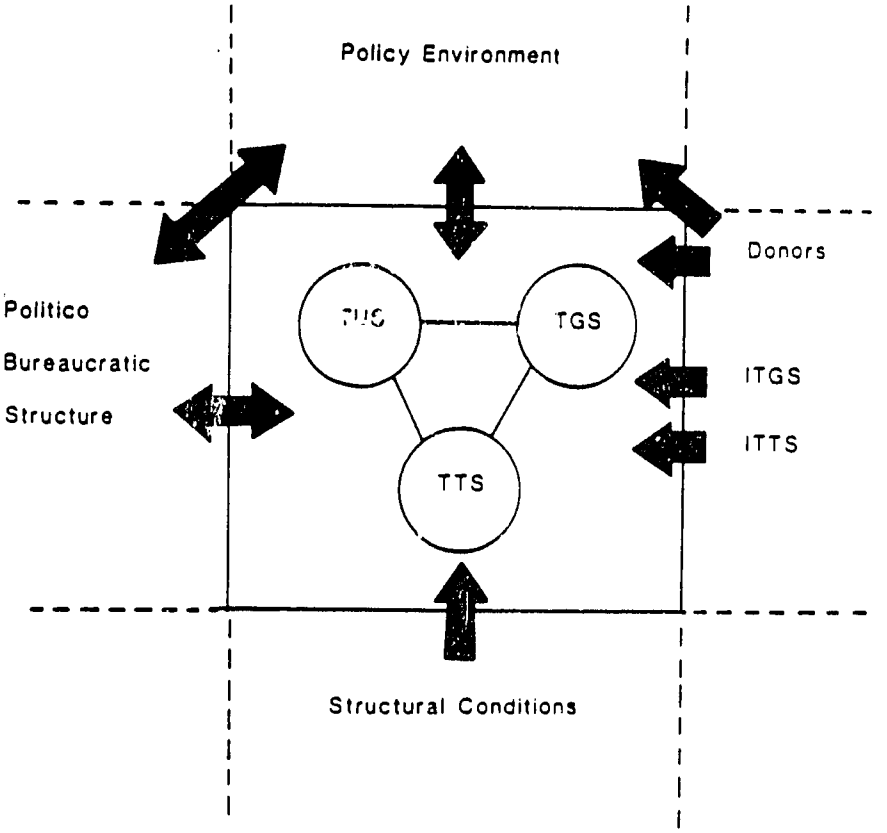
e) the management of the system.

The approach taken in the present ATMS study is generally called a "contingency" approach. It attempts to understand the interrelationships within and among organizations as well as the relationship between the individual organization and its environment. It attempts to understand how organizations operate under varying conditions and in specific circumstances and is ultimately directed towards suggesting organizational designs and managerial actions most appropriate for specific situations. In short, it says there is no one best way of organizing and managing research systems... i.e., that there is a middle ground between trying to apply "universal principles" and saying "it all depends".[4]

III. THE AGRICULTURAL TECHNOLOGY MANAGEMENT SYSTEM

The ATMS comprises all institutions, individuals, and their interdependent relationships, aimed at the generation, assessment, and diffusion of improved agricultural technologies in order to increase agricultural production and incomes. By "agricultural technology management" we mean that the component parts of the system, individually or collectively, are able by some management means to deal with the constraints to the system, either by adapting the system to the constraints or by attacking the constraint. Improvement in the ATMS also implies that the system is able to endogenize some of the constraints that were previously considered part of its environment.

A generic ATMS which places the component parts of the system in relation to each other is described in the following diagram.



TGS - Technology Generating System
TTS - Technology Transfer System
TUS - Technology Using System
ITGS - International Technology Generating System
ITTS - International Technology Transfer System

These are:

- the "technology sector", with its subsectors (the technology generating sector, the technology transfer sector, and the technology using sector);

- the politico-bureaucratic structure, composed of formal representatives of the government and decision makers, and the channels through which interests of all groups in the system are made known to policy makers;

- the "external sector", composed of donors, international technology generating institutions, and multinational firms engaged in technology generation and transfer;

- the underlying "structural conditions", which include world markets for inputs and outputs, the resource base of the country, and the initial distribution of resources and power;

- the "policy environment", made up of all laws, regulations, customs and practices which limit the way in which components of the technology sector behave.

IV. A THREE-LEVEL ANALYSIS AND ITS ASSOCIATED TOOLS

The ATMS approach was developed first for use in Latin America, where the public sector had a pervasive impact on both the supply of and demand for agricultural technology. In many cases, however, the private sector has been emerging as an important force. In spite of significant investments, some systems have not been very productive. Reconciling competing theories of the evolution of technical change in Latin American

agriculture led to our three-stage analysis which could deal with all the issues they raised. These theories included:

a) induced innovation, which explained the development of inappropriate technology by incorrect market signals;

b) structuralists, who emphasized the role of land distribution in producing biased technical change;

c) political economists, stressing the role of special-interest groups;

d) monetarists, emphasizing incorrect exchange rates and pegged interest rates in inflationary situations;

e) technological determinists, describing the role of external organizations and the international transfer of technology;

f) institutionalists, focusing on management weaknesses within the research system.

All of these approaches emphasize different factors which affect the nature and quantity of improved technologies, both supplied by the agricultural research system and demanded by users of those technologies.

On the supply of technology side, the ATMS model looks at the system's research resources, component units, internal management, and its attempts to influence its environment. On the demand for technology side, the model postulates that the nature of technology demanded is conditioned by a number of structural conditions and policy constraints that limit the range of options open to farmers of different classes. Some of these constraints, through improved technology management, may be changed.

The ATMS approach involves three levels of analysis which are logically linked to one another and are iterative in their contribution to identifying opportunities to improve the system. It begins holistically but focuses rapidly on the key points of intervention, a) at the system level, b) the institutional level, and c) the commodity level. Information generated at each succeeding level is used to confirm hypotheses advanced at higher levels and will be available when formulating strategies for improvement in the technology management system.

Stage 1: The System-Level Analysis

The Stage 1 analysis is the most aggregative level and generates the information and hypotheses about the influence of key environmental variables, primarily the structural constraints and policy environment. It fully describes the system and its evolution. It includes the following tools and products.

Analysis	*Tools and Products*
Functional Analysis	Responsibility charts for key organizations in the ATMS, providing a complete mapping of the system's structure and management mechanisms.
Events Analysis	Analysis of major policy, institutional, and technological events in recent history of the system, providing a chronology of the system and the interrelationship between policy, institutional, and technological events.
Policy Analysis	An assessment of key policies which affect the overall level of economic activity in the system, relative prices of factors and outputs, and direct investments in the agricultural sector.

Stage 2: Institutional Analysis

The institutional analysis focuses only on the few key organizations within the system concerned with technology generation for agriculture. As a component of the ATMS, each organization can be approached (as a subsystem) in terms of its mandate, objectives, resources, and management of both its internal functions and outward linkages to its environment. In many ways, an ISNAR review of a national agricultural research institute concentrates on this level of analysis. The key functions that the analysis looks at are:

- problem identification;
- priority setting;
- obtaining adequate financial support;
- attracting and retaining human resources;
- developing and managing infrastructure;
- programming and executing research;
- managing linkages with the technological environment;
- monitoring and evaluation research;
- communicating results to clients and policy makers.

It is at this level that we begin to look at the management

issues that are basically under the control of the director of an institute (including the way he manages his relationships with the broader ATMS).

Stage 3: Technology Performance Analysis: Case Studies and the Interventions Opportunity Matrix

This third level of analysis brings us to the disaggregated level of the individual commodity and an attempt to assess the impact of technology management activities related to one crop. Case studies on carefully selected commodities are carried out using an integrating framework which we called the "Interventions Opportunity Matrix" (IOM). At its simplest this is a checklist of factors which positively influence or constrain the path of technological change at the level of the individual commodity. In its more complex form, one can attempt to quantify the variables.

It is at the level of the individual commodity that hypotheses about the adequacy of resources, management, or the impact of external factors are confirmed or disproved. It is, for example, quite conceivable that a system, which in the aggregate is underfinanced and understaffed, may manage to give stable funding and allocate its best scientists continuously to its most important commodity and achieve an impact.

For each selected commodity, covering the principal food, export and industrial crops, a number of technological events are studied in detail. The impact on production is estimated, and each factor is assessed as having contributed positively or negatively to the production impact.

Looking across the range of technological innovations and commodities, one can see the extent to which research resources, management, farm-level constraints, structural conditions, and the policy environment have been constrainis on or contributors to success in generating and diffusing improved technology.

V. THE STAGE 1 (SYSTEM-LEVEL) ANALYSIS AND STRATEGIC PLANNING

In this paper we now concentrate on the role of the Stage 1 analyses in generating hypotheses about system-level constraints and in providing the information required to assess alternative proposals for improving the overall agricultural technology management system.

The strategic planning process involves three steps: 1. an assessment of the present scenario and its critical problems; 2. the generation of a range of alternative solutions from which a preferred scenario is chosen; and 3. the establishment of the action program and choice among the strategic options for implementation. In many cases, the strategic planning process is faulty because action-oriented managers jump from the problem to action without considering the range of alternative scenarios. The tools developed in the ATMS approach lend themselves well to Steps 1 and 2 of the process and consequently help ensure that a range of alternatives is considered before choosing the preferred scenario.

The Functional Analysis and Responsibility Charting

The mapping of the ATMS is carried out using a modified form of a project management tool called a responsibility chart. The responsibility chart identifies all relevant actors in a particular project, describes their roles, and determines the level of responsibility they have with respect to a particular function (e.g., "makes final decision", "must be consulted"). In applying this tool to the ATMS, we identify the key organizations or classes of participants, describe their principal mandates and place within the system, and assess their level of participation in each of thirteen key functions that the system must be able to perform (or at least influence in its own behalf). Having determined the level of participation, we describe the mechanism by which the organization participates in the function.

The thirteen key functions of the ATMS are:

1. define macroeconomic strategy;
2. determine the intersectoral allocation of resources;
3. develop human resources for the agricultural sector;
4. generate domestic political support for agricultural research;
5. generate external support for research;
6. set clear goals for the agricultural sector;
7. allocate resources within the agricultural sector;
8. determine agricultural research strategies;
9. generate and assess technology;
10. transfer technology;
11. provide support service to technology adoption;
12. evaluate the impact of technology development efforts;
13. ensure the marketing and use of the product.

All of these functions can be associated with the various resource, management, and external variables discussed above.

We can illustrate this with a responsibility chart from the case study of Panama. Tables 1 and 2 show the responsibility charts for the functions of "generating" and "transferring" technology (two of the thirteen functions described).

The responsibility chart provides three ways of looking at a system:

* the "structural" (number of organizations involved in the system and their mandates);

* the "functional" (the critical functions of the system and how they are carried out);

* the "operational" (the mechanisms that are used to perform these functions.

The concentrated technology generating sector contrasts with the fragmented and overlapping activities of various organizations performing the technology transfer function, which grew in the vacuum created by the abolishment of the extension service during the reform in the late 1960s.

There are three principal advantages of constructing responsibility charts:

* they make very explicit the hypotheses about the role and behavior of institutions within and outside of their principal mandate areas;

* they point out the presence of superfluous institutions or the absence of essential actors with respect to each function;

* they help suggest alternatives for improvement of a structural nature (combine institutions, create new ones) or of a managerial nature (strengthen the mechanisms for performing the function through more resources, additional meetings, more permanence of staff, etc.)

In this respect the information helps lay out the range of alternatives from which a preferred scenario is chosen.

With respect to the Panamanian ATMS, we identified several critical weaknesses:

- few agricultural institutions influence agricultural policy;
- the system is complex and fragmented;
- there is an absence of mechanisms for establishing policy;
- real coordinating structures are different from the formal ones;
- external assistance is uncoordinated;
- system is isolated from domestic support;
- fragmentation leads to some duplication, and even contradiction, in the messages reaching farmers.

From these observations, hypotheses about alternative structural and management improvements were formulated, carefully taking account of the target farmers to be served and the historical fact of autonomy among the various parastatals involved in the sector. This history limits the degree of centralized direction the system will permit.

The Events Analysis

The events analysis is a methodology for systematically recording and analyzing information about significant events in the development of an agricultural research and technology management system.

It uses a relational database management program to explore the relationships among technical, institutional, and political factors associated with individual events. By cross-referencing different types of information we can not only identify patterns of interaction, but at any moment can provide the supporting evidence which will have been drawn from a wide variety of sources.

An "event" is essentially defined by the fact that someone has cited it in literature or conversation as being important in illustrating some point about the system. Once recorded and accurately described, it may be recovered and used in other contexts and may bring out relationships that would not have been apparent when the event was considered in isolation.

For each event, the following information was obtained and recorded in the database program:

a. description of the event, e.g., introduction of CIAT germplasm;

b. nature of event (agronomic, biological, chemical, mechanical, economic, institutional);

c. crop to which event relates;

d. year of event;

e. sector in which event originated (public or private, external or domestic);

f. organization principally responsible;

g. sector of the ATMS to which principal organization belongs;

h. collaborating organizations;

i. sector to which collaborating organizations belong.

With such information on literally hundreds of events, one is able to carry out the following analyses:

a. a chronology of technological events by commodity, their nature, and the characteristics of the participating institutions;

b. an analysis through time of the interaction between classes of institution (public and private, university and research institute, donors and private sector, etc.);

c. a chronology of major institutional changes or principal policy changes in the system.

This historical perspective, which is most easily carried out by a local study team, generates the database of information needed to assess the feasibility of alternative policies or organizational structures, some of which may have been attempted before under the same or different circumstances. The simple chronology of events in pastures, shown in Table 3, brings out the change in strategy that accompanied a change in donors and the interaction between the public, private, and international donor sectors.

A separate chronology of events in rice indicated clusters of technological events of the same type (early reliance on mechanical and chemical innovations in the 1940s and 1950s prior to the Green Revolution in the 1960s). The private sector was associated with those mechanical and chemical innovations and public institutions more than with the latter.

The Policy Analysis

The third tool in the Stage 1 analysis looks at the implications of key macro policies for the agricultural sector. The technique is to identify those policies that affect the level of economic activity, relative prices of agricultural inputs, factors of production, and outputs, and reflect key policy decisions for direct investment in technology generation and transfer.

The key variables that operate at the macro level are obviously the exchange rate and the level of government involvement in the sector. Policies influencing the real cost of imported chemicals and equipment, the wage rate, and the real rate of interest will influence the nature of technology demanded.

Table 4 shows the key policy variables that were seen to be important in the case of Panama. The analysis identifies the policy and assesses its impact on the agricultural sector. At the same time, it explains the reasons why such a policy exists (often to serve interests outside the agricultural sector). By recognizing that some policies are unlikely to be changed in order to facilitate the generation and diffusion of improved technology, one can avoid recommendations that would never be implemented.

VI. CONCLUSION

In this paper I have attempted first to describe the three-stage analysis of an agricultural technology management system. The analysis begins with a system-wide look at key policies, structures, and management processes; it then descends one level to look at key institutions and their internal functions; and finishes with a detailed look at particular technological events within specific crops. The method is iterative, and information at each level serves to confirm or revise conclusions reached at the other levels.

The paper then gave particular attention to the functional analysis and the way it can be used to generate hypotheses for improvements of an organizational or management nature in order to carry out key functions. The information made explicit by the approach helps in the assessement of alternative options for improving the functioning of the system. The policy and events analyses complete the information needed for identifying opportunities to improve the overall agricultural technology management system. This then leads to the institutional and technology performance analyses at the level of particular organizations and commodities for which another set of tools is available.

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Table 1: Panama: Responsibility Chart: Generation of Technology

INSTITUTION	ROLE	MECHANISM FOR PARTICIPATING IN TECHNOLOGY GENERATION
MIDA	coordinate	Overview of agricultural sector
MIPPE	none	none
Legislature	finance	none
ORP	none	none
CAN	none	none
CAR	none	none
CAL	none	none
Crop Commiss.	none	none
BID	none	none
USAID	finance	support to IDIAP, previous support to FAUP
CIID	finance	technical assistance in dual purpose livestock
IICA	none	none in generating sector
World Bank	none	none
IMF	none	none
IDIAP	decide/exe	on-station and on-farm research
FAUP	execute	research stations, on-farm research
CIMMYT	execute	provide germplasm, research methodology,IDIAP/FAUP
CIAT	partic.	CIAT approach: germplasm for acid soils strategy
CATIE	partic.	Rice farming systems Baru, technical assistance
CIP	execute	research on station, support to PRECODEPA
Rutgers	partic.	Rutgers staff in onions, potato, pastures, cattle
ISNAR	partic.	nascent collaboration in economic studies
Chemonics	none	none
SENEAGRO	partic.	proposed role in farm-level trials; validation
BDA	partic.	BDA gerente is member IDIAP Junta Directiva
BNP	none	none
Private Banks	none	none
ENASEM	none	none
Seed Companies	none	none
Input Suppliers	none	none
ANDIA	none	none
COAGRO	none	none
IMA	none	none
ISA	none	none
ENDEMA	none	should be link to IDIAP for mechanization
IPACOOP	none	none
Pioneer Seed	execute	hybrid seed produced for sale in Latin America
Citricos	execute	abandoned disease research, 4 ha varietal trials
Nestle	partic.	provide land and labor to test IDIAP material
United Brands	execute	research on station with production interest
Corp Bayano	none	none
SONA	partic.	field-level trials of technology
ANAGAN	none	none
CONAC	partic.	some asentamientos collaborate in on-farm trials
Arroceros	finance	rice tax partially allocated to research
Low Income Farm	partic.	on-farm trials in IDIAP/FAUP programs
Small Farmers	partic.	on-farm testing of IDIAP/FAUP material
Large Farmers	none	none
Asentamientos	partic.	on-farm testing on some asentamientos
Molineros	none	none

Table 2: Panama: Responsibility Chart: Transfer of Technology

INSTITUTION	ROLE	MECHANISM FOR TECHNOLOGY TRANSFER
MIDA		
MIPPE	execute	Integrated Rural Development project under MIPPE
Legislature	finance	finance
ORP	none	none
CAN	none	none
CAR	coordinate	theory: coordinate credit, extension, input support
CAL	coordinate	coordination at micro level of intervention
Crop Commiss.	none	none
BID	none	none
USAID	finance	Chemonics in SENEAGRO, Education for Rural Development
CIID	none	no role in transfer beyond on-farm trial impacts
IICA	none	none
World Bank	none	none
IMF	none	none
IDIAP	partic.	on-farm research, diagnostic studies, documentation, communication methods
FAUP	execute	on-farm research, materials for SENEAGRO, courses
CIMMYT	partic.	on-farm research, germplasm IDIAP/FAUP
CIAT	partic.	livestock program works on farm
CATIE	partic.	on-farm research
CIP	none	none
Rutgers	partic.	work with SENEAGRO on-farm programs, large farmer
ISNAR	none	none
Chemonics	execute	develop transfer methodology
SENEAGRO	execute	field agents, local committees, extension material
BDA	execute	technical assistants enforce norms as condition
BNP	partic.	agricultural agents supervise loans, techniques
Private Banks	none	none
ENASEM	execute	production, storage, certification of seed
Seed Companies	partic.	link to producer associations, sales to clients
Input Suppliers	partic.	sales agents contact farmers, advertise, recommend
ANDIA	inform	through individual member companies
COAGRO	none	none
IMA	none	none
ISA	partic.	enforce technical recommendations as condition
ENDEMA	none?	work with other public agencies
IPACOOP	partic.	provide some technical assistance beyond management
Pioneer Seed	partic.	literature, recommendations for local distributors
Citricos	execute	request SENEAGRO agent to help outgrowers (pina)
Nestle	execute	tech. assistance, fix planting dates, purchase quotas
United Brands	execute	technical services to associated outgrowers
Corp Bayano	partic.	some extension to farmers in project area
SONA	execute	2000 families reached (76%), 12 crops covered
ANAGAN	partic.	organize demonstrations with IDIAP
CONAC	partic.	asentamientos one-time target of MIDA services
Arroceros	inform	technical publications for members and government
Low Income Farm	partic.	targets of transfer and research efforts
Small Farmers	partic.	targets of area development, crop programs
Large Farmers	partic.	on-farm testing, targets of private efforts
Asentamientos	partic.	MIDA agents concentrated on asentamientos 1972-82
Molineros	partic.	seed distribution, credit

Table 3: Panama- ATM Events in Pastures

YEAR	CASE	NATURE	DESCRIPTION OF EVENT
1953-54	pastures	biol	Controlled introduction of forage
1962	pastures	agron	FAUP introduces and evaluates species at Tocumen
1968+	pastures	agron	Priorities shift to legume crops for forage
1968-72	pastures	agron	FAO/Minag introduce and test forage species at Gualaca (high-input approach)
1968-76	pastures	agron	FAO/MAG work on high-input pasture, frequency of cutting, fertilization
1972-75	pastures	agron	IICA-CATIE give priority to utilization and systems of production
1979	pastures	biol	Introduction of new species (*Andropogon gayanus*) with BNP, FAUP, CIAT
1980+	pastures	econ	BNP, Nestle, BDA make credit available for improved pastures
1983	pastures	biol	CIAT-Rutgers program focuses on germplasm for acid soils, seed multiplication
1983	pastures	educ	One IDIAP researcher receives training at CATIE
1983+	pastures	educ	Eight of fifteen researchers receive short-term training at CIAT pastures program

Table 4: Panama: Implications of Key Macro Policies for the Agricultural Sector

POLICY	INTENTION OF POLICY	IMPLICATIONS OF POLICY FOR AGRICULTURE
Use of US dollars as currency	Stability of exchange rate, facilitate international service economy, self-generated inflation impossible	1. overvaluation of dollar hurts export and import substitution; 2. facilitates importation American chemicals, equipment; 3. exchange rate offers no protection from American producers; 4. compensating measures required for agriculture; 5. research essential to attain U.S. levels of productivity.
Reduction in budget deficit	Containment of government expenditures on bureaucracy	1. compression of government budgets for public agricultural sector; 2. makes recruitment of new research staff difficult; 3. budget cuts may tend to fall on operating budgets rather than personnel.
Liquidation of state-owned enterprises	1. reduce budget deficit; 2. liberate investment funds for other purposes	1. closing of sugar mills; 2. review of Citricos de Chiriqui; 3. refrain from creating new public enterprises.
Revise labor legislation	1. social policies of 1970 gave Panama high labor costs; 2. less favorable interpretation of labor code; 3. facilitate the structural adjustment process	1. power of unions in agricultural industries may be reduced; 2. restrictive practices in food industries may be lightened (e.g., milk, tomato, bananas); 3. more flexible hiring and firing practices may generate more employment.
Reinterpret Agricultural Incentives Law	progressive dismantling of protection by quotas; sufficiency must be at world prices	1. privileged situation of certain crops will be reduced; 2. self-increased emphasis on cost-reducing technology; 3. increased attention to non-traditional exports.
Revise incentives to agricultural capital	1. reduce credit subsidy for agriculture; 2. review tax exemption for imported equipment and inputs	1. exchange rate and import legislation favored over-capitalization of agriculture; 2. research oriented towards meeting needs of mechanized farmers.
Expenditure on agriculture	relatively high expenditure on agriculture in relation to Agricultural Value Added	1. high expenditure ratio due to relatively small sector; 2. expenditure has not produced high productivity; 3. expenditure in form of subsidies, bureaucracy, and government enterprise; 4. reform of expenditure pattern sought by donors.
Creation of Science and Technology Unit, MIPPE	1. defence of research as necessary function; 2. monitoring of resources devoted to research	1. recognition that science and technology research is inadequate; 2. recognition of need to coordinate research policy among sectors; 3 forum for debate of agriculture versus other sectors.
Credit Policy	1. public sector credit small portion total; 2. differentiated clientele	1. public credit targeted to small and medium farmers; 2. donors have favored specialized credit; 3. private banks select prime customers; 4. government use of credit as means of directing production is weak tool.

INSTITUTIONAL REORGANIZATION OF AGRICULTURAL RESEARCH IN URUGUAY

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INTRODUCTION

Important efforts are presently being made in Uruguay to strengthen and improve the national agricultural research system (NARS). One of the most important actions undertaken since 1985 is that involving the institutional reorganization of the system. Two international organizations, IICA and ISNAR, have been working with national research center authorities and staff members in trying to identify limitations and constraints and to prepare some preliminary documents related to the organization, structure, and functioning of the new agricultural research institute.

This paper presents an overview of the actual process of institutional reorganization of the NARS in Uruguay and analyzes the role that these international institutions are playing and should have in the near future.

To better understand the nature and scope of the proposed reorganization, some general background information on the country, its agriculture, and a brief history of research organization and functioning is necessary.

GENERAL BACKGROUND INFORMATION

Uruguay is a relatively small South American country some 30-35° south, and bounded by Brazil, Argentina, and the Atlantic Ocean. It has an area of 187,926 sq.km and an estimated population of only 3 million.

Agriculture is fundamental to the Uruguayan economy, both for production of almost all the food that is consumed internally and as the source of nearly all export earnings. Agricultural products, at different levels of processing, represent over 90% of total Uruguayan exports. Similarly, the agricultural sector provides over 50% of the basic inputs for the industrial sector.

Approximately 65% of the AGDP comes from animals (meat, wool, and milk), with the remaining 35% coming from plant crops. Between 50 and 60% of total meat production (400,000 t/yr) and over 90% of total wool production (80,000 t/yr) are exported. Dairy production has substantially increased over the past 10 years (800,000 t/yr), and today 20 to 30% of total production is exported. Most of the crops produced are used internally, with the exception of rice and, to a lesser degree, soybean, barley, and citrus, which are exported.

Despite its importance as a source of export earnings and for internal market food supplies, the contribution of the AGDP to the national GDP is around 10-12%.

There is a consensus that agriculture in Uruguay must be intensified as soon as possible to increase the productivity of the sector and to improve its competitiveness in international markets. The existence of an effective system of agricultural research, with the capability to adapt or to generate technological packages for the different agro-ecological and/or socio-economic regions of the country, becomes, therefore, an essential need.

AGRICULTURAL RESEARCH

Agricultural research has been an important activity in Uruguay since the beginning of the century, and the system reached a reasonable efficiency and effectiveness in the mid 1960s. In 1914 'La Estanzuela' was established as a plant breeding research station in the southwestern region of Uruguay. Under the direction of Dr. Alberto Boerger since its founding in 1957, La Estanzuela was a

leading station for South American cereal breeding. In 1961 it was transformed into the 'Alberto Boerger Agricultural Research Center' (CIAAB). Its research program was expanded to several commodities (crops, pastures, beef, sheep, and dairy production) and several disciplines (soils, agricultural climatology, plant protection, plant breeding, animal nutrition, economics, and statistics).

From 1961 to 1968 there was an effective consolidation of the Center as the executive unit for agricultural research of the Ministry of Livestock, Agriculture, and Fisheries. This was essentially due to strong government support in the form of adequate financial resources and salaries and to positive international cooperation with FAO, USAID, and IICA in training, experts, and equipment.

Between 1968 and 1973 the decentralization of research activities from 'La Estanzuela' was achieved by increasing regional field experimentation and creating a national network of five experiment stations (mainly commodity oriented) as well as some Experiment Demonstration and Production Units (UEDP).

From 1973 to 1985 the agricultural research system deteriorated considerably.

First, there were failures in the consolidation of the experiment station network, mainly caused by a reduction in government financial support and the exodus of the better-qualified staff for economic or political reasons. Secondly, efficiency in using external technical cooperation was very variable. For example, a USAID loan for more than $5 million was abruptly interrupted in 1980 before reaching its objective of consolidating infrastructure, equipment, and training to ensure the adequate functioning of the experiment station network. However, other cooperation projects, like the Chinese technical cooperation on rice and the Japanese technical cooperation on vegetable production, helped to improve, at least partially, the facilities of some experiment stations.

The regional IICA/BID Procisur regional network for the horizontal transfer of technology between Argentina, Brazil, Uruguay, Chile, Paraguay, and Bolivia was probably the most significant contribution to an effective and relevant flow of information from southern Latin American regions to Uruguay.

MAJOR LIMITATIONS AND CONSTRAINTS PERCEIVED IN 1985

This significant deterioration in some of the components of the NARS led the democratic government, installed in 1985, to give priority to strengthening and improving the agricultural research system. Several limitations and constraints were apparent in the NARS. These were essentially related to:

a) *Objectives.* There was a weak articulation of agricultural research programs with national socio-economic development programs, as well as a lack of formal participation of clients.

b) *Financial Resources.* There was a poor allocation of financial resources, as well as variability in the amount and timing of their release.

c) *Human Resources.* The exodus of the best-qualified researchers was one of the most striking realities, leaving the institution without the required expertise in research planning and prioritization. Also, there was not a well-defined policy for human resources management.

d) *Operational Efficiency.* Research programs showed discontinuity, probably as a result of the close linkage of research projects with individual researchers (and the exodus of personnel) and also as a direct consequence of the variability and shortage of financial support. In particular, there was a significant reduction in the regional field experimentation that has traditionally been an important component of research activities in all regions. Work in the UEDPs could not be adequately maintained, except in some special cases where farmer organizations supported part of the cost associated with the research program.

e) *Administrative Aspects.* Excessive rigidity in administrative procedures for using financial resources prevented the director of the center from administering research programs with the flexibility normally required in research, and especially in biological research.

f) *Specific areas of work or services.* Specifically, there were areas of work or services which showed definite constraints:

- Monitoring, evaluation, and economic analysis were loose, weak, and essentially informal.
- Planning and priority selection of research projects

were rather diffuse and weak.

- The transfer of technology mechanisms was almost non-existant, reducing the possibilities for CIAAB to reach the existing network of public and private organizations working on extension and technical assistance.
- Library services and internal and external flows of information were minimal.

MEASURES ADOPTED IN 1985 TO STRENGTHEN AND IMPROVE NARS

Four actions were simultaneously begun in 1985 to strengthen and improve the agricultural research system:

1) an institutional reorganization, leading to the creation of an institute linked to the Ministry of Agriculture but with mechanisms and means to avoid short-term fluctuations in its financial support and economic policies;
2) application of special laws, already available, to rehire experienced staff who had earlier left the institution, either for economic or political reasons;
3) an overall system development project to be financed by some external agency (probably the Interamerican Development Bank, IDB) which could, in a very short time, improve the potential of the institution through postgraduate and in-service training, equipment, and experts;
4) to maintain and increase national and international cooperation.

INSTITUTIONAL REORGANIZATION

During 1985, the Ministry of Livestock, Agriculture, and Fisheries appointed an advisory commission with broad representation from farmer organizations as well as public and private institutions linked to research, teaching, extension, and technical assistance. This commission worked out a draft proposal for institutional reorganization. Next, during 1986, the Minister appointed a much smaller commission which worked on a second proposal, based on the draft, but with a narrower scope according to the Ministry's mandate. During this second stage, ISNAR was consulted, and its expertise was of fundamental importance in developing the rationale of this second and definitive approach.

1. General Characteristics of the Proposed Law

Some important aspects of the new institution, as defined in the proposed law, are summarized below to highlight the most relevant characteristics of the new institutional model.

- **Scope of action:** The institution will be a 'research institution' linked to the existing network of public and private organizations of extension and technical assistance by a transfer of technology department.

- **Legal Status:** A semi-autonomous organization linked to the Ministry of Livestock, Agriculture, and Fisheries.

- **Governance:**
  a) *Board of Directors:* This will have four members, two representatives of Government, one of whom is nominated President, and two representatives from farmers' organizations. The Board's main functions are those related to the definition of policies and strategies for the institution.
  b) *Director General:* He is the executive arm of the Board of Directors and will implement their decisions. He will also have direct responsibility for the preparation of a national research program and budget, human resources management, and internal and international network cooperation strategies.
  c) *Regional Directors:* They will carry technical and administrative responsibilities at the regional level.
  d) *Consultant Committee:* This will include farmers' organizations with national or sectoral importance. In addition, it also includes the university and the MOA divisions related to the planning and programming of agricultural policy. The Consultant Committee is intended to give opinions about research programs and priorities.
- **Financial Resources:** These will come from more than one source. This should buffer the institution against fluctuations due to political changes or economic oscillations affecting budget assignments. Essentially, resources will come from:
  - public funds (annual budget defined by Government);
  - taxes on agricultural products at points of sale or, for certain products, only if they are exported;
  - revenues from production at the institute or from services offered by the institute.

2. Factors affecting the rate of progress

Two factors of a different nature have been operating in the country during the past two years which, in our

opinion, explain the relatively slow rate of draft law preparation at the government level.

First, the institutional reorganization of agricultural research in Uruguay is being accomplished alongside a change in the political framework of the country associated with the re-establishment of a democratic regime. The first steps in the discussion of institutional reorganization of agricultural research coincided with the very early stages of the new democratic regime, which followed an 11-year strong dictatorial regime. This meant that a large number of social, technical, or professional organizations, with various relationships to agricultural research itself, participated in the initial advisory commission. The result was an initial proposal for an institution with a wide scope of action in research and extension and with the participation at the board level of a very large number of organizations. It was then necessary to develop internal strategies to demonstrate that for the efficiency and effectiveness of the research system, as well as the actual possibilities of financial support, it was absolutely necessary to conceive an organization with a scope of action which gave priority to the activity which suffered the greater deterioration, i.e., research, and with a rather simple mechanism for its direction.

Second, for a long time and publically, especially since 1984, several farmers' organizations asked to share responsibility in the administration and economic support of agricultural research. However, when this desire was considered, the resistance to possible new taxes became so strong that the government slowed down the processing of the law and redefined the proposed taxation mechanisms. The relatively high taxation pressure imposed on the rural sector in the past, especially on products like meat and wool, probably accounted at least partially for this resistance.

COOPERATION OF INTERNATIONAL INSTITUTES IN SUPPORTING NATIONAL RESEARCH REORGANIZATION

Since 1985, ISNAR and IICA have been complementing their efforts in working with CIAAB in the process of research reorganization. The primary purpose is to produce a series of basic documents which will be used in the design and organization of the new institute. Each agency is assisting with the preparation of four documents. ISNAR is working on research policy, research priorities, organization and structure, and human resources development. IICA is dealing with the mid-term research plan; programming, budgeting, and evaluation systems; administrative and financial mechanisms; and transfer of technology organization.

There are basically four stages in the preparation of such documents:

1. Diagnosis of the situation and general discussion of the problems between experts from IICA or ISNAR and leaders of the national research center. In some cases, e.g. transfer of technology, representatives of other local institutions directly involved in the process are also invited to participate;

2. Preparation of a preliminary document, with the international institution expert responsible for this action;

3. A workshop at the national institution with the participation of all local staff and experts to discuss the preliminary document and to identify critical areas. Comments and suggestions relevant to the preliminary document are then obtained;

4. Preparation of the final document. The main responsibility for this lies with the national institution leaders, with advice from the international institution experts.

Given the length of time that the process of institutional reorganization normally takes, the positive contribution of international organizations would be best achieved if their supporting work and expertise is continued regularly; not only during the primary stages of designing the institute, but also during the later stages, in which the functioning of the institute according to its new organization and structure has to be ensured.

This is a continuous learning process for everyone involved, and it seems that for an international institution like ISNAR, Uruguay's case of institutional research reorganization poses a definite challenge.

STRATEGIC PLANNING FOR A NATIONAL AGRICULTURAL RESEARCH SYSTEM

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Translated from the original French

I - UTILITY AND CHARACTERISTICS OF STRATEGIC PLANNING

Strategic planning[1] is a planning method used in the industrial sector, where it is by far the most suitable method when an organization is confronted with an uncertain future, and with an unpredictable environment, so that it is continually subjected to abrupt changes. Under such circumstances, 'management planning' (or 'long-term planning'), which aims at determining the resources to be used to attain preset goals, is not applicable.

In strategic planning, the vision of a desired future is acquired through an exercize in futurology, based on the method of 'scenarios'. A scenario is a description of a future situation which is uncertain but plausible. Different scenarios are identified within limits of probability, then a decision is taken on the preferred scenario(s).

When this method is applied to a national agricultural research system, the characteristics of strategic planning are the following:

- Its point of departure lies in a description of the situation which is desired to occur in future (the preferred scenario). The difference between the current and the desired situation gives a measure of the changes that are to be brought about.
- The strategies to be used to proceed from the current to the desired situation, take into account the constraints, as well as the capabilities, of the system (the potential of a NARS).
- The strategic choice, i.e. the reasons why one objective and one strategy are preferred to all others, are clearly explained.
- The search for the best possible linkage between a NARS and its environment (all factors that have influence on the process of generating, transferring and adapting technology) has a central place in the exercize.
- The necessary institutional changes for accomplishing the planned activities are fully taken into account.
- All authorities involved (political decisions-makers, planners, directors of research institutes, users of research results) participate in its preparation. Such participation enhances validity of the decisions, and the chances that they will be put into practice.
- Lastly, strategic planning is a continuous process. A strategic plan may be periodically revised to take into account changing circumstances.

II - STAGES OF STRATEGIC PLANNING

The development of a strategic plan consists of five major phases, which can be subdivided into a number of steps (Figure 1):

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(1) The present study is mainly based on the following works in the abundant literature on the subject:
- Seleuk Ozgediz, 'A Strategic Planning Process Model', CGIAR office, April 1987. Unpublished document.
- Nagy Hanna, 'Strategic Planning and Management. A review of recent experiences', World Bank Staff Working papers No. 751, 1985.
- Michel Marchesnay, 'Strategy. From diagnosis to industrial decision', Chotard et Associés editors, 1986.

Figure 1 - Phases and Stages of strategic planning

Phase	*Stage*
1 ORGANIZATION OF THE PLANNING	1 Assigning the planning responsibility 2 Determination of time period 3 Circumscribing the NARS
2 STRATEGIC DIAGNOSIS	4 Proceeding to stragegic diagnosis
3 DEVELOPMENT OF LONG-TERM OBJECTIVES	5 Setting the level of national research effort 6 Defining the missions assigned to NARS 7 Developing the strategic program
4 DEVELOPMENT OF STRATEGIES	8 Developing NARS reorganization strategies 9 Developing resource mobilization stragegies
5 OPERATIONALIZATION	10 Measuring the importance of projected changes 11 Developing a short-term action plan

- organization of the planning;
- strategic diagnosis (current situation);
- development of long term objectives (desired situation);
- development of strategies (how to proceed from the actual to the desired situation);
- operationalization.

Phase 1
ORGANIZATION OF THE PLANNING

Stage 1 Assigning the planning responsibility

The strategic plan is a political decision; therefore, final recommendations should be approved at the highest political level.

Organizational responsibility should be assumed by a planning committee, appointed at political level. The members of this committee should be chosen on the basis of three criteria:
- the ability to devote necessary time to the accomplishment of the task;
- they should hold a high level government office;
- they should have a deep and direct knowledge of national agriculture.

The committee should have an interdepartmental as well as a multidisciplinary character. It should have a permanent office, and be able to use working groups (or experts' missions) for preparatory investigations.

The development of a strategic plan is a complex process, taking a long time (one to two years) at high cost in terms of money and manpower. From the beginning, that should be clearly appraised and accepted by political authorities.

Stage 2 Determination of time period

As the essential objective of strategic planning is the reinforcement of a NARS, the period to be considered should be that judged necessary for allowing a NARS to achieve optimum size, and a maximum in efficiency - effectiveness.

Stage 3 Circumscribing the NARS

It is best to use a wide definition of a NARS, including not only those institutions that have a formal research mandate, but also institutions that contribute to the production of knowledge and the generation of technology in the agricultural field.

However, one should clearly distinguish between those institutions that one wants to plan the activities and which will be required to implement the plan, and those for which simple recommendations will be formulated.

Phase 2
STRATEGIC DIAGNOSIS

Stage 4 Proceeding to strategic diagnosis

Two steps have to be taken:

(a) A monographic study of NARS
This study consists of a description of the essential elements of the NARS in the present situation (the present scenario), in order to allow item by item comparison with the future situation (the preferred scenario(s):
- activity programs;
- origin, value and allocation of resources;
- organizational structures.

(b) An analysis of the strengths and weaknesses (potentials and constraints) of the NARS.
This last aspect is the heart of strategic diagnosis, because it results in an evaluation of the potential and capacity of NARS to implement plans.
At methodological level, strategic diagnosis requires a dynamic analysis of NARS that could be based on the study of evolutionary phenomena (the forces contributing to the development of the system), and that is able to learn from experience.

Phase 3
DEVELOPMENT OF LONG-TERM OBJECTIVES

Stage 5 Setting the level of national research effort

The level indicators which are most often used are:
- percentage of the agricultural Gross National Product devoted to research,
- percentage of agricultural research expenses with respect to the Gross National Product per inhabitant.

However, it is also relevant to use:
- average expense per research worker, multiplied by number of research workers;
- number of research workers per hectare of cultivable land.

On what level should one fix, in a long-term perspective, the research effort?

A. Examination of strategic options

Several elements can help to reach a decision[2]:

- *International comparisons.* Lessons can be learned by comparing the situation in the country being studied with observations in 'similar' countries.
- *The impact of research on development.* Retrospective studies on the profitability rates of research investment are difficult to conduct. Besides, it is not safe to extrapolate from a past situation to a future situation. However, such studies, and particularly studies on 'similar' countries, are always useful, if only because they show that profitability rates on research investments are in general high (according to product between 30% and 100%).
- *The importance of technological innovation as a factor of agricultural development.* This importance depends on the agricultural development strategy followed by a country, and on the diversification of its agriculture:
  (a) Agricultural development based on the increase of arable surface, and/or large-scale agricultural exploitation, could be assured easily enough by simple transfer of technology (which could be part of buying technology in developed countries). On the other hand, intensification of agriculture and aid to smaller farmers will require a higher degree of organization of new production systems, and the generation of new technologies.
  (b) Research needs in a given country are as extensive as the diversity of the conditions of agricultural production (production types diversity, or agricultural-ecological diversity).

  Summarizing the political choices concerning agricultural development for which agricultural intensification, promotion of small farmers, diversification of production, and regionalization of intervention will require increased research efforts:
- *The importance of research in the 'production function'.* From the point of view of return on investment, is it better to invest in research, in extension, or in development of agriculture? In developing countries, one can often observe a tendency towards low investments in research at all stages of growth:
  (a) At the primary growth stage, developing countries generally give priority to extension and agricultural training, considering the extension of available techniques and training of staff for agricultural development require the most urgent attention. However, one factor is often undervalued: research investment only yields profits in the long run. Low investment in research stems from absence of a prospective vision of future needs.
  (b) At a later stage of growth, the need for training of new staff is less urgent and the messages of

(2) On these points, cf. Howard Elliott 'Resource allocation and priority setting in antional agricultural research systems'. ISNAR, February 1987. Unpublished.

extension need to be renewed. Governments have a better perception of the need for investment in research. On the other hand, they have difficulties in understanding that the accepted supplementary efforts will not result fast in extension-ready results.

Consideration of the dynamic equilibrium to be maintained between investment in research, extension and agricultural training is an essential period in the strategic planning process.

- *The competition in financing agricultural research vs non-agricultural research.* Other research-development disciplines will compete with agricultural research for the attribution of public funds; examples are medical research and new forms of energy research. The problem is particularly clear when all research is placed under the single tutelage of a Ministry of Research.
- *The possibility of obtaining outside technical and financial assistance.* The significant parameter here is not primarily the importance of aid as an absolute value, but its relative importance when compared to the national effort. Beyond a certain limit, the necessary continuity of research is no longer guaranteed. Preoccupations with national independence can also influence decision.

B. Developing strategic options

One could proceed to draw up a maximum hypothesis and a minimum hypothesis concerning:
- the increase in absolute value of the national research effort. For example: 100 to 150 researchers in 1995;
- the importance of external aid as compared to national research efforts. For example: 10 to 20 technical assistants as compared to national workers.

In that way, one could select four possible scenarios, from which one could be preferred:
Scenario 1: 100 national scientists, 10 technical assistants
Scenario 2: 100 national scientists, 20 technical assistants
Scenario 3: 150 national scientists, 15 technical assistants
Scenario 4: 150 national scientists, 30 technical assistants

Stage 6 Defining the missions assigned to NARS

A. Examination of strategic options

All NARS have as their primary mission to contribute to the *production of technical innovations* corresponding to the needs of technological and agricultural development.

However, other functions can be assigned to a NARS:
- *Contributing to the advancement of knowledge.* It is important, even when it does not include the implementation of research of a cognitive nature (fundamental or strategic research), that a NARS should be correctly and constantly informed of the advancement of knowledge in the field of fundamental research relevant to the development problems of concern. This could imply that NARS scientists are sent for limited periods to institutes conducting research of that type, at regional or national level. It could even be useful for NARS to be represented on the program committees of the same institutes, in order to contribute to better compatibility of their activities with national agricultural needs.
- *Making available to planners the information needed to elaborate agricultural policies and agricultural development projects.* This applies mainly to economical research projects which are most often executed via the Ministry of the Plan or technical ministries.

  Several arguments justify that economists should be represented in research institutes: better collaboration between economists and natural science experts; feedback of information to other scientific disciplines, which leads to better programming of research activities.
- *Contributing to the distribution of research results to other agricultural development sectors:* extension and agricultural training.

The point here is to decided whether or not NARS should contribute to (to what degree and in what form), and thus spend part of their resources on, the diffusion of their own results.

Two remarks can be made:

1) The often excessively academic and specialized character of training in faculties of agriculture tends to justify direct participation of researchers in agricultural training. At the same time, more participation of teachers in research activities can be more easily envisaged.
2) Experience proves that the difficulties of communication between agricultural research and extension could be lessened through the contributions of groups of scientists:
   (a) to the training of extension staff,
   (b) to the defining of annual extension programs,
   (c) to the implementation of actions common to research and extension, which could involve creating research support stations for extension and recruiting by research institutes of communication specialists.

B. Developing strategic options

Decision needs to be taken at three levels:
- Distribution of national efforts between various NARS missions.
- Specification of lines of action to be privileged to implement NARS functions other than technological research.
  For example:
  - contribution to the advancement of knowledge: sending 3 to 5% of the staff in international institutes dealing with fundamental research in soil conservation and drought fighting;
  - economic research: setting up a group of minimally 3 to 5 scientists in the national institute;
  - contribution of research in extension of its results: creating a network of research stations to support extension in three regions.

- Development of the strategic program (cf. infra 7).

Stage 7 Developing the strategic program

The strategic programming relates to general political decisions: the idea is to determine the general lines of action which will define the choice of intervention domains and the research approaches for several years.

A. Examination of strategic options

First level: Priority objectives for technological development to the realization of which agricultural research should contribute:

(a) Production priorities:
  - production to substitute import vs production for export,
  - food production vs commercial production,
  - introduction of new products (diversification of agriculture vs development of current products).

(b) Thematic priorities:
  - conservation of natural resources and reproducibility of production systems vs productivity growth,
  - agricultural mechanization vs human investment,
  - irrigation vs dry agriculture.

(c) Regional priorities:
  - high-potential regions vs marginal regions,
  - colonization of unused land vs development of territories which have been inhabited a long time.

(d) Priorities of target groups:
  - rural producers vs urban consumers,
  - large vs small-scale exploitation,
  - controlled vs free sector.

Second level: Impact desired for research projects to be undertaken (the impact which is judged most apt for the promotion of agricultural development):

- increased productivity vs increase of yield per hectare,
- increase of production vs reduction of production costs,
- introduction of new production systems vs improvement of current production systems,
- selection criteria for genetic improvement,
- types of methods for prevention and control.

Third level: Research approach:

- 'vertical' research (centered on the development of particular production methods) vs systematic research (centered on the development of production systems),
- multidisciplinary research vs monodisciplinary research.

Fourth level: Research type to be undertaken:

- local adaptation research vs generation of new technologies.

1) Each NARS has a primary obligation to *adapt available technologies to the local production constraints*, which is a condition for their adoption by direct producers. All other activities should, subject to evaluation, be considered as residual.

   Therefore, it is necessary to start by reflecting on the importance of adaptive research, which primarily depends on two factors:
   - the diversity of agricultural situations in the country (at an agro-ecological and socio-economical level);
   - the existence of 'available technologies'.

   Such a reflection should be supported by exact knowledge of the various conditions of national production and the results of agricultural research, at national level (results obtained in controlled environment laboratories and experimental stations) and at international level (results obtained in other parts of the world approaching the national conditions).

2) In a number of cases, one will have to admit that there are no appropriate available technologies to satisfy the needs of important sectors of national agriculture. The importance and the nature of the resources secured by NARS for the *generation of new technologies* will depend on decisions concerning the

incorporation of the NARS activities in the frame of an international division of scientific work. This includes two main modalities which are not mutually exclusive:

(a) Vertical cooperation: One can distinguish three levels of responsibilities:
- international research centres which concentrate their efforts on fundamental and strategic research;
- trans-national regional centres generating technologies adapted to specific conditions in large natural regions of a continent;
- NARS which adapt technologies to specific national conditions.

Results coming from international and regional research centres being useful to a large number of countries, the resulting economical use of means proves to be considerable. Therefore, there is every advantage for a NARS to concentrate on adaptive research in vertical cooperation.

However, that supposes either that part of the national finances are invested in regional organs (such as WARDA in Africa) or international organs, or that a certain degree of dependence on the regional and international research agencies is tolerated.

(b) Horizontal cooperation: Several NARS with common objectives cooperate to the advancement of an agreed program, each taking part of scientific responsibilities according to its relative advantages. Economical use of means is also important.

This formula has the great advantage that it permits a NARS to contribute directly to fundamental or applied research without having to renounce essential tasks and priorities of adaptive research.

B. developing a long term strategic research program

The result of the reflection is the development of a strategic program which explicits the outline of desired research interventions, in an order of priorities including 2, 3, or at most 4 degrees[3].

Such a program has several uses:
- it provides clear directives to the leaders of research institutes, to which they can refer when programming their activities;
- it facilitates continuous evaluation of the actual contribution of the NARS to the attainment of national development objectives;
- it facilitates distribution of research responsibilities among various NARS institutes, and coordination of their activities;
- it considerably improves the initiative capacity, that is the negotiating capacity of the NARS in its relationship with outside agencies, on scientific cooperation;
- finally, it constitutes a frame of reference to be used for government investment decisions related to the NARS.

Phase 4
DEVELOPMENT OF STRATEGIES

Stage 8 Developing NARS reorganization strategies

The question is to know whether or not changes in the structure and organization of a NARS are necessary, in order to satisfactorily accomplish planned activities and, if so, to define ways and means of the change.

The principal strategic choices concern the degree of unification of the system, the more or less autonomous character of research institutions (which could even go as far as privatization), and the degree of centralization or decentralization, administratively and geographically, of the system.

Reorganization of a NARS must remain within limits fixed by the political environment and by the capacity for evolution of existing structures; therefore, there are no universally valid reference models. However, the science of management has advanced past the stage of pure empirism: compared evaluations, in time and space, of organizational systems of research have resulted in conclusions of sufficiently general applicability to be usable for research adapted to individual situations. But it is also known today that there is no 'perfect' solution to solve all structural and organizational problems in every particular case. Experience shows that various solutions can always be considered in a given context, all having advantages and disadvantages. If this point of view is correct, the right approach consists in considering various alternatives available to reorganize a NARS, to study their advantages and disadvantages, and then to make the

(3) For a decision aid models study to establish research priorities, cf. George W. Norton, and Philip G. Pardey 'Priority-setting mechanisms for national agricultural systems: recent experience and future needs'. ISNAR, April 1987.

most appropriate choice for the desired objectives, within available means. The progressiveness of the decided changes should be carefully considered.

Stage 9 Developing resource mobilization strategies

A. Global strategies

Acceleration vs progressiveness of growth
The rate and rhythm of progression of national expenditure on research should take into account constraints in the development of NARS, which limit its capacities for implementation and are very frequently underestimated. There are constraints at personnel level: newly recruited young researchers need to be guided; therefore one should start by assembling a small number of top managers and give them time to acquire experience, before proceeding to more extensive recruiting. There are contraints at administrative level: considerable and rapid growth of research expenditures necessitates that the capacity of research institutes for managing new resources should be reinforced beforehand. On the whole, a slow though sustained progression of a NARS is in all circumstances preferable to sudden acceleration followed by period of slowing down, due to difficulties encountered.

Expansion vs consolidation
The temptation is always to use additional resources for expansion: new recruitment, creation of infrastructures, and new laboratories. It may well be preferable, however, to spend at least part of additional resources on consolidation of existing systems, in order to augment productivity and quality of performance by existing personnel (through improvement in training, remuneration, and working conditions) rather than recruiting new staff, and in order to maintain existing infrastructures and laboratories rather than creating new ones.

Nationalization vs increase of resources
New resources of a national origin can be used to nationalize research and staff, though not to augment them.
The nationalization of a NARS financing is primarily justified by the need for continuity of the research effort, which outside aid does not guarantee. Nevertheless, one should moderate that judgement: national financing is more urgently needed for operating expenses than for equipment and investment expenses.

Disinvestment vs new investments
Research programs terminate but staff and infrastructures remain. Certain NARS are endowed with infrastructures which are only partially used or which no longer correspond to the present needs. In such a context, new investments, without simultaneous elimination of superfluous appliances, will result in excessive maintenance costs and management costs for infrastructures, at the expense of operating budgets for current research programs.

B. Sectoral strategies

Personnel policy
The efficiency of a NARS depends on the existence of a group of scientists and technicians who are stable, competent, and motivated.

Stability: the essential variable here is the employment market. Emigration of scientists to other sectors is inevitable when salaries and conditions of work are better there.

Competence: the academic level of scientists is an important criterion, though insufficient. Experience, proper scientific supervision, practical field experience, acquisition of experimental research techniques, are all decisive factors as well.

Motivation: it can improved through the introduction of incentive systems (productivity bonuses, promotion by performance evaluations) which will incite staff to conform to assigned objectives and to accept research constraints.

Nevertheless, it is an established fact that governments are very rarely ready to modify the application of public regulations in favour of one category of staff, especially concerning salaries and the progression of careers. An alternative policy is to de-regulate research staff rules (short-term contracts, salaries related to individual competence).

Financing sources
National financing sources should be diversified, if national budget is insufficient, in relation to what is possible: para-fiscal taxes collected on the profession, service performance contracts with development operators, production income. Nevertheless, the advantages of such diversification have limits:

(a) Financing by the profession (for example cotton industries) could introduce biases in the research priorities of NARS.
(b) Sales of services could exaggerately orient research towards short-term conjunctural preoccupations.
(c) The existence of an important production sector

could exaggeratedly overload the administrative management of research institutes.

Use of finances
It is obvious that operating budgets allocated to research institutes are mainly destined to carry out research programs. Nevertheless, just as Emil Q. Javier correctly notes[4], other types of activities ('organizational activities') which respond to 'non-targeted' objectives, should also be taken into account:

- *'Opportunity activities'*. Here, activities are related to the need for research institutes to prove at any time their usefulness and their impact: service performance and short-term interventions in response to urgent needs. The credibility of the institution with the government, and its other partners, is concerned here.

- *'Transition activities'*. Here, activities are related to implementation of institutional reinforcement (administration and organization) decided upon, the cost of which cannot be supported by the programs.

- *'Research entrepreneurship activities'*. This is concerned with all incentive measures, including financial aspects, having for purpose to motivate staff: productivity bonuses, grants.

Phase 5
OPERATIONALIZATION

Stage 10 Measuring the importance of projected changes

Measuring the changes to be made results from a comparison between the current situation and the desired situation. It should be expressed, in most cases, in terms of increase or decrease of the importance attributed to each of the essential parameters of the strategic plan.

Stage 11 Developing a short term action plan

The action plan again places the NARS in the perspective of 'management' planning: the expected results are defined in a non-equivocal way and are foreseeable. The time horizon to be considered for the action plan should correspond to a period of relative stability in the NARS environment.
Once general and long-term objectives have been defined, *what are the possibilities for attaining these objectives on a short-term basis?*

The starting point should be an evaluation of the strengths and weaknesses of the NARS in the current situation, of constraints impeding its development (at the level of financial, human, physical resources), of the capacity of various component institutes to make the required institutional changes (strategic diagnosis).
The compatibility of defined objectives with the NARS capacities for their implementation, provide a realistic short-term perspective on the basis of the distinction between:

- *certain action*, which the NARS seems able to carry out on its own or at least to start up in a significant way, and for the implementation of which necessary resources seem to be available;
- *conditional action*, of which the implementation is subject to conditional decisions or initiatives to be taken by one or another authority (government, donors);
- *delayed action*, of which one can predict with certainty that the NARS would not be able to start them up in a significant way on a short-term basis, either because they are premature, or because the required prior conditions will certainly not have been fulfilled in time, or because necessary resources will certainly not be available.

Such an approach has the advantage of placing development of the NARS in a realistic framework and, above all, to put in evidence the 'waiting problems', the solution of which is a condition for the implementation of the projected objectives (Table 1, Annex).
It is convenient to treat 'conditional' and 'certain' actions seperately, namely:

- In the first place, deciding actions to be taken to solve 'waiting problems' as soon as possible.

- In the second place, deciding on ways in which the 'certain' actions will be carried out, in NARS as well as in the various institutes having responsibilities for carrying out the plan. Simultaneously, short-term objectives should be compared with the means needed to attain them, in order to establish 'operational plans': material investment plan, personnel plan, and

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(4) Cf. Emil Q. Javier: 'An integrated approach to priority setting and resource allocation in agricultural research'. ISNAR. Paper presented at the Rockefeller Foundation Conference in 'Allocating Resources for Developing Country Agriculture Research'. Bellagio, Italy, 6-10 July 1987.

financing plan. Decisions taken should be compatible with strategic choices concerning the mobilization of the resources.

III - LIMITATIONS OF STRATEGIC PLANNING

Strategic planning has a number of limitations which, if not clearly appreciated, could annul its usefulness:

- an excessive tendency towards formalization, towards bureaucratization of planning procedures and of regular implementation of the plan, which can block the capacity for initiative and creativity of NARS managers;
- an excessive tendency towards rationalization of choices whereas it is known that attitudes characterized by a dose of improvisation, risk-taking and jumping into action are factors of excellence for an organization;
- finally, the risk of overestimating the importance of the planning function as compared to other management aspects, which are therefore neglected.

A good strategic plan does not by itself guarantee the capacity of an organization to evolve and transform itself.

ANNEX

Table 1 - *POSSIBILITY FOR SHORT-TERM IMPLEMENTATION OF LONG-TERM OBJECTIVES*

LONG-TERM OBJECTIVES	*POSSIBILITY FOR SHORT-TERM IMPLEMENTATION*		
	ACTIONS		
	'certain'	*'conditional'*	*'delayed'*
1. *National research effort*			
a) Going from 60 to 100 national scientists	+		
2. *Outside assistance*			
a) Going from 40 to 20 technical assistants			+
3. *NARS missions*			
a) Training: supervision of theses by scientists	+		
b) Extension: creating three support stations			+
4. *Strategic programming*			
a) Developing an irrigated rice program together with IRRI		+	
b) Developing research on systems of high plateaux	+		
5. *Reorganization of NARS*			
a) *Privatizing research* on coffee		+	
b) Creating single autonomous institute for food crops	+		
6. *Mobilization of resources*			
a) Inactivate one research stations for livestock		+	
b) Introducing productivity bonuses			+

STRATEGIC EVOLUTION OF PLANNING AT THE NATIONAL INSTITUTE OF AGRICULTURAL RESEARCH IN NIGER

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Translated from the original French

HISTORICAL ACCOUNT OF AGRICULTURAL RESEARCH IN NIGER

Niger is a landlocked country in the Sahel zone. It is about 1,267,000 sq. km in area and subdivided into regions. Two-thirds of the territory is in the sahelian area. Climatologically, the north sahelian is pastoral and the south sahelian is agricultural. The 300 mm precipitation line delimits the agricultural area, which accounts for 45-46% of the country. In this part, the rainfall varies between 300 and 600 mm per year, and this includes a small area near Sudan with 600 mm. There are about 30 million ha of useful or cultivated land, 50 million ha which could be used, 3 million ha under rain-fed cultivation, and 3 million ha under irrigation.

Rainfall varies widely from one year to another. Since 1975, there has been a rainfall reduction period, and so far this year, nowhere in the country has the annual average been achieved. Since 1968, the main problem has been drought, and things do not seem to be improving.

The main crop is millet, grown over an area of 3 million ha. Production varies according to the rainfall. The second crop is cowpea. Production also varies in relation to the rainfall. The third crop is sorghum. Here too production fluctuates and is dependent on rainfall.

NATIONAL INSTITUTE OF AGRICULTURAL RESEARCH

In 1975, the National Institute of Agricultural Research was set up, taking over French institutions such as IRAB, INVT, IRACHO, to try and control the agricultural research system. The previous institutions were completely independent. Some coordination problems were met, and it was quite useful for politicians to promote the idea of having a national institution for agricultural research.

We now have six agricultural research centers: zootechnics; veterinary; forestry; rural economics; ecology; and the computer and statistical center, for statistical analysis and drawing up of protocols. The national institute has its stations mainly in the west, with a large center in the middle of the country. This means that there is a concentration of centers in the western part of the country. At present, the centers are divided into departments, and there are quite a number of stations with laboratories and various operational activities.

In spite of financial investments in research, the results were not up to expectations. So the Niger government asked ISNAR to study the system, and advise on strengthening it. This study has gone through various stages which are descibed below.

The first stage was the definition or drawing up of a mandate for research, with development priorities defined by the government and using the projected resource allocations for agricultural research. This required the setting up of a national program and defining priorities, taking into account the present situation of our national agricultural research system. This had to be developed as a program of agricultural research per region, and included an assessment of the contributions from foreign aid.

When determining the basic principles of the plan, the mission and scope of research must be decided. This means one must decide where one is headed, what one wants to do, how intervention is limited, how to abide by national strategy, giving priority to applied research and, lastly, defining research priorities on the basis of socio-

economic interests and production potential, and on the basis of considerations peculiar to each sector which affect research productivity in that sector.

REINFORCEMENT

Research is not the exclusive preserve of research institutes, because its results must be applied in the field. To prove the value of the agricultural system, some requirements had to be satisfied. Since there was an expert team, we had to gather all information possible on agriculture. To obtain this information, we had to call in specialists in research, administration, and development. Then these specialists had to work together to give their common assessment of the situation and draw up the plan. The approach was as follows.

The ISNAR team had a general discussion, talked to all technical and research departments, then visited the whole country to obtain a first assessment of the situation. Then six working groups were set up on main crops, irrigated agriculture, non-irrigated agriculture, forestry, institutional problems, and identification of sectoral research, to define the manpower required.

The basic philosophy is control of the research sector through a national system. Niger being one of the less-developed countries, we have modest ambitions. We seek moderate growth and control of the national system. We have about 25 researchers now and hope to reach 140 at the end of our plan. We believe this is feasible. Of course, foreign aid is indispensable, but we ask for moderate aid, so we can keep control of the system ourselves.

CHANGES

Then we planned changes in a number of centers, major and minor: the Maridi center, which we already have, a new center in Zendaire, and a new center in Ta Atawa, with specific missions, plus small centers such as in the Sudan area. Another area to monitor is irrigation. We have four centers with national coverage, plus some support centers. If we examine the system closely, the main focus is on rain-fed crops, with very little work being done for irrigated crops. Livestock and soils must also be considered. The plan aimed at readjusting discrepancies, to achieve a certain harmony and equilibrium in the national system.

The principal result has been better balance between the distribution of resources. In the distribution per sector of 1985-6, we try to apportion manpower in a coherent manner within our institution. The breakdown per sector is also more homogeneous. At the end of the plan, we have centers in Niamey, Colo, Rawa, and Zindaire. Zindaire hardly had any researchers on the spot, and although we have a large station in Niamey, we tried to distribute manpower and worked out a breakdown of researchers per sector and per zone. For the operations sectors, we aimed at greater precision in the distribution. For each of these sectors, we tried to indicate the operating area and the allocating of resources in relation to priorities.

ASSESSMENT

In this exercise, we started from the basis of cost per researcher, to assess the system. This is a considerable improvement because, in the distribution of technicians and scientists, we had limited possibilities, taking into account the national potential for training, which is also a problem. Foreign training for our researchers is expensive. Very often, when they return they have considerable adaptation problems, because they have become accustomed to amenities, installations, and facilities better than exist in their home country. We try to carry out cost assessment on the basis of GDP financing over a number of years.

Another important feature is integration of the entire research system.

To carry out the plan, we believe that the preliminary conditions are the following.

The national agricultural research system must be able to coordinate and finance its research. Also, it must set up procedures for programming and periodic assessment of the plan. It should provide for improvement of the working conditions of researchers and give them staff statutes, which they do not yet have. There is also the synergy of research with the University, which is very important. We would like for the National Institute for Agricultural Research and for the University, which are the two main research institutions, to achieve coordination of their activities, and thus contribute to the development effort.

The Institute depends on the Ministry of Agriculture and of Higher Education. Next to this planning, there is reorganization of the structure, because so far we have only one director general without a deputy, whereas we want a scientifically oriented deputy director general, to carry out and supervise all scientific activities.

ADMINISTRATIVE MANAGEMENT

Another important problem for the management of the institution is the administrative and financial aspect. We need managers who understand the needs of research and can establish an administrative coordination system; the deputy director general will deal with coordination of the scientific program.

The regional centers will have center directors reporting directly to the director general. Because they will have to coordinate various programs in their stations, these centers will need to have secretaries general who are in direct contact with the administrative manager.

LINKAGES

Next, we have the problem of relations between research and extension. A unit that will establish a link between research and extension is needed. A second unit is a communication unit; this has been mentioned on various occasions. There must be communication aiming at introducing the institute, making it known, adapting it to the environment, having it accepted. The stability of research financing, apart from political instability, depends on the efficiency of the institution to solve the problems it confronts. If the institute gives evidence of its utility, everyone will agree that research must be carried out.

The third unit is a training unit, for the training of researchers and technicians.

The political organization divides the country into seven departments or regions. These are administrative units, which from an administrative point of view will have great autonomy in the definition of their development process. That is to say, the national development program will be the sum total and integration of regional development programs. For research to be coordinated, we have provided linkages with research at the regional level. These are units which will gather the researchers of the regional centers and the people responsible for technical departments of the participating ministries, and the representatives of the cooperatives, in order to define research needs at the regional level. These research needs will be centralized by the coordinator of the research unit and will be sent to the ministry, in order to be examined and compared with the assessment carried out at the ministerial level, so that it fits in. The representatives of the ministries must set up a national program committee for the expression of national research needs. It is planned that the director of the institute will preside over this national committee, and will provide its secretariat. But we are trying to be realistic about this.

SCIENTIFIC COUNCIL

Considering that we do not have sufficient high-level professors and researchers, we set up a Scientific Council for the institute. It is a unit which advises the Director General on programs, to make sure that they are formulated properly, and that they are carried out adequately as well. This scientific council gathers all the people recognized at the university level, and also outside consultants according to the specific fields needed in our research programs. Above that, we have a Board of Directors; the President now is the Dean of the University of Niamey, which underlines our desire to achieve synergy with the university. We have then a Higher Council of Agricultural Research. The Higher Council will group various ministries, such as the Ministry of Agriculture, the Ministry for Animal Resources and Forestry, and representatives of the Prime Minister. For this council to be efficient, it must be able to take decisions. So, all the work of the National Council for Programs and the Scientific Council, adpated or modified by the Board of Directors, must be approved by the Upper Council of Research, who will submit it to the Government and the Council of Ministers.

AGRICULTURAL RESEARCH PLANNING, MONITORING, AND EVALUATION IN VIETNAM

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INTRODUCTION

Vietnam has a land area of 329,566 sq. km, of which 16% is cultivated, 35% is forest, and 14% is pasture. Geographically, there are three distinct areas: the plains, extending through the length of the country, with the Red River delta in the north and the Mekong River delta in the south as the two granaries of the country; the highlands, with mountain ranges in the northwestern parts running south to central Vietnam; and the seacoast, which is over 3000 km long. Administratively, the country is divided into 40 provinces and three cities.

Vietnam lies in the tropics from 8°N to 23°N. There are two different seasons in the north: winter from November to April, with a relatively low temperature (16°C on average) and low rainfall; and summer, from May to October, with high temperatures, frequent floods and typhoons. In the south, there is a monsoon-type climate with temperatures between 25°C and 28°C. The humidity is high throughout the year in most parts of the country.

The population of over 60 million is divided almost equally between north and south. Population density varies widely, from the heavily populated main river deltas to the moderately populated coastal regions. Nearly 70% of the active population are engaged in agriculture, which accounts for 45% of GNP. The annual population growth rate is 2.2 to 2.4%.

CROP PRODUCTION

The agricultural system includes crops, livestock, and fisheries, with rice, maize, sweet potatoes, sugarcane, potatoes, vegetables, and fruits being particularly important. The basic feature of agriculture, however, is rice monoculture, with two annual crops in the north and two or three crops in the Mekong River delta. Recently, there has been an emphasis on diversification, and the rice area has gradually declined from 90% to 80%.

The labor input in rice farming is high - from three to four persons per hectare and even five in some areas. Rice yields compare favorably with those of other countries in South and Southeast Asia, where they apply much higher chemical and mechanical inputs. Average yields are increasing and are approaching 3 t/ha, but some good cooperatives in the north reach or exceed 10 t/ha per year from two rice crops. The higher productivity is due to the introduction of suitable high-yielding varieties, better irrigation, and use of organic wastes, azolla, and fertilizers, as well as good cultural practices based on labor-intensive farming. Cooperative social organizations also facilitate the quick transfer of technical innovations for production.

Agricultural production is trying to keep pace with the population growth, but at the current rate of population growth, the country has to produce 400,000 t more food every year. This is the challenge which agricultural scientists in Vietnam have to face.

Despite a steady increase in rice production, there is malnutrition, primarily due to an overwhelming reliance on rice as almost the sole source of nutrition. Consequently, emphasis is now being given to improving the quality of diet through diversification of production. Soybeans, groundnuts, pulses, potatoes, maize, vegetables, fruits, fisheries, and livestock are receiving increased research attention.
In order to obtain raw materials for industry and to promote exports, industrial crops are also receiving more attention. Most of these are produced on state farms.

During the last three decades, crop cultivation has been greatly intensified by the construction of thousands of major and minor hydraulic works, and nearly 30% of the cultivated area is now irrigated. In the deltas, it is over 80%.

LIVESTOCK PRODUCTION

Livestock production, generally pigs, buffaloes, cattle, goats, poultry, and ducks, is widely undertaken by both cooperatives and individual households. Pig rearing gets highest priority, since pigs are the major source of meat as well as an important source of fertilizer. Introduction and development of new and improved breeds, artificial insemination, and improved management practices are some of the steps undertaken to stimulate production. From 1980 to 1985 pig production rose by 25%, reaching nearly 12 million head, and live-weight at slaughter for 8 to 9-month-old pigs rose from 45 kg to 62 kg.

THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

The first agricultural research institute, on crops, was established February 10, 1952 and later became the National Institute of Agricultural Sciences (INSA). The primary mandate of the institute is to carry out long-term, strategic research to support and improve agricultural production.

During the 1960s, several research departments of INSA separated from the main institute and emerged as new institutes to undertake expanded programs of applied research in various commodity and non-commodity areas, leaving INSA to work more on long-term research. Ten institutes were formed:

- The Food Crops Research Institute, responsible for applied and adaptive research on important food crops, including rice, sweet potatoes, potatoes, pulses, and vegetables.

- The Industrial Crops Research Institute, responsible for crops like tea, citrus, and leechee.

- The Animal Husbandry Research Institute, with responsibility for research on genetics and crossbreeding, husbandry and management of pigs, buffaloes, cattle, horses, poultry, and other livestock in tropical conditions. AHRI has seven research stations throughout the country.

- The Veterinary Research Institute, working on animal diseases, their control, and vaccine production.

- The Soil and Fertilizer Research Institute, conducting research on effective soil utilization and optimal fertilizer rates for different crops.

- The Plant Protection Research Institute, responsible for studies on pests, plant diseases, and their control.

- The Agricultural Economics Research Institute studies production ecomonics, methods for improving economic managment, and effective production organization.

- The Institute of Agricultural Machinery and Mechanization does research on agricultural machinery manufacture, machine operation, and maintenance.

- The Agricultural Planning Institute is responsible for studies on soil resources, determining and regionalizing crop production, and establishing optimal resource exploitation approaches.

- The Institute of Agricultural Construction and Design carries out research on capital construction and agricultural design.

- After the reunification of Vietnam, the Ministry of Agriculture set up the Agricultural Technology Institute in Ho Chi Minh City and the Rice Research Institute in Mekong Delta.

- A number of research centers also form part of the research network, including ones dealing with maize, mulberry, and sericulture, veterinary drug testing, and scientific-technological information.

Some companies and enterprises have research centers for testing and applying improved agricultural technologies in various crops and animals. They combine research with production and help shorten the time needed to transfer technological innovations to production. These are:

- the Coffee Research Center of the Union of Coffee Enterprises;
- the Cotton Research Center, under the Cotton Company;
- the Vegetable Research Center of the Vegetables and Fruits Company;
- the Pig Crossbreeding Research Center belonging to the Pig Production and Crossbreeding Company;
- the Chicken Research Center, under the Union of Poultry Chicken Enterprises;

- the Bee Research Center, under the Central Bee Company;
- the Fodder Research Center of the Central Fodder Company.

Some Research Institutes have established testing stations and application centers within their network systems in various parts of the country.

Agricultural research is also carried out by the agricultural universities, which make a great contribution to agricultural science and technology.

AGRICULTURAL RESEARCH PLANNING, MONITORING AND EVALUATION

1. Methods of Developing Program and Topics

Initially, research programs and topics are formulated by the research institutions and a national program chairman in consultation with crop and livestock production departments, taking into account the goals and objectives of the national five-year plans.

Subsequently, the proposals formulated are submitted to the Ministry of Agriculture (MOA) according to standard procedures, which include the following information:

- program outline, providing a general review of the content and objectives;
- list of topics;
- justification of content, and procedure for each topic;
- facilities available for implementation and management;
- input requirements (manpower, equipment, materials, capital construction, etc.);
- summary of activities and achievements of earlier programs or topics.

The Department of Agricultural Science and Technology (DAST), on behalf of the MOA, receives the proposals. It does the initial scrutiny and holds discussions with the concerned institutions and scientists for any necessary clarification and approval.

DAST coordinates approval and integrates research proposals, prepares overall agricultural research plans, and sets priorities on the basis of their urgency in solving production problems and their potential economic effectiveness. It also develops norms for consideration by the MOA and the State Committee for Science and Technology. Research plans are derived according to the goals and objectives of the national five-year plan. Besides research topics in national programs, there are also separate topics implemented by the Ministry.

2. Approval Procedures

After being vetted by the Council of Agricultural Science and Technology, and with the concurrence of the Minister of Agriculture, the research plan is sent to the State Committee for Science and Technology. This committee examines the plan in consultation with the State Committee for Planning, the Ministry of Finance, and the MOA. Thereafter, the State Committee for Science and Technology, on behalf of the MOA, announces the approved research plans, including programs and topics at both national and ministry levels, together with the resources allocated for their implementation.

3. Management of Implementation

The Ministry of Agriculture, based on the approved plan, allocates specific responsibilities to the research units (institutes, centers, agricultural units, etc.) and, in turn, assigns tasks to the concerned research departments. The research units are responsible for submitting progress reports every three, six, and twelve months.

In recent years, agricultural research has usually been carried out through programs. Topics on the same commodities, or economically and technically related matters, are put into one program. For instance, the rice program consists of topics on genetics, breeding, intensive cultural practices, and pest management, and includes farming tools, seed storage design, and policies to stimulate rice production. This helps draw all research workers into one integrated team and in forming links within or outside the MOA, and among units at research and production levels.

Each program has a Board of Directors responsible for formulating and monitoring the program. The board of a national program is appointed by the State Committee for Science and Technology, upon recommendations by the MOA, and its chairman is appointed by the Council of Ministers. The Board of MOA Programs is appointed by the Minister.

The research units, which may include universities,

may be given responsibility to implement one or more topics in a program, and the chairman of the concerned program manages the whole program.

4. Research Management

At the base level, each research institution has its Council for Science and Technology which does on-the-spot supervision, examines reports, evaluates the topic, and submits its observations through DAST to the Council of Agricultural Science and Technology for the necessary actions.

At the ministry level, DAST, on behalf of the Council for Agricultural Science and Technology, organizes periodic evaluations. Based on these, a topic may be dropped or intensified. DAST identifies the production technologies to be approved and applied for production and recommends the results for regional trials. The Ministry then gives directives to the concerned agencies for implementation. Every year, the number of topics may change. Some are terminated, some dropped, some modified, and some added.

At the State level, inter-ministerial programs are evaluated by the State Committee for Science and Technology. Based on the committee's observations, the MOA takes the necessary actions.

5. Research Monitoring

The regular measurement of program inputs, activities, and outputs is undertaken periodically during implementation. Monitoring is normally concerned with the procurement, delivery, and utilization of the project resources, adherence to the work schedule or progress made in the production of outputs. The purpose of monitoring is to indicate, as soon as possible, any shortcomings in the delivery of outputs, execution of activities, or production of research outputs, and to undertake timely corrective measures. Thus monitoring is a device to improve program management. It is restricted to watching and overseeing and does not question the program objectives.

REMARKS AND CONCLUSIONS

In planning agricultural research, Vietnamese scientists try to meet the objectives laid out in the state plans. Research programs and projects are identified and implemented in close coordination among the State Committee for Science and Technology, the State Committee for Planning, the Ministry of Finance and Ministry of Agriculture, and between central and local levels.

Research planning has not involved the participation of the majority of research users or the collaboration of research institutes and non-agricultural institutions. Hence, many targets have not been achieved, and some topics have overlapped, causing a waste of investment and resources.

After a program has finished, evaluation is carried out by the Council for Science and Technology, but so far, standard criteria for more accurate evaluation have not been developed.

Like other developing countries, Vietnamese agricultural production aims at:
- food self-sufficiency;
- increasing national income;
- adequate nutrition for the population;
- supply of goods to export;
- provision of industrial inputs.

It is hoped that, in keeping with these targets, ISNAR and colleagues from other countries will give us support and cooperation in agricultural science and technology.

PRIORITY SETTING AND RESOURCE ALLOCATION IN AGRICULTURAL RESEARCH AT THE NATIONAL SYSTEM LEVEL

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INTRODUCTION

Basically the administrator of a national agricultural research system sees his principal functional responsibilities as follows:

1) justify and generate resources;
2) establish priorities and allocate resources;
3) see to the proper planning, programming and implementation of the research and research support programs;
4) see to the formulation of proper technology and policy recommendations and their adoption by producers and policy makers.

Priority setting and resource allocation, therefore, is only one of four major interrelated tasks. A national research administrator looks at his priority setting and resource allocation responsibility with the three other equally important functions in mind.

Thus, for some, priority setting and resource allocation is as much an attempt to introduce more rationality in the process as to generate resources by demonstrating to its publics the relation between research priorities and national development goals.

To assist research administrators and decision makers in establishing priorities and allocating resources, a number of methods or approaches have been developed. The basic purpose is to inject more objectivity and transparency into what is by practice an intuitive and subjective exercise. The premises and details of some of these methodologies are dealt with at length by the companion paper in this session of the workshop.

However, these priority-setting methodologies have not found much use yet in developing countries.

In those countries where these quantitative approaches have been tested, research administrators have found them stimulating, informative, for the most part reassuring, but not entirely useful.

In the first place, the assignment of relative weights to national development goals is *a political act beyond the competence of the research community*. If the research community on its own were to make assumptions of this fundamental nature, the assumptions should be made very clear to high political authority for validation.

Moreover, it is doubtful if the relative values of national development goals are intended to be resolved by society and governments in the manner in which current priority-setting procedures approach the problem. Depending on the weights assigned to them, it is entirely possible that some of the national goals will hardly be served at all.

For comparisons to be valid, the criteria which address different national development goals must be expressed in common terms, usually in cash terms. Unfortunately, while most national goals are clearly economic, others are not.

Integration of ethnic and/or religious minorities is often a very important national goal. If the alternative is political dismemberment, what is its economic value? Of course, one can assume that the costs of counter-insurgency efforts can be substantially reduced with improved relations among national communities. However, the estimates of economic benefits are highly conjectural.

How does one quantify the economic benefits derived from reducing third-degree malnutrition among pre-schoolers, one of the most reliable indicators of malnutrition? It is doubtful in any civilized society today,

however rational, will entertain such quantification. A society seeks to promote the well-being of its people not only because it makes economic sense but more so because it is ethical and just.

For the above reasons, it is more likely that *national policy will decide priorities by assigning budget resources directly among competing national development goals on a fixed ratio over a specific planning period.* In other words, all the goals must be addressed. Importance is expressed by the level of resources assigned to them. The ratios are reviewed periodically as governments change and as progress is achieved in meeting stated goals. This is not the same as giving the national development goals differential weights in an integrated priority-setting exercise which lumps all the goals together.

In the second place, the methods by themselves do not resolve allocation decisions. Priority setting is simply the ordering or ranking of activities in their claim to available resources. A higher priority rank means that the activity is up front in the queue; resources are allocated to it ahead of others in the line as resources become available. A higher priority rank would imply under most circumstances a higher resource allocation, but this need not be so.

Third, these methodologies, while addressing long-term strategic program needs, do not take into sufficient account the near-term, tactical aspects of running organizations. Current priority-setting methodologies are strong on program priorities but soft on *organizational* priorities.

Finally, current priority-setting methodologies do not relate clearly with the organizations' structure and other management functions.

Nevertheless, there are strong and valid arguments for further refining and streamlining of priority-setting methodologies, provided their limitations are recognized. Resources will always be scarce. A clearer relation between activities and potential benefits will not guarantee optimal utilization of scarce resources but should at least minimize opportunities for gross misallocation.

Moreover, in contrast with non-formal, heuristic methods, formal priority-setting exercises will tend to promote stability and continuity of research support, given the periodic changes in leadership which many NARS undergo.

However, priority-setting methodologies should not be overly ambitious to integrate all national goals into a single exercise. Their rigor and credibility decline as the less obviously economic goals are given cash values which many find difficult to accept, both on scientific and ideological grounds. Moreover, priority-setting methodologies give the false impression of precision, which perhaps is not intended but nevertheless comes out without the proper qualification.

The following discussion attempts to accomplish three things: 1) to recognize the limitations of current methodologies; 2) to relate the priority-setting methodology with the political processes which set national goals and with the essentially technologically oriented processes which build up the research activities relevant to those goals; and 3) to pick up where most priority-setting exercises leave off - actual research allocation.

It is written very much in the perspective of a national system administrator, with the intention of giving an insight on how a research administrator might look at priority setting and resource allocation in the context of his other responsibilities.

ESTABLISHING PROGRAM PRIORITIES

Levels of Decision Making. Program priorities are established in at least four levels:

- at the Cabinet/Parliament level, where national development goals are determined;
- at the level of the Ministry of Agriculture, where sectoral objectives are spelled out;
- at the national research system level, where agricultural research programs are built;
- at the level of implementing research institutions which decide on their respective research activities.

The process ideally is iterative; i.e., one echelon feeding information to the other sequentially and in both directions until a final decision is reached. However, basically there is a dominant top-down flow from national authorities to the research system in terms of national policies and directions; and a strong bottom-up flow from the implementing cadres to the policy makers in terms of which realistic and feasible activities can contribute towards those national goals.

A fifth level could be added - *the level of the individual scientist.* However, for the purposes of this discussion this level is subsumed under the fourth, while

recognizing that, indeed, individual choices can be decisive factors in the final outcomes.

The levels of decision making and the relationships among the different echelons are diagrammed in Figure 1.

National development goals are normally spelled out in the five-year plans and annual government budget documents. Since the national goals are invariably broad, noble and ambitious, they have not been constraints in program priority setting.

Similarly, the agricultural sector objectives derived from the national development plans are sufficiently broad to accommodate practically every activity proposed by the research community.

Agricultural Sector Operational Targets. The research community needs more clear, directive statements in order to plan more accurately. More importantly, the research community organizes and builds its research agenda not on the bases of development goals but along commodities, disciplines, factors of production and agro-ecological zones. *There is therefore a need for a set of statements which form the bridge between development goals and the research agenda to establish very clearly the connection between the two.*

These statements are usually implied in the manner the Ministry of Agriculture builds up its major production programs, campaigns and activities. Where these indicative directions are not sufficiently clear, the research community may have to take the initiative to spell out the sector targets in behalf of the ministry, or preferably jointly with it.

The foregoing can be easily shown by an illustration. Tables 1, 2 and 3 are examples of how the national development goals, the agricultural sector objectives and the agricultural sector operational targets in a particular country may be described.

Tables 1 and 2 state the broad national development goals and agricultural sector objectives of the country.

FIGURE 1 - PROGRAM PRIORITY SETTING IN AGRICULTURAL RESEARCH

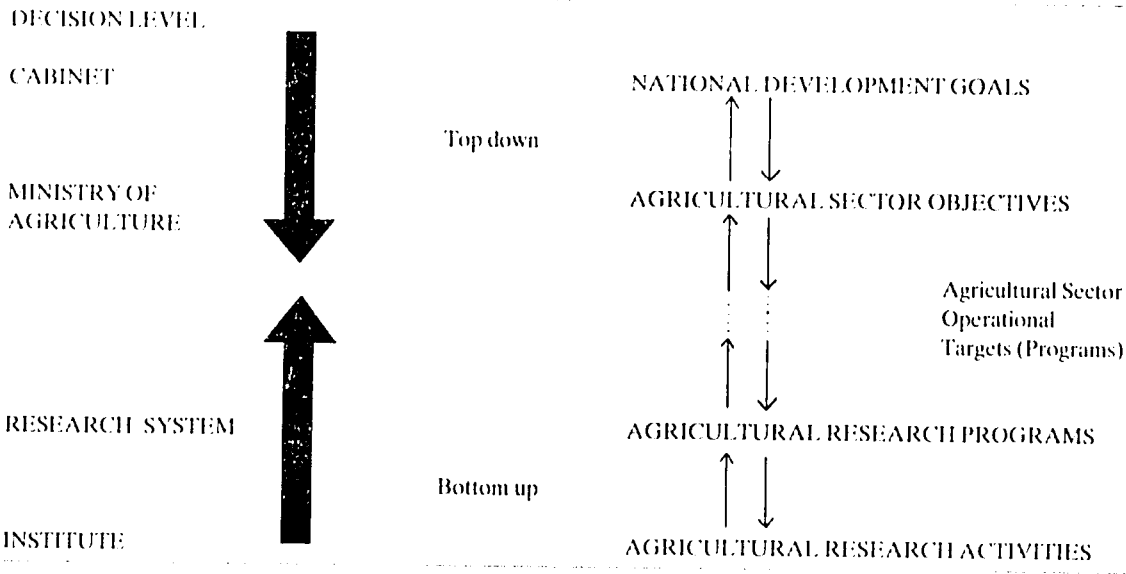

Table 3 attempts to express the national goals and objectives into more operational terms indicating specific sets of activities, their target clienteles and introducing the notions of time and scale of effort.

In addition to translating national goals into more operational terms, the statements in Table 3 are an opportunity to test whether the research community and the leadership in the Ministry of Agriculture are operating on the same wave length, as well as an opportunity for both to influence one another in the process. Presented as the research community's planning assumptions (if they interpreted the directives of the Ministry of Agriculture correctly!), the Ministry of Agriculture now is obliged to accept, reject, or amend

any or parts thereof of the research community's planning assumptions.

The parenthetical statement is quite important, particularly in situations where agricultural research is organizationally remote from the Ministry of Agriculture, or more precisely from the Office of the Minister. This underlines the research community's subordinate role to the political process in policy and goal setting and establishes the essential supporting role of research to the line agency responsible for development. All too often, research and extension do not come together, to the detriment of the country's real interests. This is likewise a subtle reminder to the Minister of Agriculture that he has to look after research, as he may not always do so.

At the same time, these descriptive sets of activities evoke clear research opportunities for the scientists and the research units in the national research system. They can now plan and propose their own activities which they believe can contribute to the development targets set by the Ministry of Agriculture and eventually to the national goals.

This intermediate set of statements (Table 3) serves another important purpose: they can be easily related to current priority-setting exercises.

A closer analysis should reveal that many of the targets are in fact commodities and/or objectives, targets, thrusts and disciplines which can be readily accommodated as the research activities are built-up within commodities.

Thus, in the examples given, raising cropping intensity, promotion of appropriate agro-silvicultural practices on hillsides and promotion of integrated pest management can be built into the research objectives of the commodity programs. Likewise, special attention can be given to the adaptive research needs of tribal regions and major land reform districts but still within the context of the major commodities produced by those communities and in those districts.

Since most priority-setting exercises are commodity oriented, the greater part of the national targets are therefore adequately covered.

The preference for a priority-setting exercise expressed in the main as commodities and the deliberate crafting of the agricultural sector operational targets in terms readily associated with commodities and how they may be researched but enumerated under each major national goal, as illustrated in Tables 1, 2 and 3, *provides the one-to-one correspondence between research priorities and development goals which our publics look for.*

However, there remain a number of important targets which the commodity approach cannot give sufficient justice to, such as, returning to the illustration:

2.1 to rehabilitate existing systems and irrigate an additional 200,000 hectares of land;
2.3 to promote rural industries;
3.1 to reduce third-degree malnourishment among pre-schoolers from 2.5 % to 1.0 %;
5.1 to redistribute 500,000 hectares of farm lands to tenants and landless workers;
5.2 to intensify extension and organize producers' cooperatives in major land-reform districts;
6.2 to intensify extension and organize producers' cooperatives in the tribal regions.

Since these targets cut across commodities or may have nothing to do with them, any further effort to compare them with specific commodities in the priority list stretches the validity of the comparisons beyond the point that renders the listing meaningless. Again, one can keep these targets in mind when building up activities within commodities - but the more logical and direct way to address them is to prepare a separate priority list for each of the non-commodity targets.

Thus one ends up with two priorities lists:
- a commodity priority list;
- a second list of priority activities for other concerns.

DEVELOPING THE AGRICULTURAL SECTOR OPERATIONAL TARGETS STATEMENTS

The development of the agricultural sector operational targets, particularly the process itself, is a central element in this paper and requires further elaboration.

Science, of which agricultural research is part, has two roles in society - a developmental role and a critical role. As a tool for development, priorities in science must be approached in the broader context of goal setting at the national and sectoral levels. As a first principle, therefore, the priorities in agricultural research will have to be constrained by national and agriculture-sector goals and objectives.

In its second role as critic, science, including agricultural research, must contribute to the political processes

which define those national and sectoral goals and objections.

The point of departure, therefore, is the agricultural sector objectives as defined by the responsible agency of government - the Ministry of Agriculture (and related ministries). As referred to earlier, the operational targets can be derived for the most part from the operations, activities and campaigns being undertaken by the Ministry of Agriculture.

The degree of detail and the number of operational targets may vary. Spelling out physical targets, such as hectarages, average yield levels, gross production levels and target clientele is not easy. On the other hand the physical targets, in order to be met, must be disaggregated in terms of tons of improved seeds, tons of different kinds of fertilizers, specification of major production areas, major production and marketing constraints, manpower deployment, location of test sites and a whole range of parameters which almost automatically suggest the important elements of an extension program and its complementary research program.

Since obviously the planners cannot arrive at this physical target in a vacuum by themselves, this could be a neat way of stimulating a three-way dialogue.

This is where the outcomes of the program priority-setting exercise are crucial. If programs judged very important in the *priority-setting exercise carried out independently by the research community* are not included in the agriculture operational targets, then there must be something wrong in the methodology or there must be a special reason for their non-inclusion which the research system may be well-advised to accept (or to argue, as the case may be).

In the real world there is ample scope for dialogue and maneuver. For example, should the Ministry of Agriculture spell out even as few as only five major operational targets, many NARS with their current resources will have their hands full. In any case, in most countries if one takes the five most important commodities, one would have covered easily two-thirds of the country's agricultural economy. Any NARS which adequately addresses the problems of 2/3 of its agricultural economy cannot be faulted for lack of relevance.

On the other hand, a very long shopping list is a very handy instrument for justifying additional resources for research.

ESTABLISHING ORGANIZATIONAL PRIORITIES

Current priority-setting methodologies are designed to establish the order of importance among competing programs. However, they do not capture the essence of other types of activities which are broadly defined as *organizational* in nature.

Opportunity Activities. These activities have to do with the immediate needs of organizations and their administrators to demonstrate immediate relevance and impact. Agricultural research must compete with many urgent national needs, and it is very easy for research to fall to the bottom of the priority heap for failure to demonstrate a sense of urgency in their activities.

Even as agricultural research organizes itself for long-term fitness to its environment by addressing the long-term priorities of agricultural development, it must work for its short-term fitness. It must generate resources to survive for the present. It must provide evidence of its relevance to the present to be assured of resources now and in the future.

The human element must also be taken into account. Research administrators have personal agendas alongside those of the research system and the country. They too need recognition and support to stay in office (or better yet, be promoted to more important posts where their fine leadership qualities could be put to greater use).

Transition Activities. Mention was made earlier of the need to relate priority setting and resource allocation with other management activities. One such activity is the development and implementation of the organization's *Strategic Plan.* Preparing a strategic plan is of course by itself a major institutional exercise. The point being made here is that priority setting and resource allocation should be made in the context of a strategic plan, either formally written up or implied.

The system's institutional strategy may require shifts in structure, governance, culture and management beyond existing levels of resource allocation for administration. To the extent that they can be captured in the manner which the program priorities are built up, they should be so provided. The magnitude of these activities depend upon how major an organizational overhaul the system had to undergo from its present state.

Research Entrepreneurship Activities. The public sector service in most countries does not sufficiently provide

for reward and recognition directly and immediately related to excellence and productivity. Neither are entrepreneurship and competition sufficiently stimulated to push individuals and agencies to greater productivity, as in the private sector.

Moreover, the inherent unpredictability of research requires that individual scientists be given sufficient latitude to pursue new, unconventional ideas. Since these normally are outside the mainstream of current thinking, and are naturally highly speculative, they will not merit high scores in the standard priority-setting exercises.

A system of research grants for scientists adjudged outstanding in their respective fields by their peers and/or a competitive research grant system will fall under this category.

In countries where competitive research grant systems have been adopted, they are also used to redress the bias against research in the basic natural sciences, the social sciences and the humanities and to provide incentive for many creative researchers in the universities.

The three types of activities described are but some of the organizational priorities which national research systems may have to address. How they are broken down will reflect how the research administrators themselves perceive their national research systems.

Conceptually it should be possible to add the criteria which address organizational issues onto those which deal with programmatic issues in an integrated priority-setting exercise.

However, the type of activities among which one discriminates for program content are qualitatively different from the type of activities one chooses among to satisfy organizational needs. Program priority decisions are essentially long-term activities, while organizational needs are qualified to mean those extremely visible, short-gestation, usually downstream type of activities which enhance the organization's short-term fitness to the environment.

For example, the criteria for the *opportunity activities* in their order of importance could be:

1) Chances of success
2) Quick maturity
3) Visibility
4) Cost
5) Economic impact

Note that the same criteria may be applied to strategic program decisions but their order of importance will be different.

LINKING PRIORITIES WITH RESOURCE ALLOCATION

Priorities simply establish the order in which activities are funded in a queue of competing activities. The determination of levels of allocation requires another set of information. The resource requirement of any particular activity will depend upon the current levels of investment in the activity, the inherent cost of conducting the activity at a previously set level of capability, and the capacity of the activity to absorb resources.

The method proposed is to treat the resources available to the national research system as a fund composed of several portfolios. Following the illustration in the previous sections, they may be summarized as follows:

Program Priorities
System-building portfolio
(Commodity, Non-Commodity)
Organizational Priorities
Transition portfolio
Opportunity portfolio
Research entrepreneurship portfolio

The first is based on program priorities of a long-term system-building nature, while the rest attempt to capture issues defined as organizational in orientation.

Priority lists are developed for each portfolio, based on appropriate criteria and relative weights.

Ideally, the organizational priorities should fall within the limits of the desired range of system-building priorities, with a few highly justified exceptions. In other words, the organizational priorities are established separately but are "nested" within program priorities.

For each of the activities in the list, an allocation target is arrived at, based on the actual cost of conducting the activity at a desired level and the capacity of that activity to absorb resources effectively.

An *a priori* decision is made to partition the projected available resources among the several portfolios. The activity cells are then allocated resources, starting from the top, until the portfolio resources are exhausted.

Planned Level of Capability. It is very useful at this stage

to introduce the notion of planned level of capability as a decision variable. Capability in research falls into different grades of intensity and sophistication. At the base, one simply has the capability to monitor technological developments elsewhere, and to introduce, test and adapt these technologies to local conditions. At the intermediate level is the ability to conduct applied research and generate new technology. Finally, upstream, is the ability to conduct basic and strategic research on agricultural problems.

There is always the temptation to fine-tune priority setting and resource allocation at the highest levels, ostensibly for the sake of efficiency. However, national research administrations are well advised to resist the temptation and leave that judgement to the implementing levels, which are better informed in doing so; hence, the introduction of the notion of planned level of capability as the decision variable appropriate at the national level.

For the most important commodities, one assumes that a third level of capability would be desired. For the less important commodities, the initial level would be sufficient.

The planned level of capability on a particular commodity, however, may be influenced by *research spillover effects*. As an extreme example, if basic, strategic and applied research on a very important commodity are easily accessible to a country at very little cost (in resources, national pride and sense of security), the first-level capacity may be appropriate in order to free resources for other important activities in the priority list.

Moreover, it should be possible to discriminate among disciplines within a major commodity. For scientific reasons and/or research spillover effects, a decision may be made to plan at capability level 1 in one discipline and at capability level 3 in another within the same commodity.

Returning to the illustration, all the commodities specified in the operational targets will have to be ranked high in the priorities list. All others are relegated to a residual category which includes candidates for phase-out or for low-level, essentially, monitoring activity.

Those commodities not identified as priority at present but deemed potentially important can be carried together with the "residuals" or given support in the Research Entrepreneurship Portfolio.

Capacity to Absorb Resources Effectively. The next step is to translate the planned levels of capability to projected resource requirements. However, the resource implications of the planned levels of capability cannot be generalized across commodities, disciplines and regions. Research in livestock tends to be more costly than research in crops. Social science research usually requires less than most natural sciences. On-farm research in outlying regions is more expensive than research conducted in readily accessible areas.

Thus the projected resource requirements at the planned levels of capability are best left to the judgment of the implementing agencies *subject to review at the system level.*

Moreover, in the end, the rate of injection of resources to any activity will have to be tempered by the capacity of the existing structure and human resources to absorb additional resources effectively. In the absence of highly trained manpower, an activity, however important, cannot justify a sudden flow of substantial resources.

Similarly, a poorly led unit must have its management improved or its leaders replaced before additional resources are allocated to it.

These observations are often reflected systematically in the monitoring and evaluation system (if the organization has one) or simply through the informed judgments of key administrators. In a sequential process, this factor comes in after the resource requirements at the planned level of capability have been determined.

Projected Resource Requirements of Allocation Cells. It should be possible now to set up a table similar to that shown in Table 4 to indicate the projected resource requirements of the different allocation cells. Table 4 illustrates the breakdown for the system-building portfolio for commodities. The projected resource allocations among all priorities are summarized in Table 5.

The resources are finally allocated to each of the allocation cells in descending order as resources become available for the respective portfolios.

Balance among Portfolios. The portfolios have different purposes, and therefore it is conceptually difficult if not impossible to arrive at a quantitative or systematic approach to partitioning resources among portfolios. This is an intuitive, subjective judgment which a research administrator and his most trusted advisors must make. However, a few general observations may be helpful.

1) If the research system is perceived to be doing extremely well by its publics, there is little justification for the opportunity portfolio.

2) If the reverse is true, and/or if the research administrator is new on the job and anxious to make a good impression, there is a good case for a more visible opportunity portfolio.

3) A NARS which has just undergone a strategic planning exercise which called for a major organizational shift, may require a larger transition portfolio compared with one where no major structural changes are envisaged.

4) In some of the more mature NARS, where there is some need to stir up more competition, need to stimulate performance by visible awards and recognition, an expanded research entrepreneurship portfolio may be useful.

5) In any case, the system-building portfolio should normally command the majority share of resources. The opportunity portfolio becomes an "opportunism" portfolio if short-term needs consistently overwhelm long-term goals over a period of time of a research administrator's tenure.

JUDGING THE BALANCES AMONG OTHER PRIORITY THEMES

It is naive to assume that all of our publics will want to look at agricultural research priorities exclusively in terms of commodities. That will be too simplistic a view of the real world.

The balance among agro-ecological zones, among disciplines, between basic and applied research, between production vs. environment research, are relevant priority issues.

Increasingly, legislators would like to see how their political districts or regions stand in the priorities.

In this approach it is assumed that the researchers themselves will build in these considerations as they develop their research proposals. However, this is not enough. The researchers need guidance on the planned relative shifts of priorities between the present and the next planning periods.

The first step obviously is a characterization of the present levels of effort in each of these issues. The rough congruence role can be applied to the balance of research effort among agro-ecological zones and among political regions. Unfortunately, there are no known acceptable standards for the balance between basic and applied research, for production and environment research, for balance among disciplines.

The best that can be done is merely to indicate whether current levels are adequate or whether small, medium or major shifts are desired for any of the categories.

This very brief reference does not intend to diminish the importance of these other priority issues. What is intended to be conveyed here is that these areas are much less susceptible to rigorous, quantitative treatment and thus remain gray areas of subjective (or informed) judgment.

CONCLUSION

The paper attempts to illustrate one of many possible integrated approaches to agricultural research priority setting and resource allocation at the national research system level.

The approach brings to the fore the following observations:

1) Current priority-setting methodologies attempt to cover too much ground and in doing so tend to lose credibility and acceptance. The methodologies are relevant and logical as far as economic goals and measures are concerned. However, they break down conceptually when essentially political development objectives are mixed up with economic goals.

2) National priorities are often expressed a priori by setting fixed resource allocation ratios to different national goals over a specific planning period. The allocation ratios are reviewed periodically as governments change and as progress is made towards stated goals.

   Current priority-setting methodologies, on the other hand, proceed with the premise that one can adopt appropriate criteria and assign relative weights to these criteria to arrive at the national priorities for agricultural research.

   However, for the latter approach, it is conceivable that some national goals may not be served at all.

3) The paper nevertheless strongly endorses the usefulness of priority-setting procedures and

proceeds to illustrate how they may be used in conjunction with other measures.

4) Priority setting and resource allocation can be as much an exercise to optimize resource allocation as to generate resources, if the exercise can be made to demonstrate to the research system's publics the correspondence between research priorities and national development goals.

5) An *operational statement of agricultural sector targets* is proposed to bridge the gap between national goals and the research agenda. These sectoral targets are deliberately crafted to accomplish the following:

a) to encourage the Ministry of Agriculture to be more focused and specific in its development objectives;
b) to provide an opportunity for the research system and the Ministry of Agriculture (extension system) to influence one another and synchronize their activities;
c) to provide the scientists firmer targets to hitch their research wagons to;
d) finally, to establish a one-to-one correspondence between the research agenda and development goals.

6) Carried by its own logic, the research community builds its research activities into commodities, factors of production, disciplines and agro-ecological zones. However, whichever classification is adopted, any single factor listing will miss the interactions. On the other hand, 2-way, 3-way, and 4-way classifications are unwieldy.
Among these classifications, the commodities relate most readily to development goals. *Thus a strong preference is expressed for comparison among commodities as the principal mode for assessing national research priorities.* The balance among factors of production, the balance among disciplines, the balance between basic versus applied research, the balance among research approaches (to maximize employment, to reduce pollution, to reduce cost of production, to minimize production risks, and to minimize fluctuation in yield levels, etc.) can be taken into account as the commodity research programs are built-up.

7) However, the commodity approach has its own limits. Other very important concerns are ignored or barely addressed. These non-commodity concerns simply have to be dealt with separately.

8) Priority setting establishes the order of importance among competing activities. It establishes the order in a queue of activities as resources become available. Actual resource allocation decisions, on the other hand, require another set of information which includes existing levels of support, inherent cost of conducting an activity at a planned level of capability, and the capacity of an activity to absorb resources effectively.

9) In addition to program priorities, the research system must provide for its organizational needs. *Program priorities* are defined as long-term strategic, system-building activities, while *organizational priorities* are defined as quick-gestating, visible activities which enhance the organization's short-term fitness to its environment.

10) The approach proposes to treat the resources available for research as an investment fund with several portfolios. Criteria and relative weights are developed for each portfolio. Since the individual portfolios have narrower scopes and purposes, there should be more logic and coherence in the criteria and relative weights adopted

11) Based on their respective criteria and relative weights, priority listings are established for each portfolio. Projected resource requirements are determined for each allocation cell, based on inherent costs of conducting the activity at a planned level and the capacity to absorb resources effectively.

12) An *a priori* decision is made to apportion the available resources among the portfolios. The resources are then assigned to the allocation cells in a descending order of priority until the portfolio fund is exhausted. In the unlikely event that the assigned resource level exceeds the projected resource requirements of the activities in the portfolio, the resources are reassigned to the other portfolios.

13) Priority setting and resource allocation must be approached in the context of the institution's other management functions, such as strategic planning and monitoring and evaluation.

TABLE 1. NATIONAL DEVELOPMENT GOALS

1. to achieve food self-sufficiency (inversely, to reduce food imports),
2. to stimulate employment;
3. to improve nutrition among disadvantaged sectors of society;
4. to generate foreign exchange (to fund imports and develop industry);
5. to promote agrarian reform;
6. to accelerate economic development and social integration of cultural minorities;
7. to conserve the country's natural resources and safeguard the environment.

TABLE 2. AGRICULTURAL SECTOR OBJECTIVES

1. to increase production of cereals, grain legumes, fish; livestock products;
2. to increase demand for labor by promoting labor-intensive type of agriculture;
3. to help the malnourished through expanded nutrition intervention activities;
4. to promote agricultural exports;
5. to accelerate land redistribution and to help organize farmers' beneficiaries;
6. to promote agricultural development in the tribal communities;
7. to minimize soil erosion and reduce use of agricultural pesticides.

TABLE 3. AGRICULTURAL SECTOR OPERATIONAL TARGETS (PROGRAMS)

1.1 to increase rice production by 10% to keep up with population growth and to provide for food reserves

1.2 to increase maize production by 30%

1.3 to increase fish catch by 45%

1.4 to increase poultry production by 25%

1.5 to increase aquaculture production by 80%

1.6 to sustain current productivity levels in beans, vegetables, cattle, pigs

2.1 to rehabilitate existing systems and irrigate an additional 200,000 hectares of farm land

2.2 to raise cropping intensity from 1.1 to 1.5

2.3 to promote rural industries (food processing; agricultural equipment manufacturing; handicraft production)

3.1 to reduce third-degree malnourishment among pre-schoolers from 2.5% to 1.0%

4.1 to sustain current productivity levels in pineapple and banana

4.2 to expand export of fresh mango by 50%

4.3 to expand export of canned tuna by 30%

4.4 to expand export of prawns by 100%

4.5 to develop a canned tomato paste export market

5.1 to redistribute 500,000 hectares of farm lands to tenants and landless workers

5.2 to intensify extension and organize producers cooperatives in major land-reform districts.

6.2 to intensify extension and organize producer cooperatives in the three tribal regions

7.1 to promote appropriate agro-silvicultural practices on hillsides

7.2 to promote integrated pest management

TABLE 4. PLANNED LEVELS OF CAPABILITY IN AGRICULTURAL RESEARCH AND THEIR RESOURCE IMPLICATIONS (SYSTEM-BUILDING PORTFOLIO FOR COMMODITIES)

COMMODITY	DESIRED		PRESENT		PLANNED			
					5 YEARS		10 YEARS	
	Capability[a]	Budget[b]	Capability	Budget	Capability	Budget	Capability	Budget
1	L3		L0		L2		L3	
2	L3		L2		L2		L3	
3	L3		L1		L1		L2	
4	L2		L2		L2		L2	
5	L2		L1		L2		L2	
6	L2		L0		L1		L1	
7	L2		L0		L1		L2	
8	L1		L0		L1		L1	
9	L3		L1		L1		L1	
10	L1		L3		L2		L1	
n	L1		L0		L0		L1	

a)
L0 - minimal or non-existent
L1 - capability for adaptive research
L2 - capability for adaptive and applied research
L3 - capability for adaptive, applied, strategic and basic research

b)
Projected budgetary requirements estimated by implementing units subject to review at the system level

TABLE 5. PROJECTED RESOURCE ALLOCATION

System Priorities					
Program			Organizational		
System Building			Transition	Opportunity	Research Entrepreneurship
	Commodities	Other			
Projected Resource Allocation based on - cost of conducting desired level of activity - capacity to absorb resources	AC_1	AS_1	AT_1	$A0_1$	AE_1
	AC_2	AS_2	$AT_2A0_2AE_2$		
	AC_3	AS_3	AT_3	$A0_3$	AE_3
	.	.	.	.	.
	.	.	.	.	.
	.	.	.	.	.
	AC_N	AS_N	AT_NA0_N	AE_N	

PRIORITY SETTING IN NATIONAL AGRICULTURAL RESEARCH SYSTEMS

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PRIORITY SETTING IN AGRICULTURAL RESEARCH

Research administrators in national agricultural research systems (NARS) are faced with the need to establish priorities among competing programs. As research budgets have tightened, the demand for improved methods to assist NARS administrators with priority-setting decisions has grown. ISNAR is responding to that demand by developing and testing practical yet formally structured procedures for use by NARS decision-makers when making research resource allocation decisions. The purpose of this paper is to identify critical issues in developing priority-setting methods; to review recent experience in applying structured priority-setting procedures; and to highlight plans for further refinement of the methods, development of documentation, and collaboration with NARS.

ISSUES IN DEVELOPING PRIORITY-SETTING METHODS

A series of fundamental issues is relevant to development of improved priority-setting methods:

1. Why Might More Structured Priority-Setting Procedures Be Useful to NARS

NARS decision-makers make allocative choices based on their knowledge and prior experience. That knowledge and experience frequently includes an understanding of current national and regional goals and objectives as voiced through the political process, a sense of the severity of particular types of research problems, and a general feel for what is possible to achieve through research of different types. It also includes an awareness of the desires of producer groups. Decision-makers must decide how much emphasis to place on particular commodities (e.g., rice, maize, sheep) and types of research (e.g., varietal improvement, improved livestock nutrition, farming systems). Implicit in those decisions are the locational emphasis of research; the focus on particular factors of production (e.g., land, labor, water); the emphasis placed on longer-term basic versus shorter-term applied and adaptive research; and the distributional effects of research on farm size, on producers versus consumers, and on people at different income levels.

In many NARS, research resource allocation decisions are heavily influenced by the previous year's budget and by rules of thumb such as the congruence between research spending and the value of production by commodity. Changes which do occur often result from requests by scientists, pressures from politicians and producer groups, and the dictates of foreign-assisted projects.

Judgement based upon prior knowledge and information provided by scientists is crucial for research resource allocation decisions. In addition, rapid or radical changes in research programs can be costly. Particularly as research budgets tightened, however, forcing changes in the system, the increased use of more structured quantitative methods may prove helpful in improving the objectivity of those judgements. The aim is to foster consistency of research priorities with goals and objectives and to improve the efficiency of the research system in meeting producer and consumer needs. The idea is not to replace judgement but to increase and organize the information available for updating prior knowledge and beliefs. The hope also is to inject continuity in the priority-setting process and to provide NARS decision-makers with methods they find helpful when rationalizing their decisions

to and mediating conflicting desires of scientists, producer groups, and politicians. Documenting the decision process through a structured procedure may also help generate additional resources for research.

2. Why Has There Been Relatively Little Previous Use of Quantitatively Structured Research on Priority-Setting Methods?

Many quantitative priority-setting procedures are currently available but few have been institutionalized into the decision-making practices of NARS managers. A crucial factor in the non-use of these procedures undoubtedly has been the lack of a rigorous yet cost-effective approach which can incorporate the large number of commodities and research areas, as well as the multiple goals and criteria found in most strategic decision-making situations in NARS. There have been concerns about the quantity and quality of data in many countries. Furthermore, the computer capability available through microcomputers in most developing country NARS today was not generally available even two or three years ago. Finally, the need for priority setting seemed less urgent when budgets were expanding than it does now that many budgets are contracting.

3. Priority Setting Requires Explicit Consideration of National Development Goals

While individual politicians, and even agricultural research administrators, may have personal agendas which can mask overall national goals, most countries have an overriding national goal of increasing or at least maintaining the social and economic well-being of their people.

This broad goal can generally be broken down into three more specific goals: (1) to raise the average level of well-being (frequently measured in terms of income) in the country; (2) to increase the well-being of particular groups (frequently low-income) in society; and (3) to foster economic and military (social) security in the country. One aspect of the economic security goal may involve reducing year-to-year income fluctuations and ensuring the long-run sustainability of the natural resource base. To achieve these three major goals, countries may specify more specific national goals, such as: achieving food self-sufficiency, stimulating employment, improving nutrition of disadvantaged groups, generating foreign exchange, promoting agrarian reform, and accelerating the economic and social integration of cultural minorities. These more specific sub-goals are components of the broader goals and, in many cases, are means of achieving those broader goals.

In developing improved methods for agricultural research priority setting, all three broad goals will normally need to be considered and, in most countries, it will be necessary to explicitly incorporate several of the more specific sub-goals. However, when considering sub-goals it is important (1) not to lose sight of the forest (major goals) for the trees (sub-goals) and (2) to remember that agricultural research is only one of many tools available for achieving societal goals and that research is a more powerful tool for achieving some goals than others.

4. What Quantitative Priority-Setting Methods Have Been Previously Tested

The primary methods reported on in previous studies for research priority setting include:

a) establishment and weighting of multiple criteria dor ranking commodities and research areas,

b) use of benefit-cost analysis, including expected economic surplus techniques, to select commodities and research areas;

c) application of mathematical programming to choose an optimal research portfolio incorporating multiple goals and constraints;

d) development and use of a simulation model.

These four approaches are very briefly described below. Additional information on these methods, including discussions of their advantages and disadvantages, can be found in Norton and Pardey, Shumway, Ruttan, Schuh and Tollini, Anderson and Parton, Scobie, and Norton and Davis.

a) **Weighted Criteria Models.** Several studies have established multiple criteria for ranking commodities (or research areas) and then weighted the individual criteria to arrive at an aggregate priority ranking. The relative weights attached to each criterion to arrive at the final list of research priorities are sometimes left unstated and sometimes made explicit. This procedure is often called a scoring model approach. A few studies also have used a crude scoring model, called congruence analysis, in which all weight is placed on the criterion of value of production.

b) **Benefit-cost Expected Economic Surplus Analysis.** The benefit-cost approach to selecting research priorities has been used in different forms. Most studies have employed consumer-producer

surplus analysis and have incorporated expert opinion to determine projected research impacts, adoption rates, and probabilities of research success. These studies provide estimates of the economic efficiency and distributional implications of agricultural research resource allocation. They typically calculate benefit-cost ratios, internal rates of return, and net present values for alternative types of research or for research on different commodities. These analyses may or may not include regional and international research spillovers and the effects of domestic pricing policies on research benefits.

c) **Mathematical Programming.** Mathematical programming is another alternative for research selection. It relies on mathematical optimization to choose a research portfolio through maximizing a multiple goal objective function given the resource constraints of the research system. The procedure uses similar information to the weighted-criteria model but selects an 'optimal' research portfolio rather than simply ranking research areas.

d) **Simulation.** Finally, the simulation method has been used to identify and select research priorities. For example, Pinstrup-Andersen and Franklin built a mathematical model to project the contributions and costs of alternative research activities. They established goals and then identified changes in supply, demand for inputs, and demand for output needed to meet those goals. They identified needed technologies, time and financial costs, and the probability of research success and adoption.

These four approaches are the most common formally structured priority-setting models, although none of them has been used very often by NARS to date.

5. How Does Priority Setting Relate to Other Research Programming and Management?

Research priority setting, as discussed in this paper, concerns the ranking of priorities by commodity and broad research areas such as plant breeding, livestock nutrition, plant protection, etc. Some of the methods also assist with relative allocation of funds once the commodities and research areas are ranked. However, these procedures must be combined with others before project-level decisions, human resource needs assessments, monitoring and ex post evaluation of research activities can be made. ISNAR is working on methods to assist with this next level of decisions. It must be remembered, however, particularly when making project-level decisions, that it is not advisable to 'over program' specific research activities to the extent that scientific judgement as well as possible positive effects of serendipity are impeded.

6. Importance of Institutionalizing the Priority-Setting Process

Priority-setting is a process, not simply a procedure, and must be institutionalized as part of the overall process of research management. Priority-setting techniques applied only once by people outside of the decision-making process have little value. Results of initial quantitative analyses, no matter which method is used, must be thoroughly discussed with decision-makers and sensitivity analysis conducted along the lines suggested by the discussion.

RECENT EXPERIENCE WITH AGRICULTURAL RESEARCH PRIORITY-SETTING METHODS

The two approaches with the most potential, given additional refinements, for application by NARS in less developed countries, are the weighted criteria models and the benefit-cost (expected economic surplus) procedures. In this section, we discuss recent experiences with applying weighted criteria models in three Latin American countries: the Dominican Republic (DR), Ecuador, and Uruguay and briefly compare those experiences with lessons learned from applying an expected economic surplus model applied in Peru. More detailed descriptions and assessments of the methods are found in Norton, Norton and Pardey, Espinosa et al., Norton and Ganoza, ISA, and CIAAB.

In 1986 and 1987, weighted criteria models were developed and implemented in the DR (ISA), Ecuador (Espinosa et al), and Uruguay (CIAAB) to assist with priority setting for agricultural research. In the DR, the study was carried out at the Instituto Superior de Agricultura (ISA); in Ecuador, by the planning office of the Instituto Nacional de Investigacion Agropecuaria (INIAP); and in Uruguay, by the office of the Director of the Centro de Investigacion Agricola Alberto Boerger (CIAAB).

The purpose of all three studies was to apply a procedure for prioritizing agricultural research by commodity and by major research area.

The procedures employed in the three studies were similar but with some important differences, as the

Ecuador study built on lessons learned in the DR, and the Uruguay study built on other lessons learned in Ecuador (Norton). National goals for the research system were elicited in each country and a series of criteria established which relate to those goals. Separate criteria were developed for commodities and for research areas, and weights were elicited from decision-makers to establish the relative importance of the criteria. Commodities and research areas were ranked according to each criterion and these rankings were multiplied by the elicited weights to arrive at research priorities.

Goals

The three major goals identified above were used in each study: (1) to raise the average level of income in the country, (2) to increase the well-being of low income groups in society, and (3) to reduce year-to-year income fluctuations in the country, especially on the downside. These goals are referred to in Figure 1 as 'efficiency', 'equity', and 'security'.

Criteria

A set of criteria was established to measure whether particular commodities or research areas contribute to the attainment of the above goals. A large number of criteria were discussed in each country, and a total of 15 criteria were eventually used in the DR, 14 in Ecuador, and 10 in Uruguay to determine priorities by commodity. A total of five criteria were used in each case to determine priorities by research area. Refinements were made in successive studies to increase the independence of criteria and to remove criteria that were questionable measures of whether research contributed to the stated goals.

Commodity Criteria

Commodity criteria were grouped into four conceptual groups: product importance, probability of success, efficiency in use of research resources, and distribution of impacts (Figure 1). The first three of these groups relate to the efficiency or income level goal and the last group relates to the equity or distributional goal. In none of the three studies was criteria included which represented the third goal (reduced income fluctuations). Future weighted criteria studies may want to add criteria which explicitly rank commodities from lowest to highest with respect to annual gross income variability (or price and yield variability separately) (Figure 1).

The group of criteria referred to as product importance contained four criteria in the Uruguay study: value of production, generation or saving of foreign exchange, expected future demand change, and comparative advantage. The major criterion used to measure probability of success was the potential for success as indicated by the researchers themselves.

The group of criteria referred to as efficiency in the use of research resources contained three criteria: the relationship to research in the international centers, the degree of emphasis on the commodity in the current research program, and the incentive for the private sector to conduct the research. The group of criteria related to the distribution of research impacts contained two criteria in the Uruguay study: number of producers and the effect of increased productivity on the price of product. The DR and Ecuador studies also included the value of home consumption as a criterion.

The rationale for including each of these criteria is described in Norton along with a discussion of other criteria which were considered but not included or were included in the DR or Ecuador studies but dropped in Uruguay (e.g. protein and calories, land area, employment).

Research Area Criteria

The five criteria used to select research priorities by research area were (1) whether the research causes an increase in the use of relatively abundant resources and a saving of relatively scarce resources, (2) the quantity and severity of research problems, (3) non-duplication with transferable research from outside the country, (4) the extent of private-sector incentives to conduct the research, and (5) current emphases in the research program. These criteria all relate to the income growth (efficiency) goal. It is difficult to identify research area criteria which measure whether particular types of research affect income distribution or variability.

Data Collection and Model Implementation

Information used in the analysis included both quantitative data on value of production, numbers of farms, value of exports and imports, person-years devoted to research on different commodities, etc, as well as qualitative or subjective information on such factors as probability of success, private-sector incentives, severity of research problems, etc. Furthermore, weights had to be elicited from decision-makers to place relative emphasis on the various criteria.

Step 1. Develop Commodity and Research Area Lists. In the DR, information was collected on 74 commodities. In Ecuador, an initial list of 109 commodities on which INIAP was conducting research was discussed. This list was reduced to 44 commodities for the analysis through decisions to eliminate some and to group others. In Uruguay, a smaller list of

commodities was reduced to 21 commodities or commodity groups. The list of research program areas contained nine areas in the DR, 16 in Ecuador, and 16 in Uruguay.

Step 2. Collect Quantitative and Qualitative Data on Chosen Criteria. Information on quantitative criteria was gathered from local and FAO secondary data sources and one table was constructed for each criterion. Commodities were ranked for each criterion. Information needed for the qualitative criteria, as well as the weights to place on criteria, was obtained through interviews with scientists and administrators at both the national and regional experiment stations.

Step 3. Elicit Weights on Criteria. Relative weights to place on the different criteria were obtained from national and regional research system administrators. In Ecuador, a total of 34 people were used to determine the weights. These weights were established separately for the commodity and the research area criteria. In Uruguay, fewer people (seven system and station directors) were used to determine the weights, and more attention was devoted to grouping the criteria which pertain to particular goals. A Delphi procedure was used in which the seven directors were shown the average of the group and provided with an opportunity to adjust their weights.

Step 4. Derive Rankings by Commodity and By Research Area. Once the basic information was collected and organized into a series of tables, one procedure was followed to arrive at a final ranking of research priorities by commodity. A second procedure resulted in lists of priorities by research areas.

Step 5. Analysis and Interpretation of Results. In the DR, the results of this weighted criteria analysis were used to determine a small set of commodities and research areas with the highest priority. Further assessment was then made of human, physical, administrative, and other resources needed to structure research programs focused on these commodities and research topics. In Ecuador and Uruguay, the prioritized list of commodities was split into a high-priority group, an intermediate-priority group, and a low-priority group. Research area priorities were identified for each region of the country.

In the DR, a team of consultants followed up the initial priority-setting exercise with additional analysis and discussions at the experiment station level and eventually recommended the establishment of five national commodity programs and one additional major research program. In Ecuador, the prioritized lists were distributed and discussed in the Ministry of Agriculture, the Board of FEDIA, the Commission on Science and Technology, and in AID. There seemed to be a recognition in Ecuador that priority-setting with a weighted criteria model is an iterative process and that much of the model's value stems from the discussion of criteria among the decision-makers and from the sensitivity analysis. In Uruguay, the results from the first run with the model were discussed with the research directors. The directors made small changes to the weights placed on criteria and the model was rerun, resulting in a new prioritized list. Personnel in CIAAB undertook additional sensitivity analysis and, with the assistance of ISNAR, have been developing an implementation plan.

AN ASSESSMENT OF THE WEIGHTED CRITERIA MODELS USED IN THE DOMINICAN REPUBLIC, ECUADOR, AND URUGUAY

A number of strengths and weaknesses in the procedures were identified during the analyses described above. The first strength is the ability of the procedure to systematically incorporate both quantitative and qualitative information related to a set of multiple goals and criteria in order to prioritize a long list of commodities and research areas in a relatively short period of time.

Second, the procedure proved relatively easy for both research administrators and the local analysts to understand. Third, the analysis, as applied in Ecuador and Uruguay with the direct involvement of research system administrators at various stages, helped those decision-makers to consciously identify and trade off goals and criteria. Fourth, the use of spreadsheet programs in Ecuador and Uruguay facilitated sensitivity analysis after the initial set of priorities was determined. Fifth, the procedure provided a relatively objective assessment of priorities because individuals were not allowed to rank commodities or research areas directly, but had to weight criteria.

The first weakness inherent in ex ante research priority setting, and thus in the procedure, is that there is a large amount of subjectiveness. Although the approach is less subjective than unstructured judgement, there is subjectiveness in the responses to questions related to some of the criteria and also in the weights placed by decision-makers on the criteria. Second, it proved difficult to specify independent criteria with no overlap.

Third, certain of the criteria are difficult to explain to the interviewees (e.g., comparative advantage and potential future demand for the product). In Uruguay, the comparative advantage and future demand questions were answered by a small group of economists from the ministries of agriculture and trade.

In the Ecuador study, more attention was devoted to assessing the most appropriate people for answering different questions than was the case in the DR. However, some criticism surfaced about the weights placed on criteria. In Uruguay, decision-makers were given the opportunity to change their weights after viewing the initial results. This was very useful because it demonstrated the implications of placing different weights on the various goals and criteria.

Computer spreadsheet programs were a major help in Ecuador and Uruguay. Additional work needs to be devoted to developing a more menu-driven program, but the analysts in INIAP and CIAAB were able to use the spreadsheet programs without too much difficulty. It became clear from working in all three countries that it is preferable to work directly with the final decision-makers or their designees. In the DR, the study was conducted by a very competent set of consultants from the local agricultural university, but the procedure was not institutionalized to allow for additional sensitivity analysis or future priority-setting efforts. In Ecuador, and especially in Uruguay, the decision-makers were more directly involved, conducted sensitivity analyses, and are better able to assess why certain commodities or research areas received high priority as a result of the analyses.

THE USE OF EXPECTED ECONOMIC SURPLUS ANALYSIS IN PERU

In 1985, an expected economic surplus analysis was conducted for the five major commodity research and extension (R & E) programs in Peru: rice, corn, small grains, potatoes, and beans. The intent was not to prioritize among the five commodity programs but to estimate rates of return to the R & E investment and to calculate the distribution of benefits between producers and consumers to provide information to the new government about those programs. However, the same basic procedure could be used for priority setting. In fact, Davis, Oram, and Ryan have recently developed an expected economic surplus model to assist the Australian Center for International Agricultural Research (ACIAR) in establishing its research funding priorities.

The following assessment based on the Peru study provides a perspective on the potential application of this approach.

The procedures briefly summarized here are described in more detail in Norton and Ganoza, 1985. The first step involved developing questionnaires to be used in interviews with researchers and extension workers. Forty-five experiment station researchers were interviewed to obtain their projections of the most likely yield or cost changes due to particular research projects, probabilities of success, and time lags for the release of new technologies. Forty extension workers were interviewed to obtain their projections of the timing and geographical spread of new technologies and estimates of the depreciation of previous technologies. Research and extension workers were asked about additional inputs needed to use the improved methods, possible expansion of area cultivated and/or replacement of existing crops, and about the spread of new technologies with and without extension.
The benefits of agricultural R & E were quantified using an expected economic surplus criterion. Changes in producer and consumer surplus were calculated which result from rightward shifts in the supply curve which were projected to occur due to technological change. Separate analyses were conducted for each commodity and different benefit formulas were used depending on the situation for each commodity with respect to imports or exports, marketable surplus, shifts in demand over time due to population and income, and government pricing policies. Internal rates of return to research were calculated and the distribution of benefits to producers and consumers assessed. Calculations were performed using a microcomputer spreadsheet program and a substantial amount of sensitivity analysis was performed.

AN ASSESSMENT OF THE EXPECTED ECONOMIC SURPLUS PROCEDURE USED IN PERU

The expected economic surplus approach used in Peru proved particularly useful for identifying the effects of alternative pricing policies on both the total and the distribution of research benefits. Thirty-five cases were included in the spreadsheet program to allow for different demand, trade, policy, and other assumptions. The study was conducted over a four-month period of time. Because a different spreadsheet analysis must be completed for each commodity and because of the detailed information required on factors such as income

and price elasticities, it would be difficult to apply the procedure used in Peru to a long list of commodities. It may make sense in future studies, however, to narrow the list of alternatives, using a weighted criteria procedure, to a small set (10-15) and then use the expected economic surplus approach to prioritize those alternatives, using the weights derived from the first step to weight the efficiency, distribution, and security goals. It is difficult to use the expected economic surplus procedure for ranking research areas because of the problem of applying it to certain areas such as socioeconomics, to relatively basic research, and to systems or interdisciplinary research. The expected economic surplus approach also requires a higher level of economic training on the part of the local analyst than does the weighted criteria approach. In addition, the procedure, as currently implemented, appears to be more of a black box for decision-makers. It was easier to explain the logic of the weighted criteria procedure to administrators than it was the expected economic surplus procedure.

Finally, the expected economic surplus procedure cannot readily incorporate certain criteria, such as private-sector incentives, to the conduct of research. However, with additional refinements some of these problems can be overcome.

IMPLICATIONS FOR DEVELOPMENT OF IMPROVED RESEARCH PRIORITY-SETTING PROCEDURES

Multiple goals and criteria are important in most strategic decision-making situations in NARS, and decisions of different levels of importance are made, and differing amounts of time and resources are available for making those decisions. At times, research systems are substaatially restructured. At other times, changes are made at the margin. In some countries, the basic research institutions (facilities and scientists) are available for research, but in others, the institutions are much less developed. Consequently, there is a need for a flexible approach that can be tailored to the time-frame, resources available, and the economic importance of the decision. Furthermore, priority-setting exercises such as those described above require additional follow-up activities of several types. Research projects must be defined, human resource decisions made, and programming completed for other aspects of the research activity.

It is important to recognize the direct relationship between the weighted criteria method and the expected economic surplus approach. Essentially, the expected economic surplus procedure explicitly assumes that the research goals are: raising the level of national income (efficiency) and equity (distribution).

Therefore, it captures most of the criteria mentioned in the weighted criteria discussion and removes the need to weight individual criteria. There remains a need to weight the efficiency and distributional goals, but the same procedure used in the weighted criteria model can be used to elicit weights for those goals. Within the set of distributional goals, weights can be applied to different regions, income levels, and to producers versus consumers. If only the economic (internal) rate of return is used to rank commodities, then all the weight is implicitly placed on the efficiency goal.

FUTURE PLANS

General guidelines, weighted criteria models, expected economic surplus models, and others, all have their own comparative advantage and can also be used together. Therefore, one logical solution to meeting the needs for priority-setting mechanisms in NARS is for ISNAR, in collaboration with other institutions interested in agricultural research priority setting, to develop a flexible menu-driven interactive computer program which can assist NARS in selecting and employing alternative procedures. The procedure selected by a NARS for a particular situation would depend on the adequacy of the data, resources and time available, economic importance of the decision, etc. This program would be used as part of an institutionalized priority-setting and research management process. This flexible priority-setting procedure would build on existing weighted criteria and expected economic surplus models.

Over the next two years ISNAR has joined up with ACIAR to concentrate on (1) formulating improved priority-setting procedures which are well-grounded in economic theory, (2) conducting a series of in-country case studies in collaboration with individual NARS to help refine the research priority-setting procedures, (3) developing a flexible, menu-driven computer program to assist with research priority setting, (4) writing a book which discusses priority-setting theory, methods, and lessons from the case studies, and (5) providing a manual for NARS which documents in detail the use of the procedures developed.

COLLABORATION WITH NARS

In the longer term, the goal is to integrate these priority-setting procedures with the other research organization

and management tools being developed by ISNAR. The procedures would be incorporated into the service and training activities of ISNAR.

Collaboration with NARS has been and will continue to be important in developing improved priority-setting procedures. The collaboration in the Dominican Republic was helpful in refining the procedures which were used in Ecuador. The Ecuador collaboration was important not only for Ecuador, but for refining the procedure used in Uruguay. The lessons from Uruguay will be important for future refinements of the procedures. Plans are under way for four case studies in Asia over the next two years. There are possibilities for studies in West Africa and for follow-up work in Latin America as well.

Those of us working on developing the procedures are attempting to balance our time over the next two years among case study work, further study of the theory behind various components of the procedures, writing of the book and manual, and designing the computer programs. We are not yet in a position to undertake a large set of in-depth in-country studies over the next two years, but any suggestions you have for improving priority-setting procedures would be very much appreciated. We will share with you our progress as we refine agricultural research priority-setting procedures over the next couple of years.

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PRIORITY SETTING IN THE TANZANIA LIVESTOCK RESEARCH ORGANIZATION (TALIRO)

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INTRODUCTION

The livestock industry in Tanzania is still dominated by peasant farmers who own about 99% of the total livestock population. For most of these farmers wealth is still reckoned by numbers of livestock. The indigenous stock is largely unimproved, and the industry as a whole is very undercommercialized. The small amount of commercial activity within the livestock sector is dominated by government through parastatal organizations.

Tanzania is reputed to rank third in Africa (after Ethiopia and Sudan) in livestock numbers, with 13 million head of cattle, 5.6 million goats, 3.8 million sheep, 250,000 pigs, and 25 million chickens; yet the majority of Tanzanians experience periodic nutritional stress. The present population of 20 million is expected to double by the year 2000. This will increase demands on livestock, both for animal products and for draught power to help produce more grain and vegetables.

BEGINNING OF LIVESTOCK RESEARCH

Livestock research in Tanzania began in 1905, when the first livestock research station was opened by the Germans at Mpwapwa in central Tanzania. In 1907 they constructed the first cattle dip in East Africa. Following the end of the First World War in 1918, the Germans left Tanzania, and the British took over. Under British rule, the research effort was not maintained because of frequent changes in staff and policy. Most emphasis was placed on cash crops for export of raw materials to the 'home' industries.

Even after independence, livestock research suffered from a lack of adequate research personnel and financial backing. The same cash crops continued to enjoy high priority because of their export value.

A considerable amount of research was carried out between the 1920s and 1950s, much of which has been reported in the literature. Current research should note that:

1. Some of the conclusions arrived at in earlier years are no longer necessarily valid due to changed circumstances. For instance, early workers ruled out the raising of Bos taurus cattle in the tropics because of a very hostile environment. Since 1975 Tanzania has imported several thousand head of purebred exotic dairy cattle from New Zealand and the USA. Our limited experience has shown that, under good management, such animals do perform well in high-altitude areas. It is now generally accepted that in most cases genetics per se is not the most important factor; management is.

2. Some of the experiments carried out in earlier years were limited in scope and were inconclusive. There is, therefore, a need to repeat them under our present conditions and knowledge.

EVOLUTION OF LIVESTOCK RESEARCH PHILOSOPHY

The philosophy of livestock research has gradually changed over the years according to what was perceived as the most pressing problem at a given time. During the 1920s and 1930s much effort was spent on controlling animal diseases which used to kill large populations of livestock whenever there was an outbreak; e.g., rinderpest, contagious bovine pleuropneumonia (CBPP), and East Coast Fever (ECF). Much progress was made after the discovery of effective vaccines and/or drugs to control the causative organisms and their vectors.

Control of the most deadly diseases enabled the

importation of cattle *(Bos taurus)* for crossing with local breeds, and this was the beginning of genetic improvement by crossbreeding and selection. Since the 1930s exotic breeds of cattle have been introduced into Tanzania from Europe, Asia, the USA, New Zealand, Kenya, and Zimbabwe and crossed in many combinations with local and other exotic breeds. A major constraint to production plans at present is the lack of specific knowledge about the kind of animal best suited to commercial dairy and beef production in different ecological zones.

While animal scientists preoccupied themselves with disease control and genetics, relatively little effort went into improving animal nutrition. Most livestock in Tanzania subsist on rangeland grasses and browse, sometimes supplemented by seasonal crop residues and byproducts. Little or no formal supplementary feeding is practiced. Both the quality and quantity of intake vary markedly from region to region and from season to season, but inadequate nutrition is probably the most serious malady of livestock in Tanzania. Inadequate supply of feed during the dry season (equivalent to winter in the temperate zone) often causes animals to lose most of the weight gained in the rains. Milk production also falls drastically. The most important area of animal nutrition research would, therefore, seem to be the feeding of preserved forages to cattle, especially dairy cows, during the dry season. Until a solution to the dry season feed shortage is found, livestock production will remain well below its real potential. However, there are serious technical and economic limitations to forage preservation.

In recognition of the importance of pasture and forages for animal production, the Tanzanian government has recently given higher priority to pasture research. A new and independent Pasture Research Institute is under construction. The main target for pasture research is the dairy sector, with the ranches as the secondary target. Livestock research as a whole will be problem oriented, and the problems identified will be tackled by complete research packages designed for each production system. Pasture research and livestock nutrition must go hand-in-hand.

Thus, it can be seen that priority in livestock research has evolved over the years from desease control to animal breeding and genetics, then to animal nutrition and culminating in pasture and forages, but closely tied to animal nutrition.

REORGANIZATION OF RESEARCH

Following the break-up of the East African Community (EAC) in 1977, the Tanzania government took steps to ensure that the former EAC research institutes in Tanzania continued their research programs. At the same time it was directed that the opportunity should be taken to review and reorganize the existing Tanzanian research institutes of the ministries into autonomous organizations (parastatals) to which qualified scientists and administrators were posted. Subsequently, the Tanzania Livestock Research Organization (TALIRO) was one of the organizations created by an Act of Parliament in 1980. It consists of four research institutes, each with a number of centers, although some have yet to be established. The institutes deal with research on animal diseases, livestock production, tsetse and trypanosomiasis, and pastures.

During the last 25 years many sound research proposals were formulated but never started due to a lack of financial and/or personnel support. Since the creation of TALIRO, steps have been taken to:

- Analyze, evaluate, and publish past results. This exercise is in progress.

- Draw an integrated long-term research program that will take into account old and new research proposals from conception to completion. The first ever five-year research program on animal production, animal diseases, tsetse and trypanosomiasis, pasture and forages was approved by TALIRO's Council during 1986. What remains now is implementation as and when resources permit.

- Insure realistic cost-related field station development. Until now most of our research has been conducted under 'Central Research Institute/Center' atmosphere and the results interpreted accordingly. Extension recommendations were made for completely different conditions from those under which the results were obtained. The concept of testing new technology under producer conditions as early as possible and verifying farmers' acceptance of the new technology is gradually gaining acceptance. This approach will require researchers to be much more mobile. Massive donor support will be required to make this goal a reality. So far no firm commitment has been made by any of the potential donors.

- Project the long-term research manpower and training requirements. Currently TALIRO has 75 graduates and nearly 200 technicians. The organization would be

doing rather well if it were able to make full use of the trained professional and technical staff. As it is, the staff are not used fully due to the lack of essential facilities, e.g., laboratory equipment, transport, e.e. Our staff is entirely Tanzanian, which reflects the heavy investment the government has put into manpower development.

- Develop research-extension linkages and publish results needing translation into field language for extension use. The link between research and extension is still very weak or non-existent. There is provision for an extension unit within the research department of each institute/center.

- Establish library, documentation, publication, and general information services. Current information is very expensive and difficult to come by. A number of donors have generously included library support in their budgets set aside for TALIRO.

TALIRO's mandate is very broad: 'Initiate, organize, conduct, and establish priorities to promote and carry out applied and basic research designed to facilitate livestock research and other fields related to livestock development'.

As a parastatal organization under the Ministry of Agriculture and Livestock Development, TALIRO is responsible for executing the approved research program. The parent ministry is responsible for broad policy issues.

Within each discipline or area, the various research committees decide on research priorities in accordance with government policy. Once the minister responsible gives his formal approval, the program will be implemented to the extent available resources will permit.

MAJOR CONSTRAINTS TO SETTING RESEARCH PRIORITIES

There are a number of practical problems which make priority setting in livestock research very difficult.

1. Lack of clearly defined national policy on research and the political will to support the stated policy. Too often the authorities seem to merely pay lip-service to the importance of research. When it comes to actual budgetary allocation, the funds are simply not there. In general, agricultural research has been given such low priority that it has benefitted little from donor support. Most donors have been more willing to invest in short-term profitable projects where the return on investment is certain. Recipient governments have similarly shied away from long-term projects whose outcome is uncertain or cannot be quantified in cash terms. There has also been a very negative attitude by poor countries in regarding research as a luxury that only developed countries can afford.

2. One common feature of developing countries is little or no consensus on what should be done. Our countries are characterized by much instability, as evidenced by frequent changes of policy and personnel. As yet we do not have a tradition of or respect for research. Due to limited resources, often only short-term projects have received high priority. Research, unfortunately, is a long-term activity requiring considerable patience and investment. The benefits of research are not immediately obvious or appreciated: they are vaguely described in long-term socio-economic benefits. Politicians are more interested in politically visible projects, e.g., industrial plants, many of which have turned out to be white elephants. Many developing countries are now paying the very high price of industrializing at the expense of agriculture. They did so with the full encouragement of donors who were only too glad to sell them industrial plants.

3. Lack of basic infrastructure to support sustained livestock research. Local funding of agricultural research has been very erratic. The percentage of GDP spent on all research has been estimated to be about 0.3. It is not certain how much of this goes to agricultural research.

   Many of the inputs required by researchers have to come from outside. Foreign exchange has been in short supply recently, so scientists have had to do without imports, including literature.

4. The major constraint to improved livestock production is not knowledge per se, but the application of already known technology. Usually, technology is available which could, in principle, increase livestock productivity, but the difficulty is to bring improved technology and management systems to the livestock producers. Where new technology is accepted and applicable, such as in the small commercial sector of the livestock industry, the supply of necessary inputs required by the farmers, such as building materials, water, farm machinery, fencing, drugs, feedstuff, etc. will make all the difference to production. More often than not many

of the basic inputs are either inadequate or lacking, thus making sustained livestock production impossible. If such inputs were guaranteed, we have adequate knowledge to make packages for different types of livestock.

5. The major problem with pasture research is that over 90% of livestock production takes place in uncontrolled grazing areas. This makes the application of improved pasture technology difficult, if not impossible. In the main cattle areas of Tanzania, animals are owned and managed individually, but the grazing areas and other resources are shared. There is, therefore, little incentive for individuals to restrict livestock numbers and manage herds in order to conserve grazing. A change in the land-tenure system must be brought about before it is possible to apply new pasture technology.

CONCLUSION

This paper has dwelt more on the priorities needed to organize a viable livestock research system than on setting priorities in livestock research. To do the latter, certain assumptions must be made:

1. That there is a clearly defined policy and national goals to be achieved through research. The political system is committed to supporting the research effort;

2. That the basic infrastructure to support sustained research is available;

3. That target groups are receptive to the new technology generated through research. Agricultural production has improved steadily as a result of the research effort.

In the absence of the above, it is likely that researchers will be doing little more than fumbling. Substantial resources will be used in the name of agricultural research without making any impact on overall agricultural production.

To date research priorities are more or less based on past experience and knowledge of what others have been able to achieve through research.

ISNAR STUDY ON THE ORGANIZATION AND MANAGEMENT OF ON-FARM CLIENT-ORIENTED RESEARCH IN NARS

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THE ISNAR OFCOR STUDY

In January 1986, ISNAR initiated a two-and-a-half-year study on the organizational and managerial implications of integrating an on-farm client-oriented research (OFCOR) strategy within NARS. In today's presentation, I will first give an overview of the study before we present various aspects and preliminary conclusions of the study relevant to today's theme: Linkage Issues in Research Organizations.

The objective of the study is to understand the critical policy, organizational and managerial factors for implementing, integrating, and sustaining on-farm client-oriented research within a NARS in such a way that it effectively strengthens national research capacities and advances the process of technology generation and dissemination.

WHAT DO WE MEAN BY OFCOR?

OFCOR is a research strategy which links research aimed at technology generation (i.e., applied and adaptive research) with the ultimate client of research -- the farmer. The principal characteristic of OFCOR is that problem diagnosis and the design, development, adaptation, and evaluation of appropriate technological solutions occur primarily at the farm level. OFCOR is fundamentally farmer-oriented.

Since we are examining organization and management issues in this study, we have defined OFCOR more specifically in terms of the roles or *functions* it can play within the research and extension process, rather than in terms of methodologies, as is common in the literature on Farming Systems Research. Looking at these functions together provides a good definition of what we mean by OFCOR.

When fully integrated into a research system, OFCOR performs the following seven inter-related functions:

1) support within research using a problem-solving approach, which is fundamentally *oriented to farmers as the primary clients of research;*

2) contribute to the *application of an inter-disciplinary systems perspective* within research,

3) *characterize major farming systems and client groups,* using agro-ecological and socio-economic criteria, in order to *diagnose* priority production problems as well as identify key opportunities for research with the objective of improving the productivity and/or stability of those systems;

4) *adapt existing technologies and/or contribute to the development of alternative technologies* for targeted groups of farmers by conducting experiments under farmers' conditions;

5) *promote farmer participation in research* as collaborators, experimenters, testers, and evaluators of alternative technologies;

6) *provide feedback to the research priority-setting, planning and programming process* so that experiment station and on-farm research are integrated into a coherent program focused on farmers' needs;

7) *promote collaboration with extension and development* agencies in order to improve efficiency of the technology generation and diffusion process.

WHY IS ORGANIZATION AND MANAGEMENT OF OFCOR AN ISSUE?

Over the past 15 years, many NARS have instituted OFCOR programs of varying scope and intensity. Use of this research strategy has increased significantly. This has resulted from the growing recognition that information on farmers' needs, production conditions, and demands for technologies -- particularly those of small, resource-poor farmers -- has often not been incorporated effectively as a basis for research priority setting, planning and programming. The result has been that, in too many instances, research has produced technology which may be sound in its own right but is inappropriate for this client group. OFCOR has thus been seen as a way of building a better link between research and farmers -- particularly resource-poor farmers.

Still, despite the increased emphasis on OFCOR as a strategy for linking research and farmers, too little attention has been paid to ways of integrating this approach within the research process so that it performs its desired functions effectively. Emphasis has been placed on the development of methodology, but now that experience with the approach is accumulating, problems of implementation are emerging, and the institutional challenges are much more apparent.

Many NARS have undertaken major OFCOR efforts with little orientation or accumulated experience upon which they could draw regarding the actual implementation of this type of research. They have had to move ahead by trial and error, finding solutions to organizational and managerial issues and problems as these problems have arisen.

The objective of this study is, therefore, to address these issues of implementation directly and to try to synthesize the experiences of diverse NARS with integrating OFCOR as a complementary research strategy. This will then provide a base of practical research management experience upon which research managers can draw when trying to build-up OFCOR as an integral part of the research process in their institutes or research systems.

THE OPERATIONAL STRATEGY OF THE OFCOR STUDY: CASE STUDIES AND COMPARATIVE ANALYSIS

In the OFCOR study we are developing nine case studies of selected NARS which have had sufficient time to experiment with and develop diverse organizational arrangements and management systems for implementing and integrating OFCOR. The case study countries are, by region:

Latin America	Asia	Africa
Panama	Nepal	Senegal
Ecuador	Indonesia	Zimbabwe
Guatemala	Bangladesh	Zambia

In each case study we ask: What lessons for research policy and the organization and management of OFCOR can be drawn from this experience which would be relevant to other research managers trying to integrate or strengthen OFCOR within their own systems?

These case studies will then serve as a basis for the comparative analysis which is the second part of the OFCOR study. In the comparative analysis we will systematically analyze this wide range of experiences and synthesize relevant lessons in order to create guidelines for research managers. The synthesis is, thus, a consolidation -- or a digest -- of the practical experiences of research managers in these nine OFCOR situations.

The major analytic themes being developed in the comparative analysis of the OFCOR study are:

- Alternative Arrangements for Organizing OFCOR: Comparative Strengths and Weaknesses;
- Organization and Management of Linkages between OFCOR and Experiment Station Research;
- Organization and Management of Farmer Collaboration in Research;
- Organization and Management of Linkages between OFCOR and Extension;
- Management of OFCOR Research Process and Decentralized Field Operations;
- Development and Management of Human Resources in OFCOR;
- Financial Resource Use and Management;
- Management of Relations with Donors and External Sources of Knowledge;
- Issues in the Institutional Development of OFCOR in NARS: An Evolutionary Perspective.

Synthesis papers will be written on each one of these themes.

OPERATING PRINCIPLES

There are three operating principles for the OFCOR study. First, the study is being conducted on the principle

that we should learn from the experiences of NARS with integrating on-farm client-oriented research. Analysis and synthesis of these real-world experiences should serve as the basis for developing guidelines or checklists of key issues on organization and management of OFCOR for research managers. The second principle of the study is that national researchers should be responsible for developing the case studies. The third principle is that the case studies should directly benefit the collaborating NARS by contributing to their system-building efforts.

PRODUCTS OF THE OFCOR STUDY

The OFCOR Study will have three groups of final products: first, practical guidelines and training materials for research managers for organizing and managing on-farm, client-oriented research within NARS; second, a series of analytic papers on key organizational and managerial themes which synthesize the relevant lessons that can be drawn from the nine country case studies of OFCOR situations; and third, a series of individual case studies with detailed analysis of specific OFCOR situations. These will be stand-alone products, as well as primary sources of data for developing the guidelines.

CURRENT STATUS OF THE STUDY

At this point in the study, we have most of the case studies finished and we expect to be able to get at least four published by the end of the year. We have also already begun the papers on the major analytic themes of research policy, organization, and management of OFCOR. Case study summaries highlighting practical lessons and guidelines for research managers to be drawn from the diverse OFCOR situations will be developed by June of next year.

AGENDA FOR THE PRESENTATION

The agenda for this morning is to present some of the findings of this study relevant to the theme of today:

Linkage Issues in Research Organizations.
The principal linkages we have looked at in the study are:

- linkages to farmers;
- linkages to extension;
- linkages to experiment station research.

Today we will focus on the last two. The presentation is in two parts, representing the two principal products coming out of the research study.

Stuart Kean and Lingston Singogo, who were the principal researchers on the Zambia case study, will present the key findings and conclusions from their case study research. Emphasis is given to the management of the linkages between OFCOR and experiment station research, and OFCOR and extension. Their presentation will demonstrate the kind of analysis coming out of the individual case studies.

Then, in the second part of this presentation, I will give a brief summary of the theme paper I am in the process of developing which intends to synthesize the relevant lessons from all the case studies on organizing and managing the linkage between OFCOR and on-station research. This paper is still very much in the working stage, and we have more analysis to do before we have a fully developed set of guidelines.

But what I would like to do today is to present, in the limited time we have, an overview of the *approach* we are going to use for the synthesis and the development of the guidelines. That is, to indicate to you:

- how we intend to analyze the issue of managing the linkage;

- how we intend to organize the information in such a way that it will be useful to you as senior research managers.

I am putting this out for your review and feedback essentially as product-testing, since you are the principal clients for our research.

ORGANIZATION AND MANAGEMENT OF LINKAGES BETWEEN ON-FARM RESEARCH AND EXTENSION: LESSONS FROM ZAMBIA

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INTRODUCTION

On-farm research in Zambia is conducted mainly by the Adaptive Research Planning Team (ARPT) which was established within the Research Branch of the Department of Agriculture in 1980. At present, ARPT is operating in eight out of nine provinces of Zambia. On-farm research was introduced at the time when the relevance of research and extension programs to the majority of Zambian small-scale and traditional farmers was under review. The results of this review led to the introduction of the Training and Visit (T&V) method in the Extension Branch and the reorganization of the Research Branch into Commodity and Specialist Teams with a national focus and the ARPT with an area focus. In both extension and research there was, and still is, a general concern that they lack appropriate extension messages for small-scale farmers. This is due partly to the existing gap between research and extension and partly to that between extension and farmers. This paper discusses how ARPT's programs and activities have been organized and managed to narrow these gaps, the problems encountered, and some proposals for improvement.

ORGANIZATIONAL STRUCTURE OF THE DEPARTMENT OF AGRICULTURE

The Department of Agriculture is headed by the Director of Agriculture (DAO), who is supported by two assistant directors, one for research and the other for extension. The Assistant Director Extension (ADE) is supported by a number of Chief Subject-Matter Specialists (CSMS) at national headquarters. The Assistant Director Research (ADR) is supported primarily by the Chief Agricultural Research Officer (CARO), under whose command are the Commodity and Specialist Research Teams (CSRTs) and the ARPT. At the provincial level, extension is represented by the Provincial Agricultural Officer (PAO), supported by Subject-Matter Specialists (SMSs). Every province has a regional research station headed by an officer-in-charge. He represents the Research Branch in the province. Research activities at this level are undertaken by the station agronomist and to a lesser extent by ARPT.

The extension organization at the district level is headed by the District Agricultural Officer (DAO), assisted by SMSs. The district is divided into blocks which comprise camps. Research activities at these levels are carried out either at sub-research stations and/or in recommendation domains by station supervisors and ARPT staff respectively. Each recommendation domain comprises three clusters on average. Trials in these clusters are conducted by trial assistants (TAs). The TAs are administratively and technically responsible to the DAO and the farming systems agronomist in ARPT respectively.

ORGANIZATIONAL OPTIONS FOR ON-FARM RESEARCH IN ZAMBIA

Before establishing the Adaptive Research Planning Team to conduct on-farm research, three possible options were considered. First, to undertake a major reorganization of the whole research branch and establish regional research teams or institutes comprising all possible combinations of biological and social scientists. These teams would have been responsible for carrying out both on-station and on-farm research in the regions. The second option was to place social scientists into the already existing Commodity and Specialist Research Teams. This would have meant all CSRTs undertaking surveys and on-farm research trials.

The third option was to form a separate team, in addition to the CSRTs, which would have an area focus in order to complement the national focus provided by

Commodity Research Teams. It was decided by senior research and extension managers to opt for this approach. Since then, ARPT has expanded along these lines. It is believed that the option chosen has affected the nature of the linkages between on-farm research and other institutions such as extension.

ARPT is now operational in eight of Zambia's nine provinces. Each provincial team includes an agronomist, an agricultural economist, and a Research Extension Liaison Officer (RELO) who is on secondment from the extension branch. This team is based at the Regional Research Station. It is planned to have four rural sociologists who should support the activities of the provincal teams. At the national level, there is a nutrition coordinator and a national ARPT coordinator. In provinces where livestock is an important enterprise, adaptive livestock research officers have been appointed, two thirds of whom have been drawn from extension. At the field level, ARPT uses the services of TAs who have been seconded from extension.

MANAGEMENT OF FORMAL AND INFORMAL ON-FARM RESEARCH-EXTENSION LINKAGES

In institutionalizing on-farm research into the research branch, one of the major aims and objectives of ARPT was to narrow the gap between research and extension. This would be achieved by drawing extension workers at national, provincial, and field levels into the process of technology generation for small-scale and traditional farmers. ARPT provides many opportunities for bridging the gap between research and extension. These occur in two main ways:

A. Involvement of ARPT in Extention Activities

In provinces where ARPT has been established for some time, ARPT has been participating alongside extension staff in a number of extension- oriented activities, including:

1. **Farmer and Extension Field Days**
   The RELO has assisted extension workers in planning and executing farmers' field days. Other ARPT members attend these field days as resource persons. Whether the field days are intended as result demonstrations of adopting recommended technology or are for testing new technology, extension workers are involved in explaining the processes to the farmers. Attendance at field days has been one of the most important occasions for ARPT-extension interaction and feedback.

2. **The Training and Visit program**
   The T&V program of extension has been fully operational in a few provinces only. In these provinces, ARPT's involvement has been significant. The most noteworthy contribution by ARPT has been the production of monthly extension bulletins based on the latest trial results and socio-economic studies. Other activities have included participating in district training sessions and production of bi-monthly extension newsletters.

3. **In-Service Training of Extension Workers and Farmers**
   In provinces where the T&V system has not been operational, ARPT has nevertheless participated in the formal in-service training sessions for both extension workers and farmers. These seminars/ workshops are usually held at farm institutes and farmer training centers.

   The RELOs prepare and present lectures on communication skills and a farming systems perspective. In return, ARPT receives comments from extension workers and farmers about on-farm trials.

4. **Dissemination of New Technology**
   Out of eight provincial teams which have been established, only three have been able to either revise old or produce new recommendations for specific farming systems. However, observations and discussions with farmers suggest that some farmers have already adopted some aspects of on-farm trials. In Central Province, farmers demanded more seed for an early-maturing maize variety during its first year of on-farm testing. In North-Western Province, farmers would not give back 2 kg of seed to ARPT staff after harvest as earlier agreed because they decided to keep it themselves and replant it next season.

B. Involvement of Extension in ARPT Activities

ARPT has been seeking the participation of extension personnel at all levels in most of its activities. The following activities highlight this aspect of linkage:

1. **Program Planning and Evaluation**
   At the national level, CSMSs participate in the quarterly and annual reviews of ARPT's activities. During annual reviews, the current year's on-farm

research results are discussed and the following season's program agreed on. At the provincial level, there is a formal provincial ARPT steering committee which meets at least twice a year to review on-farm trial results, discuss the following season's program, and the revision and release of provincial recommendations. The membership of this committee includes all Provincial SMSs, ARPT members, DAOs, and all agribusiness representatives. The committtee is chaired by the Provincial Agricultural Officer. It is through this committee that the views of extension personnel are considered in planning and evaluating ARPT's programs.

2. **Participation in ARPTs Surveys**
   The participation of extension workers in ARPT surveys has mainly been with field-level extension workers, at the block and camp levels. Extension workers have been the main source of information for demarcating farming systems in each province. Field extension workers have participated in informal and formal surveys mainly as interpreters for the discussions between ARPT staff and farmers. Trial Assistants have been used to collect data related to trials on trial farmers' fields and surrounding farmers.

3. **On-farm Trials and Tests**
   Most of ARPT's on-farm trials are being implemented by TAs who have been seconded technically, but not administratively, from the extension branch, to work full-time with ARPT. Originally, it was planned to second extension workers to ARPT for at most four years, after which they would be surrendered back to extension in exchange for others. The current feeling of most ARPT members is that these TAs should be permanently seconded to ARPT. In implementing these field programs, TAs elicit the involvement of other extension workers operating in the same target area. In this way a wider range of extension workers is exposed to the activities of ARPT.

   In Eastern Province, more than 50% of on-farm trials were run by extension workers during the first three seasons. On-farm testing of suitable technologies is supervised by local extension workers who are guided by the RELO.

4. **Revision and Release of Crop Recommendations**
   In conjunction with the provincial SMSs, the ARPT agronomists and the RELOs propose the revisions and recommendations which are discussed by the provincial ARPT Steering Committees. This has been the case in Eastern and North-Western Provinces. In Northern Province, however, the RELO approached all extension workers in the province and requested their opinions about the technical content and format of the new recommendations. Extension workers' views and comments on these issues have been quite useful to ARPT.

PROBLEMS ENCOUNTERED WITH ON-FARM RESEARCH-EXTENSION LINKAGES

The development of the organizational structure and the management of linkages between on-farm research and extension outlined above has not occurred without problems. In order to give a balanced view of the situation, it would be appropriate to state the nature of these.

1. The secondment of RELOs to the provincial teams has been incomplete. Out of eight established provincial teams, there are only three Zambian and three expatriate RELOs, some teams having two RELOs. Three provincial teams are still without RELOs. Given the importance of this position in ARPT-extension linkage, much more could have been done if all provinces were fully staffed.

2. Some ARPT staff have suggested that limited extension participation in ARPT activities has been due to lack of motivation by extension workers. In general, ARPT personnel have had more access to physical and financial resources with which to do their work than their extension counterparts. This has created a level of inequality between the two sides.

3. Although the mechanisms for contributing to ARPT's activities have been established, extension workers' contributions have been limited. This has been partly caused by a lack of understanding of the nature of ARPT's work. This has been particularly so for extension workers outside the target areas. This also applies to SMSs who have had limited involvement in ARPT activities.

4. The training and orientation of extension staff has traditionally been towards commercial farmers. Consequently, many extension messages have not been wholly appropriate for small-scale farmers, which has meant that extension workers have tended to work more closely with commercially oriented farmers. This difference in client group has

sometimes hindered communication between ARPT and field extension workers.

5. There has been insufficient forward planning by ARPT staff on activities to be undertaken. This has reduced the involvement of extension workers in ARPT activities. Since extension workers are involved in several other activities, they need to be informed in advance of their anticipated participation in on-farm research activities.

CONCLUSION

The basic organizational framework for strengthening on-farm research and extension linkages does exist in Zambia. Several management strategies have been instituted to operationalize linkages. These strategies have been influenced by the level of staffing, the demand by extension for appropriate extension messages from on-farm research, and the willingness of each side to get involved in on-farm research and extension. So far, intensive participation of extension workers in technology generation has been limited to target areas. Ways need to be developed to spread this involvement. All these efforts are made in the belief that drawing extension workers into the process of technology generation will enhance the dissemination of that same technology to the end users - the farmers.

ORGANIZATION AND MANAGEMENT OF LINKAGES BETWEEN ON-FARM AND RESEARCH STATION SCIENTISTS: LESSONS FROM ZAMBIA

Stuart Kean
Former National Coordinator of ARPT
Zambia

INTRODUCTION

The importance of the Adaptive Research Planning Team (ARPT) having good working relationships with scientists in the Commodity and Specialist Research Teams (CSRTs) was recognized from the earliest discussions about the need for a section dealing with on-farm reseach. The benefits from such interaction should be two-way.

1. Flow from CSRT scientists to ARPT

ARPT scientists could gain from interaction and information from CSRT scientists by:

- providing insight on particular problems, e.g. pests and diseases, etc.;
- making suggestions about how certain data should be collected, e.g. on weed scoring, pest and disease counts;
- giving advice, based on previous research, about solutions to problems which can be tested in on-farm trials;
- giving advice about trial designs;
- providing planting material for on-farm trials;
- giving comments about technology under test in ARPT on-farm trials;
- assisting with the formulation of new and revised recommendations.

2. Flow from ARPT scientists to CSRTs

The principal benefits of flows from ARPT to CSRTs are to:

- provide information on farmers' circumstances to help CSRTs set priorities, plan trials, and set treatment levels;
- provide information on how CSRT material performs on farms under farmer management;
- give an assessment of farmers' varietal preferences, including such features as taste and cooking time;
- supply local germplasm for possible inclusion in breeding programs;
- provide assistance to implement collaborative trials together together with CSRT;
- provide information on how present CSRT recommendations are being adopted by farmers;
- discuss possible revisions to recommendations.

Despite recognition of the need for effective collaboration between provincial ARPTs and CSRTs, the strength of the relationship has varied considerably both between different teams and over time. There have been, broadly, three phases in the evaluation of these relationships:

1979-1982 - The design phase. During this phase ARPT was getting off the ground, and there was minimal interaction. The mandate for collaboration with CSRT scientists was included in the early ARPT documents outlining the team's objectives.

1983-1985 - The establishment phase. By the end of this phase, six provincial ARPTs had been established, and by June 1985, 23 scientists were working in the team. There was resentment among some CSRT scientists that the Assistant Director of Research (ADR) was favouring ARPT, especially by allocating a lot of resources to the team, about which some of them knew very little.

There was quite a lot of interaction, mainly informal, between provincial ARPTs and CSRTs, most of it initiated by ARPT scientists. However, most ARPT staff were trying to get their own programs started and cooperation with other people did not have the highest priority. Several ARPT scientists were frustrated because many CSRTs had few technologies available for on-farm trials and were also hindered by the difficulty of getting access to previous seasons' results.

By mid 1985, there was quite a lot of friction between ARPT and scientists in several CSRTs. A new CARO was skeptical of the role of ARPT, the value of social scientists, and the ability of various ARPT team members. She was determined to redress the resource imbalance which had been in ARPT's favor and, in so doig, became a rallying figure for others critical of ARPT, most of whom were based at the Central Research Station.

1986-1987 - Consolidation of ARPT/CSRT Interaction. From the end of 1985 to the present, much effort has been made, especially by ARPT scientists, to improve interactions between ARPT and CSRT scientists. There is now a generally positive attitude towards improving interaction.

LEVEL OF INTERACTION BETWEEN ARPT AND CSRT SCIENTISTS

The study team assessed the level of the interaction between ARPT and CSRT scientists between moderate to good. However, the level of interaction and collaboration between ARPT and CSRTs has improved considerably in the last couple of years.
In most areas it appears that the level of interaction has increased over time.
The Director of Agriculture thought that ARPT had helped most scientists in the research branch to have a better understanding of the problems of small-scale farmers. He considers that ARPT helps to integrate the work of all the CSRTs, because it cuts across the work of all of them.
At the conclusion of the 1986 Commodity Research Review meetings, there was a general feeling among ARPT scientists that ARPT was being treated as an equal with CSRTs, which had previously not been the case.

The findings of the survey of functions showed that scientists in the research branch consider ARPT-CSRT interaction to be of highest priority.
However, in practice, it was considered by both groups, to have been the least well performed function.

EFFECTIVENESS OF INTERACTION BETWEEN ARPT AND CSRT SCIENTISTS

The qualitative assessment of interactions is based on information collected during interviews with 16 CSRT scientists and 13 ARPT scientists in the three provincial case studies. By type of interaction it revealed:

1. Participation by SCRT Scientists in Surveys

There has been very little participation by CSRT scientists in ARPT surveys. Evidence could only be found of a few occasions when scientists from seven CSRTs participated in surveys conducted in four provinces. Nonetheless, this involvement was considered to have been useful by the ARPT scientists.

2. Collaborative ARPT-CSRT Trials

All the provincial ARPTs have, in recent years, collaborated with 10 CSRTs in conducting trials of mutual interest. The initiave for these collaborative trials has been taken by both teams, and responsibility for management has varied although, in the majority of cases, it has rested with ARPT. The joint discussions, visits, and assessments of these trials have been extremely valuable in breaking down barriers between the scientists. The experience with collaborative trials has generally been very successful, with both sections gaining not only knowledge from the specific trial, but also having a better understanding of the other teams' work.

3. Visits to Trials

Fourteen of the 16 CSRT scientists interviewed, said that they had visited ARPT trials, although four of these said that they had seen only the ARPT trials conducted at research stations. The ARPT scientists consider that informal discussions in the field, at and between trial sites, are extremely valuable opportunities for interaction. A smaller proportion of CSRT scientists made the same comment. The Senior Maize breeder, at one time, had been highly critical of the work of ARPT in Luapula Province, but after became very enthusiastic about the team's work

4. Reviewing Results and Setting Research Priorities

All CSRT scientists interviewed said that they had been consulted, in one way or another, by ARPT scientists about the content of trials. There have been several important occasions when ARPT and CSRT scientists have been able to come together to review each season's trial results and to plan their research programs. Most of the scientists interviewed considered that informal interaction, such as casual conversations and correspondence, have been as important as formal occasions. The informal interaction has, by definition, depended on the motivation and interest of individuals. They have suited the 'loner' operating style of some individuals, but have not been so

effective as part of a systematic team activity, in which everyone knows what is going on.

There have been several important formal occasions for interaction, including:
- ARPT Provincial Committee meetings,
- Commodity Research Team Review meetings,
- Research Committee meetings.

The Commodity Research Team Review meetings, established in 1984, are considered to be the most important. Although these meetings have taken place for the last few years, there is no reason why they should not have remained simply 'talking shops'. There is no effective regulatory mechanism to ensure that the decisions taken at these meetings are implemented. In this sense, the process of setting research priorities is quite flexible. In spite of this, it appears that these meetings and discussions have not been simply formal occasions. Both ARPT and CSRT scientists consider that they can and, in some cases, have already benefitted from such interaction. Fifteen CSRT scientists said that they thought ARPT has had, or should have, a role to play in helping to plan CSRT research programs, by feeding back information about farmers' problems. Six of the CSRT scientists were able to give examples of how information from ARPT through reports and discussions, have helped them to set priorities or design trials.

There are also several provincial ARPTs which have confirmed that various CSRT research priorities are already addressing important problems. These include priorities such as the need for a range of short-duration maize varieties, acid-tolerant sorghum varieties, and the development of upland rice varieties.
The list is still small, in comparison with the size of the total research programs, and much more could be done, but it reflects an increasing willingness among CSRT scientists to consider problems and proposals from ARPT. Considerable interest has also been shown by ARPT scientists in the latest information from the CSRT scientists, in particular concerning new varieties for on-farm trials. Such interest is not surprising, given that ARPT is completely dependent on the CSRTs for all new technology.

5) Exchange of Data and Reports

All the CSRT scientists said that they had seen some ARPT reports, and most had seen that ARPT annual reports. However, nine said that they had not seen any survey reports, although most expressed an interest in them. Most CSRT scientists said that they were primarily interested in receiving reports containing agronomic data about farmers' practices. Dissatisfaction was expressed by several CSRTs about receiving insufficient data from ARPT about the production constraints faced by farmers growing their particular crops. Several teams, such as groundnuts, sunflower, and soybean, have gone ahead and undertaken their own surveys to collect such data. The problem appears, in large part, to be that an insufficient number of copies of reports are being distributed by ARPT, and then they are not being circulated among CSRT members. There has been minimal discussion of the data required by CSRTs, although the issue has been raised several times with different CSRTs.

Consequently, there is little evidence that CSRT scientists have used ARPT reports in helping to determine their research priorities. It seems, therefore, that most ARPT information has been transmitted verbally to the CSRTs.
ARPT scientists have also had some problems in obtaining the results of previous CSRT trials, which is why ARPT initiated a research data base study.

6. Miscellaneous Mechanisms for Collaboration

Several other opportunities or mechanisms have been useful for ARPT and CSRT scientists to work together. These include:
- conducting analyses, e.g., soil, oil content etc.;
- collection of germplasm and provision of planting material;
- revision of research recommendations;
- involvement in variety release;
- assignment of one CSRT scientist to liaise with ARPT;
- job description, including the need for interaction;
- research services, e.g., loaning equipment, transporting, trial requisites.

FACTORS AFFECTING THE INTERACTION BETWEEN ARPT AND SCRT SCIENTISTS

Many factors have contributed to the effectiveness of the interactions between ARPT and CSRT scientists.

1. Lack of Technologies Available for Testing from CSRTs

There have been several CSRTs which, until the last two or three years, have had few technologies which

they considered to be ready for on-farm testing by ARPT. This was the case with various varieties and still is the case with much farm equipment. Several CSRT scientists interviewed considered that at first they did not make much effort to interact with ARPT because they thought it had nothing to offer, whereas more recently, as new varieties have been released, they have had a lot more reason to interact. In those cases where the CSRTs have been weak, the ARPT scientists have been faced with the choice of either addressing less important problems areas or doing some of the CSRT research themselves. When they have tried to do some of the research themselves, for example, testing a new jab planter with farmers, they have sometimes run into great difficulties and had no specialist team to turn to. Alternatively, when they have done the research on station, they have sometimes been accused by CSRTs of doing too much station research.

2. **Resource Allocation to CSRTs**
Lack of human and financial resources has limited the ability of several CSRTs to rapidly develop technologies which could be taken for on-farm tests by ARPT. Interactions between ARPT and CSRTs have increased considerably, once the CSRTs have technologies ready for on-farm testing. The lack of resources has also severely restricted the ability of CSRT scientists to travel to the provinces and meet ARPT scientists.

3. **CSRT Scientists View of ARPTs Functions**
The majority of the CSRT scientists interviewed considered ARPT's primary role to be on-farm testing of technology developed by the CSRTs. Fourteen of them saw the secondary role to be providing feedback to the CSRTs about farmers' problems and about the performance of technology when tested under farmers' conditions. The importance given to the technology testing role indicates that the CSRTs are primarily concerned to interact with ARPT to ensure that the technologies they have developed are taken to as many farmers as soon as possible. Interaction with ARPT has indeed increased when CSRTs have had material that they would like ARPT to test in on-farm trials. This may eventually lead to a clash of priorities between those of the farmers in a particular system and the priority to test CSRT material.

4. **Proximity of ARPT and CSRT Scientists**
The majority of CSRT scientists interviewed had had most frequent contact with those ARPT scientists based at the same research stations as themselves. Understandably, most of this form of interaction has been informal in nature. When the ARPT national coordinator changed offices, from MAWD headquarters to the Central Research Station, he had more opportunities for informal contact with CSRT scientists. For ARPT and CSRT scientists based at different research stations communication has been a serious problem.

5. **ARPT Organizational Structure**
Virtually all the CSRT scientists interviewed considered the present structure of ARPT, as a separate section, to be the most appropriate because it has a whole-farm, rather than a commodity, focus. In this way it has been able to work with all CSRTs, without bias for any particular crop. Some CSRT scientists said that if the functions had been incorporated into the CSRTs, there would have been too much work, and it would have been impossible to supervise the on-farm trials.

6. **Influence of Donor Project Organizations**
The structure of donor projects has sometimes helped interaction between ARPT and CSRT scientists, e.g. when the project has supported scientists in both teams. Project documents and scientists' job descriptions have sometimes spelled out that project members must interact, and project evaluations have focused on the level of such interaction. Projects have also created a number of formal and informal occasions for interaction. The main danger with such donor project influence has been that the interaction between ARPT and CSRT scientists has tended to be largely restricted to interaction between project members.

7. **Improved Opportunities for Interaction**
Since ARPT was established, several formal mechanisms have been created for facilitating interaction between ARPT and CSRT scientists. These were described in detail above, but they include:
   - Commodity Research Review meetings (held prior to the main public Research Committee meetings);
   - CSRT field visits, which have been arranged each year to every province where ARPT has been working.

8. **The Role of Senior Research Managers**
In the last two years CARO has been very supportive of the idea that ARPT and CSRT scientists should be interacting with each other. CARO has occasionally issued directives that CSRT scientists must participate in the field visits to provincial ARPTs, as

well as organize Commodity Research Review meetings, to which ARPT should be invited.

9. Trial Outlines

The process of preparing a trial outline for each trial has encouraged ARPT agronomists to make more thorough literature reviews and to approach CSRT scientists for information. Circulation of the draft trial outlines to CSRT scientists has given them an opportunity to comment on the treatments and design of ARPT's trial program. However, few CSRT scientists have made comments on the trial outlines circulated.

10. Recommendation Release Procedure

The procedure for revising research recommendations has been very ambiguous. Consequently, it has been possible for ARPT, and virtually any other organization, to be able to revise the research recommendations. However, the ambiguity of the procedures has meant that various individuals have sometimes felt that they have been left out or bypassed. It is an area that needs to be streamlined if confusion is to be avoided.

CONCLUSION

Interaction between ARPT and CSRT scientists has improved in recent years and is presently considered to be moderate to good. Interaction has been most successful in reviewing ARPT's results and in planning ARPT's trial program. Several organizational and managerial mechanisms have played important roles in increasing the level of interaction. There is considerable room for improving interaction, and managerial mechanisms can be expected to help bring about this improvement.

OVERVIEW OF AN ISNAR APPROACH TO DEVELOPING GUIDELINES FOR STRENGTHENING THE INTEGRATION OF ON-FARM AND ON-STATION RESEARCH

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In order to present an overview of the approach we are using for the comparative analysis and synthesis of the main findings of the case studies, I intend to give a brief summary of the paper I am in the process of developing to synthesize the relevant lessons from all the case studies on strengthening the link between OFCOR and on-station research.[1] This paper is still very much in the working stage, but I present this overview of the working paper, nevertheless, in order to demonstrate 1) how we intend to analyze the issue of managing the linkage, and 2) how we intend to organize the information in such a way that it will be useful to you as senior research managers.

Our proposal for the ultimate structure of the paper is to:

1) define the nature of the link;
2) draw observations from the case studies on the process of institutionalizing the link;
3) examine the conditions and factors which affect the performance of the link;
4) develop guidelines for management strategies for strengthening collaboration and integration of OFCOR and station-based research.

WHY ARE WE LOOKING AT THE LINK BETWEEN ON-FARM AND EXPERIMENT STATION RESEARCH?

Building an effective link between on-farm client-oriented research and experiment station research is critical for the successful and productive integration of OFCOR within the research system. OFCOR is not effective as an isolated research endeavor; it is a research strategy designed to complement experiment station research, whether disciplinary-, commodity-, or systems-based. The bottom line is that the success of OFCOR depends on the strength of its linkage to on-station research.

Experience has shown, however, that the fact that although the importance of the linkage is recognized in most strategies for institutionalizing OFCOR, the full potential of the collaborative link is seldom actually realized. Our basic argument is that to be effective, the link must be managed -- and usually intensively managed. We cannot expect this collaboration to occur spontaneously. Collaboration must be encouraged and supported. This requires a clear and well-defined management strategy.

WHAT IS THE NATURE OF THE LINK BETWEEN OFCOR AND EXPERIMENT STATION RESEARCH?

The nature of the link can best be understood by looking at the functions that each can perform vis a vis the other partner. The degree to which these functions are performed and the relative balance among them characterizes the nature of the link. Furthermore, the desired emphasis given to specific functions will determine the optimal organizational and managerial arrangements developed to maintain the link.

First we will look at the functions OFCOR can perform in relation to experiment station research. We have identified three principal functions:

1) a service function;
2) an adaptive research function;
3) a feedback function.

OFCOR in its most robust form unites all three functions.

The service function involves on-farm screening, testing, and evaluation of technologies generated by experiment station research. Trials are relatively simple in design, and emphasis is placed on broad-scale coverage, or

multi-locational testing. A demonstration role is often an important secondary objective; the trials are used to expose both extension and farmers to new technologies. The service function has been the dominant role of on-farm research in NARS.

In its service function, on-farm research plays a support role which *supplements* experiment station research. It is a passive role with experiment station research programs determining priorities and "pushing out" selected technologies to be tested on-farm.

The adaptive research function[2] involves the adjustment or adaption of existing technology to a particular set of environmental conditions -- either agro-ecological or socio-economic -- through on-farm research. Through farm-level research, OFCOR identifies problems or opportunities and then "pulls down" technologies or knowledge from experiment station research as the basis for designing potential solutions.[3] In this function, OFCOR has an active research role. OFCOR researchers take the lead in identifying research problems or opportunities, setting priorities, and designing potential solutions.

The feedback function involves providing relevant information from farm-level characterization, diagnosis, and/or adaptive research to the priority-setting, planning, and programming process of station-based research. As the case study experiences demonstrate, this function, although critical, has proved to be the most difficult to institutionalize.

There are two types of feedback.[4] The first -- and most ambitious -- is feedback of information on technical and managerial problems of farmers as an essential input into priority setting within applied experiment station research programs. The objective is to assist these programs to respond to the priority problems and needs of client groups rather than to their specific disciplinary or commondity-determined interests.

A second type of feedback, which is more modest in its objective, focuses on the programming of research, i.e. the annual planning and design of experiments, rather than on priority setting. This type of feedback involves encouraging station-based researchers to systematically take into account the characteristics of farmers' environments in their experimental work. It entails providing information on the farming conditions and management practices of defined groups of farmers so that experiments can be designed to conform more closely to the actual conditions under which farmers operate. This can significantly increase the relevence of applied research and accelerate the process of developing adoptable technology.

We look next at the functions experiment station research can perform in relation to OFCOR. The two principal functions are:

1) an applied research function;
2) a support function.

The applied research function is technology generation. It is the direct complement to OFCOR's adaptive research function. OFCOR is dependent on station-based programs to generate technological alternatives which OFCOR can screen, select and adapt to meet the specific needs and conditions of designated client groups. This interdependence implies the need for a balanced build-up of applied and adaptive research programs within a NARS.

The support function involves experiment station research providing specialized knowledge to OFCOR. Professional input from station-based scientists is potentially valuable to OFCOR at all stages of the research process -- diagnosis, design of possible technological solutions, data analysis and interpretation, redesign, and evaluation. This function is complementary to OFCOR's feedback function; each partner provides specialized knowledge and expertise to the other.

OBSERVATIONS FROM THE CASE STUDIES[4]

At this preliminary stage of the analysis, there are three central observations emerging from the case studies. First, the adaptive research function has been the most successfully implemented. Second, although its relative importance varies among OFCOR situations, the service function is generally perceived to be a responsibility of OFCOR. It is the function of OFCOR which is most desired by OSR, but is not always taken up by OFCOR researchers, who often see it as the least desirable. Third, the feedback and support functions have been the least fully implemented.

It is not suprising that the feedback and support functions have been the most difficult to implement. Both depend heavily on collabration and interactions. Because of this, they bring about changes in researchers' work programs, responsibilities, and decision-making autonomy. Moreover, because these functions entail influencing the research agenda of other scientific programs, they can provoke conflicts of interests, power

and scientific judgement. And, finally, the benefits from collaboration are often greater for the institution than for the individuals, and are somewhat intangible and long-term in nature. In contrast, the additional demands made on researchers' time and scarce resources are often perceived as personal costs which are concrete and immediate in nature.

Research leaders must recognize that collaboration is not without costs, and that these costs will rarely be voluntarily assumed by researchers. The conclusion is that if these functions are to be fully implemented, research managers must develop a management strategy which defines a clear institutional policy and appropriate organizational and managerial mechanisms for collaboration.

DESIGNING A MANAGEMENT STRATEGY

Our job in this study is, therefore, to draw on the case studies to develop guidelines which research managers can use in designing a management strategy for strengthening this link that is appropriate to their particular institutional setting.

As a first step towards developing guidelines for designing a management strategy, we reviewed the case studies, asking the question: Under what conditions is the link most productive? Or, said another way, on what conditions does the effective performance of the link depend?

In analyzing the key factors determining the quality of this link, we have assumed the perspective of a senior research manager striving to strengthen this linkage in his/her research institute. The research manager operates within an institutional environment in which some conditions are inflexible parameters and others are under his/her control. Accordingly, when developing a strategy for managing this link, the two types of conditions which have to be taken into consideration are:

those *conditions which define* the decision-making environment of the senior research manager;

those *conditions which can be developed* by the senior research manager in order to strengthen the collaborative link between OFCOR and experiment station research.

CONDITIONS WHICH DEFINE THE DECISION-MAKING ENVIRONMENT OF THE RESEARCH MANAGER

These conditions determine the institutional environment of the research manager. He/she has little or no ability to change these conditions. They must be recognized as the basic structural constraints and opportunities under which realistic objectives are to be set and a management strategy for strengthening the link devised. They will affect both the nature of the link and the degree of institutionalization that is ultimately feasible.

Let me briefly review the conditions we have identified as important environmental determinants:

- *Institutional stability* of the NARS. Frequent turnover of senior research managers disrupts institutional policy making, priority setting, and planning in NARS, and is particularly problematic for non-traditional research such as OFCOR.

- *Commitment of senior research managers to OFCOR*. Senior research managers can strongly influence the quality of the link through the research policy they formally or informally set within the institution.

- *Financial resource base of the NARS*. The potential for conflicts between OFCOR and station-based research increases substantially in situations of scarce resources and strong competition for funds.

- *Human resource base of the NARS*. The number and type of staff available for deployment in OFCOR is a key factor influencing the options available for introducing or building OFCOR capacity within a NARS, as well as the rational division of responsibilities and labor between OFCOR and station-based research.

- *Current organization of research*. Whether station-based research is organized by commodity programs, disciplinary departments, or regional research stations will have an important bearing on the nature of its link with OFCOR, as well as the organizational and managerial arrangements required for strengthening the link.

- *Maturity and capacity of station-based research*. This affects the amount of "technology on the shelf" available for OFCOR to draw on for adaptive research. It can also affect the degree to which scientists in applied research programs perceive a need

for OFCOR and are receptive to feedback from on-farm research.

- *On-farm research antecedents.* The tradition of on-farm research within the NARS will affect the manner in which OFCOR is perceived by experiment station scientists, both in terms of its validity as a research strategy and its appropriate role within research.

- *Development policy* [1]. The degree to which national development policy supports the objective of channeling assistance to resource-poor farmers can have an important impact on the priority accorded to this client group in research policy and, hence, the priority given to OFCOR within a NARS.

- *Capacity of extension.* The size and competence of the extention service can significantly influence the degree to which OFCOR emphasizes, or is expected to emphasize, the service function in terms of testing and demonstration of technology.

- *Degree of centralization in research infrastructure.* Highly centralized systems will be more dependent on on-farm research to achieve necessary agro-ecological coverage. This will influence the relative emphasis given to OFCOR functions and the relative weight of OFCOR within the research system. A highly centralized system entails higher communication costs in integrating OFR and station based research.

- *Agroecological complexity.* The degree of agroecological complexity and diversity is an important factor determining the relative importance of the adaptive research and feedback functions of OFCOR within the research process.

([1] Conditions which could potentially be altered by senior research managers over the long term.)

ROOM TO MANEUVER

The environmental conditions outlined above define the parameters of what is potentially feasible for strengthening collaboration. But as you all know well, within any institutional environment there is always room to maneuver. The challange for the research manager is, thus, to identify where she or he has room to maneuver and then to develop a management strategy which is, on the one hand, realistic given the institutional environment of constraints and opportunities, but at the same time goes as far as possible towards developing a positive environment for collaboration. Although the ideal can rarely be achieved, the objective is to exploit to the fullest degree possible the potential that *does* exist for strengthening the link.

In our approach to developing guidelines for designing management strategies, we have synthesized from the case studies those institutional conditions under which the link functions most productively and effectively *and* which can be influenced by the research manager.

We have identified seven basic conditions which need to be developed by the senior research manager in order to strengthen the collaborative link between OFCOR and experiment station research. Achievement of these conditions can be viewed as the central objectives for any management strategy designed to strengthen this link:

1) *Researchers working in OFCOR and experiment station research share an applied, farmer-oriented perspective toward agricultural research.* OSR and OFCOR researchers share a common mission. The objective is to develop technologies appropriate for designated client groups. This involves researchers sharing a common set of objectives, common perceptions of the primary constraints to agricultural development, and a common understanding of the clients of research.

2) *Researchers in OFCOR and experiment station research agree on the functions that each should perform for the purposes of collaboration.* Successful collaboration depends on a clear division of labor and responsibility. Research managers need to work closely with the OFCOR and station-based staff to develop a consensus on the appropriate functions and services that each should provide.

3) *Researchers in OFCOR and experiment station research share a common understanding that OFCOR is a complemetary, not a competing, strategy for research.* It is important that each of the partners is seen to enhance the productivity of the other. The relationships are consultative, not supervisory, and the domains of authority are defined. Potential for conflicts is exacerbated if OFCOR is viewed by station-based researchers as competing for and capturing resources.

4) *OFCOR has scientific credibility among station-based researchers.* This is essential if linkage functions are to be successfully performed, particularly with respect to the adaptive research and feedback functions which depend heavily on collegial interaction. Scientific credibility involves the capacity

of the OFCOR researchers in both absolute and relative terms, as well as the degree to which station-based researchers view OFCOR methodology, modes of analysis, and criteria for evalution as legitimate.

5) *Scientists perceive the benefits from collaboration to outweigh the personal costs.* Because participation in collaborative research requires changes in objectives and activities, it is not without costs for the scientists involved. It must therefore be made attractive to scientists through material, professional, and intellectual incentives and rewards.

6) *Sufficient human and financial resources are available to support cooperative and collaborative activities.* The activities which link OFCOR and experiment station research require money and person hours which are not automatically available. Resources must be formally allocated for collaborative activities.

7) *Adequate opportunities exist for formal and informal interaction.* The exchange of information and specialized advice depends on formal and informal interaction. This requires some combination of institutional, organizational, and locational proximity for potential collaboration.

The next step in our approach is to deliniate the key policy, organizational, and managerial factors determining these conditions. That is, what are the factors which a research manager must take into account when she or he, given the constraints and opportunities established by the environmental factors, goes about designing a strategy for promoting these conditions?

The third step is the identification of mechanisms that can be employed to manipulate those factors, and so to develop the conditions required for effective collaboration. The mechanisms emerging from the case studies which have been effectively employed by research managers for strengthening this link can be divided into three types which are basic to any strategy for managing collaboration:

1) mechanisms to create *incentives* which stimulate and reward collaboration;
2) mechanisms to mobilize *resources* to support communication, coordination, and collaborative activities;
3) mechanisms to provide *opportunities* for formal and informal interaction.

AN EXAMPLE OF THE APPROACH FOR DEVELOPING MANAGEMENT GUIDELINES

Let me close this presentation by illustrating our approach to developing guidelines for effectively managing the link between OFCOR and OSR. Let's look more closely at one of the conditions necessary for a productive link: the scientific credibility of OFCOR with on-station researchers.

As I said earlier, the case studies indicate that it is essential that OFCOR researchers have scientific credibility among station-based reseachers if the linkage functions are to be successfully perfomed. This is particularly true with respect to the adaptive research and feedback functions, which depend heavily on collegial interaction.

This appears to be common sense, but in reviewing OFCOR-OSR experiences, the issue of poor scientific credibility occurs repeatedly. Moreover, it is a factor which cuts across most of the other conditions we have identified as conducive to successful collaboration. It is undoubtedly a priority management issue in strengthening collaboration between OFCOR and station-based research.

Several key factors are involved in establishing the scientific credibility of OFCOR researchers in the eyes of on-station scientists:

1) *The competence of the OFCOR researchers,* both in absolute and relative terms. OFCOR must be staffed by solid and experienced researchers who can interact with station-based scientists as colleagues of equivalent status.

2) *The scientific quality of OFCOR research.* This obviously depends in part on the general research capacity of the OFCOR staff. But it also depends on the degree to which thay have developed the specialized skills required for OFCOR.

3) *The degree to which station-based researchers view OFCOR methodology, modes of analysis, and criteria for evaluation as legitimate.* This issue refers to the common problem of the high coefficients of variation in on-farm trials as compared with station-based trials. It also relates to the degree to which social science analysis is understood and respected within the research institution, as well as the degree to which OFCOR social scientists understand agricultural

science and research methods and can communicate effectively with station-based scientists.

4) *The degree to which OFCOR scientists can demonstrate complementary expertise as specialists who understand real farming conditions and farmers' priority problems and needs.* If OFCOR is designed as a complementary research strategy, then OFCOR researchers need to demonstrate complementary areas of expertise. Because their principal area of strength should be the development of understanding of farm-level constraints and opportunities for research, OFCOR researchers who remain distant from farmers and rely on technicians to implement the OFR, can lose credibility among station-based scientists.

Some mechanisms for influencing these factors, and therefore for enhancing scientific credibility, have emerged from the case studies:

- *Build the OFCOR effort at a speed which allows OFCOR researchers to consolidate expertise and improve their skills.*

- *Provide specialized training to OFCOR staff.* This will help ensure a higher quality of OFCOR research and will develop expertise which is complementary to on-station research.

- *Create opportunities for OFCOR practitioners to demonstrate their capacity.* For example, encouraging OFCOR researchers to conduct some on-station trials has helped on-station scientists recognize OFCOR scientists as colleagues of equivalent status.

- *Tailor the presentation of OFCOR research results more directly to the needs of on-station scientists.* This has been effective in demonstrating the complementary role of OFCOR, as well as the expertise of OFCOR scientists in agricultural research and development.

- *Promote opportunities for on-station scientists to learn about the OFCOR approach.* Mechanisms such as joint field visits, direct participation of OSR researchers in the OFCOR research process, or workshops on OFCOR methods or research findings have increased the degree to which station-based researchers view the OFCOR approach as legitimate.

- *Ensure strong scientific leadership for OFCOR.* This is essential for maintaining the quality of OFCOR research and for building a sound and well-focused program.

- *Promote good trial management.* Trial clustering, for example, has been used to improve trial management in order to ensure reliable results.

- *Ensure timely analysis and presentation of data.* Making OFCOR data readily available to station-based researchers ensures more opportunity for OFCOR practitioners to demonstrate scientific credibility.

- *Generating opportunities for OFCOR practitioners to keep abreast of OSR* has helped OFCOR researchers design work to take advantage of "technology on the shelf" and available specialized advice, increasing the relevance of the research to OSR.

SUMMARY OF THE CONCEPTUAL FRAMEWORK

Having illustrated the framework we are using to develop guidelines for the design of a management strategy, I will conclude by quickly summarizing that framework.

Conditions

Certain conditions appear to facilitate the effective integration of on-farm and on-station research. These conditions can be seen as the strategic objectives of the research manager.

Factors

Key policy, organizational, and managerial factors determine these conditions. These factors must be taken into account when devising a strategy for fostering these conditions.

Mechanisms

The case studies indicate some of the mechanisms which have been effectively employed by research managers to manipulate the key factors in order to develop the conditions required for effective collaboration. We need to synthesize their experiences in using various management mechanisms.

MANAGEMENT STRATEGY

These are the basic steps we are taking to develop guidelines for advising research managers on designing effective management strategies -- particular to their institutional settings -- which fully exploit their room to maneuver for strengthening the collaboration between OFCOR and experiment station research.

FOOTNOTES

1) Deborah Merrill-Sands and Jean McAllister, "Strengthening the Link Between On-Farm and Experiment Station Research: Lessons Emerging from Nine Country Case Studies." A draft of this paper was presented to the Second Study Workshop on Organization and Management of On-Farm Research in NARS, 31 August - 4 September 1987, The Hague, Netherlands.

2) In this paper we use the CGIAR definitions for applied and adaptive research:
   - applied research = that designed to create new technology;
   - adaptive research = that designed to adjust technology to the specific needs of a particular set of environmental conditions.

3) This is the definition of OFCOR adaptive research put forth by Collinson. He introduced the idea of OFCOR "pulling down" technologies. Citation: Collinson, M. P., Senior Agricultural Administrators Networkshop on Farm Research, Lesotho, 25-28 November 1985, Briefings for the Program, Tuesday, 26 November. CIMMYT/E.S.A. Regional Programme, September 1985.

4) This is a distinction put forth by Baker and Norman. D.C. Baker and D.W. Norman, "A Framework for Assessing Farming System Activities in National Settings in West Africa: With Special Reference to Senegal and Nigeria." Paper presented at the West African Farming Systems Research Networkshop, Dakar, Senegal, 11-14 March 1986.

OFCOR CASE STUDIES

The analysis is based on the following case studies, all of which are in draft form, but will be published by ISNAR in 1988.

- The Evolution and Significance of On-Farm and Farming Systems Research in BARI
  M.A. Jabbar
  M.D. Zainul Abedin

- The Organization and Management of the Adaptive Research Planning Team: Zambia
  Stuart A. Kean
  Lingston P. Singogo

- Organization and Management of On-Farm Research in Nepal
  Badri Nath Kayastha
  Sudarshan Bhakta Mathema
  Brahma Ram Bhakta Mathema

- Organización y Manejo de Programa de Investigación en Finca de Productores: Panama
  Miguel Cuellar M.

- Organización y Manejo de Programa de Investigacion en Finca de Productores: Ecuador
  Romulo Soliz V.
  Patricio Espinosa
  Victor Hugo Cardoso

- The Zimbabwe Case Study : The Organization and Management of Five On-Farm Research Programs in the Department of Research and Specialist Services
  Marcelino Avila
  Ephrim E. Whingwiri
  Bright C. Mombeshora

- Organización y Manejo de la Investigación en Finca en Guatemala
  Sergio Ruano
  Astolfo Fumagalli

- Organisation et Gestion de la Recherche sur les Systèmes de Production au Sénégal
  J. Faye
  J. Bingen

- Study on Management and Organization of On-Farm Research in Indonesia
  The Agency for Agricultural Research & Development
  Ministry of Agriculture

RESEARCH-TECHNOLOGY TRANSFER LINKAGES

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ISNAR'S RESEARCH-TECHNOLOGY TRANSFER LINKAGE STUDY

Last year at this meeting many participants expressed the hope that ISNAR would pay more attention to helping NARS improve their coordination with technology transfer institutions in order to increase: (a) the relevance of their research efforts and (b) the transfer of the technologies they produce. They stressed that unless significant improvements were made in this area it would be impossible to rapidly increase the incorporation of new technological innovations into agricultural practice. In response to that request, ISNAR has recently initiated a three-year international comparative study of the linkage problem.

This study is designed to advance our current understanding of the key factors affecting the effectiveness and efficiency of the linkages between agricultural research and technology transfer, develop diagnostic tools to help identify linkage problems, and provide new approaches to overcoming these weaknesses. These tools will be made available to NARS managers, policymakers, and donor institutions through a set of general conclusions and guidelines, support missions on this topic and, eventually, a series of training materials for our courses and seminars.

During the first year of the study, emphasis will be placed on reviewing the existing literature and coordinating the preparation of a series of 'issues papers' which present innovative approaches to the linkage problem. The second year will be focused on the elaboration of in-depth case studies of the research-technology transfer linkages in at least six countries in Africa, Asia, and Latin America. These studies will be carried out by national researchers, in collaboration with ISNAR staff. The third year will be devoted to integrating these different materials and producing a set of concrete applicable tools. A summary conference will also be held to discuss the project's findings with research and technology transfer managers and donors.

At present the project is still in its initial stages. But even so, I believe it is useful to present a tentative framework for studying linkages in order to get your ideas and feedback. In addition, I would like to make a few general observations which have struck me while going through the literature in the hope of livening the discussion and taking advantage of your collective insights regarding these issues.

Before proceeding, however, let me note that the term 'technology transfer' has been consciously chosen for this project rather than extension. This is to emphasize that: a) technology transfer is not the responsibility of extension alone: private firms, parastatal and non-governmental organizations, producers' associations, individual producers and research institutions themselves all participate in the T.T. system; and b) many extension services carry out a wide range of activities besides technology transfer.

Moreover, even the term 'technology transfer' tends to imply a one-way flow of information. This is not an accurate reflection of the complex interactions and transformations which innovations typically undergo. Unfortunately, however, no readily acceptable alternative terminology is available. As used here, therefore, technology transfer implies a two-way flow.

TWO COMPLEMENTARY WAYS OF LOOOKING AT LINKAGES

The linkages between agricultural research and technology transfer are only one part of a broader agricultural technology management system (ATMS) or agricultural knowledge system (AKS). As such they are

influenced by all the factors affecting the system as a whole. Unless the other components of the system are effective, it is unlikely that the linkages will be. Nevertheless, for the purpose of analysis it is necessary to at least partially abstract from these broader issues and focus specifically on the linkages themselves.

These linkages can be conceptualized as both *institutional* and *functional* relationships. The first refers to any interactions which may exist between research institutions or departments and those charged with technology transfer. These interactions include the division of resources, responsibilities, and power between the two, the existing incentives for collaboration, and all of the different mechanisms that have been created for them to coordinate their activities. The second focuses on particular functions that need to be performed by the system to link technology generation with technology transfer activities, independently of the particular institutional arrangement used to achieve this.

There are three different levels of analysis that are relevant for an institutional analysis: the system, the institution, and the individual. At the system level, goals, activities, power, and resources are distributed between institutions. At this level it is decided which institutions will exist, which tasks will be assigned to them, and how they should interact with one another.

Internally, each institution also has its own structure, allocation of resources, management procedures, and informal dynamic; all of which can directly affect linkage behavior. Ultimately, though, linkage activities are performed by individuals. The behavior of these individuals is influenced by their training, experience, and incentives.
Each of these levels is generally only manipulable by a unique group of people. Policymakers and donors make decisions mostly on a system-wide basis. NARS and technology transfer managers are able to influence institutional factors, and some individual variables. Individual researchers or technology transfer workers can influence the linkages principally through their attitudes, training, and proficiency.

THE FUNCTIONS LINKAGES ARE MEANT TO PERFORM

Looking at the problem from a functional perspective, we abstract from the particular institutions involved and ask what types of activities need to be carried out to bridge technology generation with technology transfer? Seven such functions have been identified:

(1) *Input Feedback.* People involved in technology transfer, who are (or should be) in close contact with farmers, can play a role in expressing the farmers' technological needs to researchers. They can also provide information on how new technologies perform under widespread use in on-farm conditions and producers' reactions to them.

(2) *Testing or Adaptive Research.* Technologies must be adapted to local conditions and the needs of particular types of farmers. In addition, those who are expected to transfer these technologies must become familiar with them and convinced of their utility. Some authors, at least, have argued that the best way to achieve these purposes is to directly involve technology transfer workers in adaptive research.

(3) *Transformation of Research Results.* Before experimental results can be effectively transferred, the domain for which they are relevant must be specified, they must be put in a form technology transfer workers can interpret and producers can use, their economic implications must be analyzed, and certain extrapolations must be made.

(4) *Regulation.* After a technology is generated, and before it is transferred, someone must decide whether it should be transferred. This is the role of regulation. Regulation may take the form of a varieties committee, a pesticide registration decision, or a manual of recommended practices. How it is carried out, however, often has a major impact on the agility of the research-technology transfer relationship.

(5) *Communication of Research Results.* Researchers must transmit the knowledge generated by their research either to technology transfer workers or, in some cases, directly to producers. This can be done through publications, audiovisual materials, field days, informal communication, subject-matter specialists, or group presentations and discussions.

(6) *Training.* One particular way of transmitting research results to technology transfer workers is through training programs. But training also has the broader task of providing researchers and technology transfer workers with the different skills they need to interact effectively. It is primarily this second role I have in mind in defining training as a separate function.

(7) *Services.* Certain technologies are passed from

researchers to technology transfer workers in the form of services such as library and laboratory facilities and the production of improved inputs such as seed, breeding cattle, fertilizer, pesticides, and agricultural machinery. Although these services are not generally included in discussions of research-technology transfer relations, they are a significant point of interaction between the two types of institutions.

The need to perform these linkage functions is more or less common to all agricultural technology systems. How well they are carried out, however, will depend on the institutional considerations mentioned above, the general effectiveness of the institutions involved, and the environment in which the system operates.

LINKAGE PROBLEMS FACED BY AGRICULTURAL RESEARCH MANAGERS

There are many opportunities for things to go wrong. Repeatedly around the world, the linkages between research and extension have been identified as one of the weakest areas of agricultural technology systems.

Moreover, linkage problems are not unique to developing countries, agriculture, or the public sector. We have encountered numerous examples in the literature of similar problems in developed capitalist and socialist countries, in industry and the social sciences, and in large private corporations. In fact, problems in this area appear to be universal and may, indeed, to some extent, be inevitable. What makes the linkage problems particularly severe in public-sector institutions charged with promoting agricultural development in developing nations is the general weakness of these institutions, the great cultural and educational differences which exist between researchers, technology transfer workers, and farmers in these countries, and the urgency of their need to increase agricultural production, particularly among small producers.

The causes of inadequate linkages can be divided into four broad groups: (1) structural and organizational problems; (2) motivational and incentive problems; (3) resource problems; and (4) communications problems.

1. *Structural and Organizational Problems.* It may be that no one has been assigned to carry out one or more of the functions listed above. Perhaps no one is charged with adaptive research, or researchers are not assigned to communicate their research results to technology transfer workers. Or no committee has been set up to allow technology transfer workers to provide feedback regarding the technologies they work with.

   Certain activities may not have been assigned to the most appropriate institution or department. Similarly, problems may arise from separating activities among two or more institutions or, inversely, putting activities, which should be separate, in the same institution. There may be excessive centralization or decentralization. Perhaps no one has sufficient power or authority to ensure that the institutions coordinate their activities or perform their responsibilities.

   Institutional incompatibilities are another structural problem. These include situations in which research is organized nationally but extension by province; research by commodity, extension by region; research with different types of producers; a different time horizon, etc.

2. *Motivational/Incentive Problems.* Institutions, or the individuals within them, may lack motivation or incentives for carrying out linkage functions. They may have little respect for their institutional counterparts. They may want to avoid the loss of institutional autonomy which comes from cooperation. There may be more rewards from publishing their results in international journals than training technology transfer workers. Policymakers may be more interested in having them help win the forthcoming election than in facilitating some technological change whose benefits may come long after they have left office.

3. *Resource Problems.* Even if institutions are well structured and wish to perform the linkage functions, they may lack the resources to do so. There may be no budget for publications, adequate pesticide testing, or visiting the researchers in the provincial capital. They may be so overloaded with tasks that they do not have time to interact.

4. *Communication Problems.* Likewise, even with the best of intentions, researchers and technology transfer workers may find it difficult to communicate. They often have different value systems and ways of conceptualizing the problems. Frequently, they come from distinct backgrounds, have unequal levels of education, and speak different languages (either literally or figuratively).

SOME POSSIBLE SOLUTIONS

Appropriate solutions to these linkage problems will depend on the particular institutional capacities, goals, agrarian structures, and technologies involved in each case. Some problems may even be insoluble. There may be trade-offs or constraints which, at best, will only allow for 'second best' solutions. Some problems are soluble at the individual level, some at the institutional level, and some only by national policymakers. Generally, though, the solutions which get proposed are to some extent implicit in the way the problem is defined. Hence, it is particularly important that our diagnosis be on target.

Some possible solutions to the different linkage problems which have been suggested in the literature are discussed below. They are presented to suggest some of the possible alternatives open to research managers, but in no way do I wish to imply that they are the only possible solutions available for these problems or the optimal ones.

Structural/Organizational Problems. Different activities can be moved from one place on the organigram to another. Research can be placed in the same institution as technology transfer or it can be separated. Liaison departments can be organized in research institutions or in extension. Research institutions can seek new, alternative or additional institutions to transfer the technologies they produce. The commodity, disciplinary, client group, and regional mandates of research and technology transfer institutions can be redefined to make each more compatible with the other.

If the problem is missing functions, the solution may be to assign these activities to individuals and provide them with the resources necessary for carrying them out. A communications or information department may be needed to put research results in an accessible form. Someone can be assigned the task of on-farm adaptive trials. A liaison department or inter-agency committee can be created to provide input and feedback. A seed multiplication program may be required. Researchers or technology transfer workers may be assigned tasks they did not previously have.

Motivational/Incentive and Resource Problems. Positive and negative incentives can be used at both the institutional and individual levels. Additional funds can be made available specifically for achieving certain linkage goals. Linkage activities can be carefully programmed, so that their subsequent fulfillment can be evaluated. Individual job descriptions or institutional mandates can be modified to make it clear what linkage activities are expected. Staff evaluations, promotions, salaries, and prestige can be more closely tied to fulfilling 'linkage' responsibilities. More resources can be provided for the different activities.

Communication Problems. Subject-matter specialists can be hired to translate research findings and make them understandable to field-level extension workers. Staff exchanges and visits between research and technology transfer workers can make each more familiar with the language and values of the other. Training can also be used for this purpose.

SOME ISSUES FOR DISCUSSION

Finally, let me raise a few issues for discussion which have caught my attention as I have reviewed the literature on linkage problems. I believe that these are some of the issues which are currently on the cutting edge of thinking regarding linkages:

1. Are communication channels the problem?

Reading the literature, one is often left with the impression that the principal linkage problem is a lack of an available channel of communication. But is this really the case? Where do motivational, incentive, and resource problems fit in? Perhaps creating coordination mechanisms such as joint committees or programming meetings may not even address the principal underlying linkage problems; especially when mechanisms are created at the request of national policymakers or foreign donors, rather than through the institution's own initivate.

2. Is inter-institutional coordination the weak link?

Similarly, inter-institutional coordination is frequently portrayed as necessarily positive. But this may not always be the case. Efforts at coordination may consume great amounts of time and resources, with only limited results. In certain instances it may be more efficient for institutions to begin their own technology transfer programs or seek new counterparts. Obviously, research institutions need some channel for transferring their technology - but a variety of these may be available. If, on the other hand, research managers conclude that coordination with a particular institution is necessary, what are the implications of this and are they prepared to give up some of their institutional autonomy to make such coordination effective?

3. What implications do extension's non-knowledge transfer activities have for its linkages with research?

Although most discussions of the linkages between research and extension presume that technology transfer is necessarily the primary activity or goal of extension agencies, it is not necessarily the case. Not only do extension agencies often engage in other activities, but these are also frequently of primary concern to policymakers. Among the most important are: selling inputs, supervising credit repayment, enforcing government regulations, providing statistical information, carrying out pest eradication programs using long-established technologies, organizing cooperatives, participating in general community development activities, creating employment for secondary school graduates, supporting political patronage systems, and giving relatively weak national governments a direct presence at the village level. What are the implications of this and why does it continue to be true despite the rising popularity of the Training and Visit extension system, one of whose strongest precepts is that extension should confine itself strictly to knowledge-sharing activities?

4. Is 'professionalizing' extension desirable?

A further common idea is that linkage problems can be solved by professionalizing extension workers through greater training, higher salaries, and better working conditions. It is argued that this will not only motivate them more, but will also enable them to better communicate with researchers.

Again, there are two sides to this argument. Professionalized extension workers may become less willing to continue living and working in the dismal conditions in which most of the developing world's farmers live, less likely to come from a farming background, and less capable of communicating with farmers. Two suggestive studies carried out in Kenya and Taiwan conclude that extensionists with higher degrees do not necessarily perform better. While it is clearly premature to draw any final conclusions on this point, there may well be trade-offs whereby making extension workers able to communicate better with researchers makes them less able to communicate with farmers.

5. Lessons from the past, implications for the future

Finally, I think we should consider the importance of looking at linkage problems historically. Too often solutions are proposed and new programs begun without serious consideration of past experience. Thus, the same mistakes are repeated under different guises and acronyms. To avoid this, each country's search for solutions must give close consideration to its own institutional and technological history. What has worked? What hasn't? Why? If we are willing to look at these experiences critically, we are much more likely to arrive at viable solutions.

THE JORDANIAN EXPERIMENT IN AGRICULTURAL RESEARCH AND EXTENSION LINKAGE: ANALYTIC OVERVIEW

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AGRICULTURE IN JORDAN

Agriculture is virtually the mainstay of the national income of Jordan. At present only 7% of the total area is cultivable. The agricultural production balance is unfavorable, and there are shortages in certain crops, e.g., wheat, barley, dairy products, and red meat, while there are surpluses in vegetables and fruits. Some 50,000 ha are under irrigation, where vegetables and subtropical fruits are produced. The rest of the area is rainfed and produces mainly cereals and fruits like olives and grapes. Rainfall is undependable and irregular, but an increasing amount of ground water is being tapped and utilized.

The main agricultural exports are vegetables and citrus; imports are cereals, feeds, red meat, and dairy products.

The agricultural policy of the government of Jordan is mainly concerned with:

- increased food production;
- development of agricultural products for export;
- generation of rual income and employment;
- conservation of natural agricultural resources and protection of the environment;
- control of land fragmentation;
- support and development of agricultural services like research, extension, plant protection, and animal health.

The Ministry of Agriculture is the major implementor of agricultural policy, but other agencies are involved. To secure maximum coordination between the ministry and the rest, an Agricultural Council has been created, chaired by the Prime Minister. Private farmers are also represented in this council.

RESEARCH AND EXTENSION

Research is the oldest means through which agricultural development was launched in the early 1950s. The main thrust of agricultural research in Jordan was the development of improved wheat and barley varieties. Extension was also established in the early 1950s, but it did not develop into an effective means of agricultural development until the early 1960s. Until 1970 extension covered various rural development activities, of which agriculture was the major field. The administrative organization of extension was along the staff-and-line principle, with subject-matter specialists (SMSs) back-stopping extension agents in the field.

For almost 16 years extension was a separate entity set aside from agricultural research. Linkage between extension and research was achieved by having both departments within the Ministry of Agriculture. Personal contacts were also valuable and not to be ignored. The results of research were funnelled to extension through official channels which required some time and red tape.

In 1970, both departments were merged through a bylaw which created the Department of Agricultural Research and Extension. The technical and administrative functions of the new department were organized through another bylaw in 1973. The merger of extension and research into one central department helped foster agricultural dvelopment by creating better, more effective extension services and more realistic agricultural research.

The outcome of the merger was:

- Extension agents also became agents of agricultural research in the field and among the rural population.
- The cadre of SMSs was beefed up by the researchers and their assistants.

- Development and expansion of training programs for both cadres.
- Research programs were reoriented and made more realistic.
- Better feedback for researchers.
- Access to research facilities - laboratories, library, samples - by the extension agents.
- Audiovisual material available to researchers.
- Better-qualified trainers for the extension agents.
- Extension agents serving as liaison officers for researchers.
- End of isolation of researchers.
- End of academic research and enhancement of applied 'problem- solving' type of research.
- More scientific material for production of extension bulletins.

DEVELOPMENT PROJECTS

The next phase in the development of research and extension linkages came in the mid-1980s. In 1985, two large development projects were launched by the Ministry of Agriculture. Earlier managerial experiences with projects were not complete successes, and the need to foster and expedite the two projects was evident.

The first project was designed with financial help from USAID to support the existing Department of Research and Extension and help build it into a national institution. Accordingly, it was renamed the National Center for Agricultural Research and Transfer of Technology (NCARTT). Research/ extension links were maintained and strengthened.

The second project is the Zarka River Basin Project. Its aim is to safeguard the filling capacity of the lake of the King Talal Dam through soil erosion control and consequent agricultural development.

Implementation of this project depends on two factors: salesmanship and physical structures. A group of young college graduates in agriculture were trained in extension philosophy and methodology to work as extension agents for the project.

DEPARTMENT OF PROJECTS

Leadership and management of the two projects was entrusted to a new department: the Department of Projects. To safeguard this department against red tape and financial constraints, the director of the department was made to report to a steering committee enjoying considerable financial, administrative, and managerial powers. An agricultural development fund with capital of about $10 million was created to finance applied agricultural research and the transfer of technology.

Extension is an integral part of both projects. NCARTT is the generator of agricultural research and the educational organ of the Ministry of Agriculture and its Department of Projects. Research undertakings in NCARTT are back-stopping the extension divisions in both projects.

The new organization of the NCARTT emphasized:
- The institution of research and extension as a national committment.
- 'Transfer of technology' replaced 'Extension' to show the importance of the practical dissemination of improved agricultural technology but did not skip the teaching-learning element.
- The growing importance of stations and regional agricultural centers as vehicles for the process of technology transfer.
- The need to check the fulfillment of the objectives of research and extension through the creation of a monitoring and evaluation unit.
- The establishment of an 'agricultural development fund' to foster and support practical research and extension projects.

The Department of Projects as an organ of the Ministry of Agriculture was created to serve as the guardian of the institution of research and extension in the country.

CHARACTERISTICS OF THE DEPARTMENT OF PROJECTS

The salient features of the newly created Department of Projects (DOP) are:

1. The department is stronger than any other department of the Ministry through the chairmanship of its steering committee by the Minister of Agriculture and the Director of DOP serving as its rapporteur.

2. The steering committee of the Department of Projects has considerable legal powers similar to those of the ministers of Agriculture, Public Works, and Finance. The major reason for this is simply to expedite procedures for personnel, finance, procurement of supplies, and construction. This is also meant to sidestep red tape and bureaucracy.

3. In the former Department of Research and Extension, extension was merged to research, but

with the creation of DOP, extension was also merged with development projects, such as the River Zarka development project.

4. A demarcation line was drawn between the ongoing traditional programs of the Ministry and that of the DOP.

5. The creation of the Agricultural Development Fund (ADF), which is financed jointly by the Jordanian government and USAID, will serve as financier for research and transfer of technology projects, in addition to the existing programs. The ADF capital is deposited as a revolving fund to ensure continuity and duration.

6. It is envisaged by the Ministry of Agriculture that NCARTT will grow and serve the nation by becoming a national entity leading the process of generating agricultural technology and making it available to Jordanian farmers.

7. For the first time extension is in the service of not only research but also agricultural development projects with a focus on physical structures.

8. Linkage between research and extension is not only achieved, but is institutionalized. The same applies to other activities and physical development programs.

CONCLUSION

To sum up, the linkage between extension and agricultural research in Jordan has been developed through the past 30 years in an evolutionary manner. The early stages of rural extension were not a failure but paved the way towards a more definite approach to agriculturally oriented extension.

The transition of extension in the above manner was dictated by the inclination and ability of the Jordanian farmer, the necessity to feed the ever-growing population of Jordan at 3.5% per year, create more income and jobs through exports, and the availability of research results waiting only for the right vehicle for them to be transferred to the farmer.

With the help of the expertise of ISNAR, we are intent on doing the following:

1) evaluate the performance of the former Department of Research and Extension;
2) help the reorganization of the proposed National Center for Agricultural Research and Transfer of Technology so that it meets our expectations.

AGRICULTURAL RESEARCH NETWORKS: AN ANALYTICAL FRAMEWORK

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INTRODUCTION

The institutional factor plays a strategic part in the development of knowledge and technologies in the agricultural sphere. Multidisciplinary contributions, the different sites where research and trials have to be carried out, the differing requirements dictated by environment and transfer to the farmer, etc. mean that since attempts to achieve systematic technolo .cal development in agricultural production began, various patterns of coordination, complementation and integration between institutions have evolved, wi differing degrees of division of labor and cooperation.

These patterns include agricultural research networks, which are showing a constant increase in number. There is a large variety of different arrangements, due both to the natur. of the participants and to their objectives and modes of operation. The resources invested in setting them in motion and keeping them in operation are highly significant, though it is still too early to assess the results and the impact. Therefore, the sustained interest shown in institutional networks for agricultural research requires a conceptual effort that will provide suitable analytical tools for a better understanding of the attributes of the various types of networks, based on the formulation of hypotheses regarding the relationship between their nature, development and effectiveness.

This paper presents some of these hypotheses. It in no way intends to be an inventory of current experiences, nor to set out a conclusive analysis on the basis of the available empirical evidence. Partial information is used to formulate ideas that will throw light on this field of study, make some contributions to enrich the current debate, and provide further tools for the subsequent task of gathering data on experiences and carrying out research and assessment thereon. Finally, its ultimate objective is to produce some propositions that may serve in the decision-making processes of the various agents involved in agricultural research at both the international and local levels.

NETWORK CONCEPTUALIZATION

Nature of the Networks

Various approaches for network conceptualization have been used in the literature[1]. The multiplicity of definitions is due to the complexity and diversity of institutional arrangements referred to by this term.

Since the purpose of this paper is to make analytical contributions for the creation, organization and operation, monitoring and evaluation of inter-institutional mechanisms for systematically seeking the growth of members' scientific and technological capabilities, the analysis refers only to those mechanisms with the following characteristics:
a) they arise from a mutual agreement by the participants; b) there is collaboration and complementation between institutions; c) a central core coordinates contributions and manages overall interactions; d) resources are assigned specifically to totally or partially finance activities; e) members expect to obtain a net benefit from their participation.

That is, these mechanisms transcend their member organizations, and they differ from unscheduled interactions between centers and institutes, however frequent and productive these may be.

Purposes of the Networks

The networks try to fulfill various purposes at the same time[2].
Each one of the participants will have made an individual assessment of the importance of these purposes, but it

would appear that the network will be more effective when appreciations in this respect coincide.

a. **Explicit Purposes**

i. *To increase scientific and technological capability.* The networks are means of increasing the capability of their member institutions in one of the areas of work, from basic research to the transfer of technology. This capability is measured by the skill of their human resources, the information they have access to, the stock of knowledge, materials and infrastructure that makes the research possible, and the management resources available for research and transfer.

ii. *To integrate scientific and technological capabilities.* The networks are mechanisms for horizontal integration and for the articulation of the international research and transfer system. Horizontal cooperation programs provide the possibility of integrating the scientific and technological capabilities of different countries, thus allowing division of labor and resource allocation so that each country's comparative advantages and the concentration of efforts in line with political priorities may be exploited.

Networks are the only means available to small countries to gain access to knowledge that can only be obtained through investments beyond their individual possibilities. Likewise, networks joined by international centers allow access to the results of strategic and applied research.

iii. *To improve the effectiveness of research.* The progress of knowledge is cumulative; each project makes use of the information gathered by other research workers and other institutions. Networks thus allow access to the critical mass necessary for making significant contributions to knowledge, as well as dealing with research problems from a multidisciplinary standpoint and by taking environmental variations into account.

iv. *To increase research productivity.* Networks allow better use to be made of available resources and an increase in research input-output coefficients. Network operation should also result in the improvement of management efficiency and the concentration of efforts.

v. *To facilitate access to research inputs.* Networks make available to their member institutes information, physical facilities, genetic material, guidelines and methodologies for organizing and carrying out research. In this sense, they mean an increase in the resources available to the institutes, even if these do not involve monetary income for members.

vi. *To promote the dissemination of knowledge and the transfer of technologies.* Networks constitute means of facilitating articulation between basic, strategic, applied and adaptive research, as well as testing of technologies in different production systems.

b. **Latent Purposes**

i. *Institutional legitimacy.* In many countries, institutionalization of agricultural research is extremely precarious. There is insufficient political recognition, it is possible that contributions to the growth of agricultural product are not fully appreciated, and there is a lack of understanding with regard to demands for resources, organizational requirements and continuity. Links with similar organizations in other countries, particularly the backing of international centers and foreign or multilateral sponsors, mean winning domestic recognition and legitimacy.

ii. *Program stability.* This greater knowledge and legitimacy allow greater program stability. The external commitments generated by network participation limit the possibilities of institutional authorities and political administrations subjecting research programs to counterproductive fluctuations. This stability appears in two dimensions: a) in the staff allocation to projects belonging to the networks, which assume commitments the institution must honor, and b) in the resources mobilized, since external contributions usually require local complementary actions that must be carried out by virtue of the commitments assumed.

iii. *Additional resources for national systems.* Network membership in many cases involves external resources for the operation of national systems. Although financing is usually for specific purposes, its institutional impact goes beyond the consequences for program stability pointed out in the previous section.

iv. *Exploiting opportunities.* Articulation of a network involves setting up regular communication between participants. This leads to the identification of new opportunities through a better conceptualization of production and research problems, the perception

of new methods for overcoming them, and the identification of previously unperceived alternatives for institutional action.

v. *Synergistic effect.* Although this is a general purpose of all networks at the level of the participants, it also has similar impacts at institute level. Within them occurs a 'demonstration' effect regarding the ways of carrying out and managing research; modes and practices are spread, and the institution 'opens up'.

iv. *Catalytic impact.* Networks provide the opportunity to display scientific and technological potential that is often subject to institutional restrictions and obstacles imposed by the environment. Likewise, they arouse the interest of sponsors, of policy-makers and of users with regard to research results.

Additional Contributions

Networks are means of achieving a double integration: 1) institutional, among national agricultural research institutes, international centers and various other institutions setting up mechanisms for communication, collaboration and joint action, and 2) substantive, facilitating integration between the different stages of research, from basic to adaptive, including the understanding of the problems of transfer and use by the farmer.

Although this paper concentrates on the contributions to the growth of network members' scientific and technological capabilities, we should not lose sight of the level of integration relating to the international system of agricultural technology generation, transfer and utilization. Thus, the impact of network operation goes beyond the simple institutional framework of member organizations, and consideration should be given to contributions to:

- the system of technology generation and development, through better resource allocation, increases in scientific capability, in productivity and in scale economies;

- the system of transfer, by articulating actions and allowing a constant, systematic flow of materials, knowledge and resources;

- the technology usage system, by facilitating the development and dissemination of new technologies. In this sense, it is hoped that institutions that are network members will increase the number and improve the quality of technologies made available to farmers, with consequent impact on production;

- participants in the decision-making processes relating to agricultural development policies, through: 1) information on the prospects and possibilities available, 2) evaluation of the experiences the network has access to, 3) improved knowledge of the problems of technology generation and transfer and 4) evaluation of the impact of political and institutional conditions on farming research.

NETWORK ACTIVITIES

The approach adopted allows us to anticipate that participation in a network should stimulate increased complexity in the activities undertaken, a greater degree of collaboration in members' decision-making processes and a more active role by national systems.

Activities Carried Out

To achieve the aims referred to in the previous section, networks undertake different activities. The following list includes most of them, although it does not attempt to be exhaustive.

Relating to Research Inputs and Outputs

a. Information
   - exchange of information and knowledge of potential use to participants;
   - exchange of information and knowledge relating to programs and projects directed at disciplines, commodities or problem areas;
   - exchange of information on institutional activities and resources;

b. Transfer of methodologies, materials and resources
   - This covers the transfer of genetic material, contributions to methodology and the availability of an infrastructure for research.

c. Training
   - exchange and visits;
   - long and short courses;
   - postgraduate.

d. Technical assistance
   - short- and long-term technical assistance;
   - technical assistance and supervision in project design and execution;
   - institutional technical assistance.

Relating to Research Work

a. Coordinated research
   - identification of common problems;
   - independent project execution;
   - coordination at different stages of the project.

b. Research collaboration
   - distribution of responsibilities within a common program with shared objectives;
   - joint review of the progress of programs and adjustment of projects to common development.

c. Joint research
   - common problems, objectives and methodologies;
   - single or shared management of project implementation.

Distribution of Activities According to Networks

The network's level of complexity derives from the nature of its activities[4]. The activities related to the exchange of research inputs and outputs are the least demanding with regard to the degree of commitment on the part of participants to the need for articulation between them and to the consequent complementarity. These are the least complex activities, in which participants maintain their independence when carrying out their projects.

Networks involving exchanges relating to the implementation of research projects are more complex, since that means identifying common priorities, regular exchange mechanisms for evaluating research progress, and various modes of assistance. In these cases, the exchange of information and materials, training activities and technical support, are usually centered on the specific themes of research carried out on a coordinated or collaborative basis. These are necessary items that contribute to the carrying out of these activities, but not the main focus of the networks.

The exchange of research inputs and outputs lays the foundation for closer collaboration, the identification of common needs, and the coordination of research work. In this sense, the establishment of less complex networks may be the first step towards greater degrees of institutional integration[5].

Integration of Activities

Implementation of each of these activities should follow various organizational and management stages. In this respect, it is possible to distinguish:

- identification of problems and needs;
- definition of priorities;
- selection of objectives;
- drawing up of work plans;
- scheduling of activities and projects;
- implementation;
- monitoring and evaluation;
- transfer of results.

We can conceptualize a developmental path involving a progression towards the incorporation of a larger number of activities with greater integration in the implementation of these functions. This was the case with the Collaborative Potato Program (Programa Colaborativo sobre la Papa - PRECODEPA). Likewise, this is the USAID recommendation for action in Africa[6].

The most precarious networks would appear to be those whose profile shows a heavy concentration on exchange of information, training and materials, along with joint needs identification, definition of priorities and overall task design. Further development of the network would lead to an expansion of this profile. A really integrated system would include joint project implementation, with the participation of all network members, in the various stages of the planning-programming-implementation and evaluation process.

Not all networks must cover the entire length of this path. Some of them are complementary, arising from mutual interest on the part of participants, even though they do not aim to achieve the integration of their research systems. It should be stressed that a fundamental purpose of a network is to increase national systems' capabilities. Its contribution is cumulative and dynamic, but the network can also be conceived as a mechanism whose characteristics remain unchanged as these national capabilities increase.

The Contributions of Each National System

The technology generation process consists of a set of activities that can be classified analytically into basic, strategic, applied and adaptive research. Though the boundaries of these categories are blurred, they serve the purpose of this paper.

It can be argued that a national system's scientific capability is expressed by the distribution of these various research categories in its programs. This capability may differ in each program. A system may have reached maturity in certain commodities or areas of research, while in others its development is slight or non-existent:

- the weakest national programs concentrate their resources on extension, field trials and validation of technologies;
- the more developed programs add adaptive research tasks and technology development to the above;
- basic and strategic research is carried out in some programs by institutions with a high level of scientific capability.

If it is reasonable to consider that local research systems follow a developmental path that moves progressively upwards to more demanding activities, it can be inferred that contributions to the networks will be determined by this capability. That is, the less-developed systems and programs will receive inputs and assistance that will enable them to make progress in field trials and adaptive research. The more-developed systems will join networks with more complex contributions, with their basic interest centered on knowledge generated by the more demanding types of research on resource economy

Network members are usually heterogeneous in their scientific and technological capabilities; so contributions will differ. Exchange flows between network members will thus have different added value for research. In this respect, one objective of the network is to create a capability for the progressive achievement of greater added value in the contributions of each participant, and of increasing homogeneity in their contributions.

Inclusion of National Systems in Networks

The viability of the inclusion of national systems in networks is determined by factors related to: 1) each national system or program's scientific and technological capability, and 2) issues of a political and institutional nature.

Scientific and Technological Capabilities. It has been mentioned that there is a growth path in the development of national systems' capability and that the potential contributions of each network member are determined by that development.

Some extremely important network design problems must be considered:

- Collaborative actions require a high degree of formalized interactions. In conditions of low capability, the scarce resources, uncertainties and problems inherent in project management mean that task implementation interdependence is at a minimum. Each institute could carry out activities without trying to depend on contributions of other members of the network. Exchanges regarding institutional activities and communication relating to research results will be appropriate and viable, whereas division of labor in joint projects seems technically more risky.

- Shared programs, with division of labor in interdependent joint research areas, will be more viable scientifically and technically if greater capability is available. In such cases, making research processes compatible and implementing them jointly will have a greater likelihood of success.

- The organizational and management demands of the more complex networks mean that programs will be incorporated into extremely complex and precise planning, coordination and implementation systems[7].

Political and Institutional Factors. For national systems with less accumulated capability, networks are the only alternative for effective inclusion in the international flow of knowledge. In these cases, the institutional viability of networks will be greater due to the participants' effective strong interest. The division of labor, the move towards greater specialization, the development of comparative advantages and the access to critical masses of research relating to specific commodities or problem areas, may be the only means available to these systems for the growth of their capabilities.

On the other hand, larger national systems with greater accumulated capability may, for reasons of institutional autonomy, be inclined to participate in less complex networks, concentrating on the exchange of information and the coordination of certain activities, but developing and maintaining non-shared capabilities in those programs they consider to be of strong national interest. The change in agricultural technology from being freely available to becoming proprietary may discourage participation in more complex networks with more collaborative and joint components.

CONDITIONS FOR NETWORK SUCCESS

Conditions for Integration

It would appear that setting up networks require certain conditions to ensure their effectiveness[8].

A *differentiation in contributions* occurs:

- when it involves exchange of information, and differentiation is at a minimum. The variation comes

from the content of specific contributions. There is no division of labor, even though ther · may be a multiple, diverse exploitation of each participant's work.

- when the network carries out collaborative actions' either by allocating specific areas of work to each of the participants or by joint execution of research projects. There is a division of labor, which becomes the basis of the network's existence.
  The corollary is that networks made up of national institutes with a similar potential capability and task orientation will find it difficult to consolidate. In this case, it will be necessary to reach agreements on reorganization of national systems' structures and programs in order to achieve some degree of specialization in contributions through the use of comparative advantages.

- A perception of the *usefulness and relevance* of this differentiation. In this respect, the motivation of scientists and managers would appear to be related to the existence of a problem of common interest and the expectation of impact on the institutions. To achieve this, differentiation should allow a better allocation of resources, thus gaining in efficiency through the concentration of activities and the use of comparative advantages, so that concentration will improve scientific and technogical capability through the consolidation of a critical mass of research.
  The result is that the degree of viable division of labor is related to the complementary relationships that may be established. This assumes a differentiation in contributions, but at the same time requires the uneveness in capabilities between participants not to be too great. Otherwise, there would be no mutual advantage, and contributions from the better-consolidated programs would be discouraged.
  However, networks constructed round a strong central organization, as in the case of many of those in which international centers participate, are an exception. In this situation, it is precisely the disparity in scientific capabilities that justifies the network's existence.

- *Resources* for the network's operation. Although participation in the network allows better institutional resource allocation, it also involves expenses. The most impecunious institutes may face very serious difficulties in meeting these costs if they have no external support, at least until sufficient social recognition is generated. These additional resources may serve as initial contributions that will encourage greater local financial commitment. Both external and internal support are necessary if the network is to be viable.

- A *mechanism* through which participants can express their interest and commitment. Here, needs are expressed and priorities defined. The nature of the mechanism varies according to the type of network and the degree of task complexity, and responsibilities are assigned in line with the capabilities of network members[9].

- *Geographical proximity* is important, since it ensures a greater likelihood of convergence of needs, problems and interests, and facilitates network operation.

- *A strong leadership* that will help to organize the network and overcome bureaucratic and institutional inertia.

Conditions of Operation

Some authors state certain conditions whose fulfillment helps to explain the result of network operation[10]:

1. *Focusing of activities.* This involves: a) a clear definition of objectives so they will help in planning, programming and evaluation; b) a greater likelihood of achieving a clear profile of network activities, gaining legitimacy[11].

2. *Internalization of activities within each institution.* Network activities cannot involve a limited group of research workers, but must be of significance for the institution and have the support of its directors and managers. Isolation within the institution of the groups incorporated into the network would seem to make national participation very vulnerable.

3. *Institutionalization of horizontal mechanisms for policy formulation, program design and activities coordination.* Networks are usually difficult to manage due to the number of participants and the diversity of interactions. One condition necessary for it to function is a core of people to deal with logistic and support issues, to centralize and disseminate information, and to help in the coordination between participants. This management capability may be contributed by one of the institutions belonging to the network, as in the case of those built around an international center.

NETWORK ORGANIZATION

Institutionalization of Networks

It is understood that networks are inter-institutional arrangements structured around permanent, shared

objectives. This desire for permanence assumes a self-sustaining process for consolidating links:

- progressively more complex activities;
- actions that mobilize financial, human and material resources in an increasingly coordinated, collaborative and shared fashion;
- financial support for the network, provided by its members in proportionately larger amounts than finance from external sources;
- setting up of permanent network coordination and control bodies, with increasing legitimacy within the different institutes belonging to the network and in the eyes of the other agents that constitute the environment external to the research.

The network is not a static arrangement. Its operation should generate new stimuli at the institutional and inter-institutional levels. It is at the same time a mechanism for the development of scientific and technological capability and a mechanism in development as that capability grows.

Network development can be planned. This is a central issue, both for design and management. Identification of present and future participation, the contribution they anticipate making during the network's life cycle, and expansion of interactions, are matters that shape the network's institutional strategy. In this respect, networks may be open mechanisms, whose growth is limited only by the availability of resources. Closed mechanisms, set up to achieve specific results in a limited period of time, though valuable for the development of agricultural research, lie outside the objectives of this paper.

Organizational Variations in Networks

There are various organizational variations in the network universe. Although the structure adopted should be in line with the nature and activities of the network[12], the way this universe has been created has sometimes meant that organizational models have been reproduced regardless of the nature of the participants and of the institutional strategy.

The Central Core. The alternatives seem to be as follows:

1) a strong central articulating core that gives a radial shape to the interactions within the network;
2) a central coordinating mechanism, consisting of representatives from the institutes involved, with the support of an international institution through which resources are channelled and activity leadership is exercised;
3) a central directing and coordinating mechanism, with the participation of the institutes involved and with an operating secretariat around which programs are structured and managed;
4) the above mechanism can also have technical coordination provided by the member institutes, but whose functions are strictly network-related.

As can be seen, these alternatives assume a shift in the degree of participant commitment, along with their intervention in the decision- making process.

In this respect, different central core functions can be identified:
a) to initiate and convene, b) to structure and be task leader, c) to provide participants with technical support, d) to manage program resources, e) to be the hub of the communications network, f) to coordinate actions, g) to supervise actions, h) to evaluate actions.

The more evenly distributed these functions are among participants, the more decentralized and participative the networks will be. This is an additional criterion for network institutionalization. The more centralized these functions are, the more passive the member participation and the more vulnerable the collaboration achieved. The following section clarifies this observation.

Participation by National Institutes. Madamba identifies two ways in which national institutes can develop relationships with international centers: 1) receptive role, and 2) collaborative role; which may in turn give rise to two variations: a) recipient, and b) actor[13].

These modes can be extended to the network relationships established by those institutions that do not occupy a central position. Mode 2 b is the most demanding with regard to scientific and technological capability, and gives rise to less 'hierarchical' and more horizontal relationships. Mode 1 is typical of radial networks with a strong central core. As national programs assume an active collaborative role and the central core is based on local coordinators, so networks will become more decentralized.

Thus, there are various possible situations through combinations of the role assumed by the national institutes and the way the central core is organized. Some of these possibilities fit participants' contributions and capabilities more closely. In this sense, it may be appropriate to propose a dynamic hypothesis with regard to the development of the network's structural pattern. The central core will thus progressively become

increasingly more participative and less directive as its participants' scientific and technological capability grows and they take on a more active role within the network.

NETWORK VARIETIES AND DEVELOPMENT

Network Models

There are several analytical alternatives that could be identified for the construction of network models. Each has advantages and disadvantages. In this paper, networks are classified according to the articulation between their substantive aspects (activities covered and members' contributions), their organizational and management attributes, and their growth strategies. Our choice is based on the potential for generating relevant propositions with regard to the design, characteristics and viability of each resulting type.

For analytical purposes, models can be distinguished as follows:

1. Networks made up basically of national systems with weak scientific and technological capability, belonging to relatively small countries, and based on activities involving limited scientific requirements in terms of knowledge exchanged. These networks require the intervention of some external mechanism to stimulate and support them and become their central core. This central core is often an international center or a multilateral body.

2. Networks consisting of national systems with greater capability, which can carry out more demanding activities as far as the resources mobilized are concerned, going as far as participation in collaborative and joint research. They have a higher degree of internal heterogeneity so that there is a graded and varied transfer process. The benefits of participation are usually not shared equally, some national systems functioning as dynamic factors and providing transfer to the less developed. In these cases, the central core may have characteristics similar to the previous model, but with greater participation by the national systems and horizontal mechanisms being of greater significance.

3. Networks consisting of more-developed national systems and units. The activities around which they are structured are usually more specific, with clearer differentiation between participants' contributions.

These three models are, of course, extreme simplifications of a very varied and complex reality.

It should be stressed that each is an attempt at analysis, the purpose of which is to help in the task of conceptualizing this problem and clarifying the enormous variety of situations. Empirical research will enable one to verify or refute the set of hypotheses that may develop from the models.

Network Development Strategy

The three models identified represent different stages in the capability of the participating systems. This growth path involves several shifts:

- from a radial relationship mode to a central, network-articulating core to horizontal interactions between all participants;
- from the exchange of results of autonomous experiences and research to coordination, shared programming and joint implementation;
- from more decentralized structures to the generation of participative mechanisms;
- from a certain homogeneity of capabilities to increasing development of comparative advantages used in a collaborative fashion.

If the growth path is conceived in this way, a network integration constitutes a strategic way of promoting international scientific and technological capability. Each network should be thought of in terms of its members' development and of its own, leading to progressively more complex levels of complementation and integration of national systems.

This concept of the growth path leads to another important conclusion: the sought-after integration could arise from different strategies. Those that can be conceived in terms of poles would be as follows:

1. Strategies aimed at grouping national research systems so they can jointly identify their problem areas, define common priorities, program their activities, and undertake collaborative actions with a high degree of interdependence. This strategy would seek rapid integration of national systems, thus encouraging division of labor from the outset. It assumes environmental conditions of widely receptive public policies and institutions. In particular, this strategy requires absence of competition between network members in commodity markets and technologies.

2. Incremental strategies, starting from priority

activities for all participants, which consist of partial commitments, require limited resources and have low requirements of public and institutional policies.

Choice of the strategy is the result of a decision by network members. But the network is faced by significant constraints. The degree of development of national systems, regional and ecological peculiarities, and political and institutional conditions, reduce the degree of freedom available for its definition. Network design should be preceded by careful identification and a strict evaluation of these factors.

On the other hand, network integration can be analyzed by reference to the experience of other attempts at integration of policies, activities and resources between countries. These attempts offer sufficient evidence in the sense that overambitious schemes involving a certain amount of 'wishful thinking' and not backed by firm, deep commitments, come up against insuperable obstacles arising from the many interests at stake, the complexity of the integration process, and poor perception of the costs and benefits involved.

The networks that adopt incremental strategies, with specific contributions that expand progressively, help to consolidate the established mechanisms. These mechanisms are also enriched as the participants gradually increase their scientific and technological capability.

The foregoing clarifies some hypotheses presented in previous sections. Regardless of the scientific and technological capability of systems and national progams, strategic reasons may advise a certain gradualism. Networks for the exchange of research inputs and outputs may constitute the first step towards increasing integration of national systems.

Another strategic alternative arises from the tension between 'balanced' and 'non-balanced' approaches:

1. The balanced approaches argue for homogeneous growth of scientific and technological capability in the institutes' various areas of activity. Therefore, networks cover a broad range of activities, seeking a maximum mobilization of the institutes' resources.

2. According to the non-balanced approaches, participation in the network should be specific, concentrating institutional efforts, increasing particular capabilities and, from there, achieving significant internal impact.

The less developed and consolidated national systems are, the greater are their needs for information, training, and technical assistance, and the greater their interest in joining networks following a balanced growth strategy. In these cases, demands for joint identification of priorities and planning of activities will be greater, and it will be more difficult to satisfy the broader issues tackled by the network. Effective use will depend on the quality of these processes and the management capability exhibited during implementation.

On the contrary, systems and programs with greater accumulated capability will tend to be interested in collaborative efforts aimed at resolving specific problems. In this respect, we are faced with a paradox: the greater capability of network members facilitates joint planning, while joint planning makes use of network participation less critical.

Networks and the International Agricultural Research System's Development Strategy

Throughout this paper, networks have been presented as a device for integrating the national system's agricultural research and as a means for developing the capabilities of national systems. It should be borne in mind that as progress is made in both those directions, there must necessarily be a redistribution of the type of activities currently carried out by elements of the system at the overall level.

This is the issue currently under debate on the handing back of functions by the international centers to the national systems. It is to be supposed that, as some of the national systems of developing countries acquire greater capability for carrying out applied research, they will be able to undertake many of the efforts currently falling under the aegis of international centers. With the increasing importance of biotechnoloy for technological innovations, and with the ongoing process of privatization of knowledge, this handing back would seem to require a greater concentration by international centers on strategic research, and greater articulation with basic research institutions.

In this scenario, new networks can develop among the developing countries that have accumulated the greatest scientific and technological capability, processing more complex knowledge and making use of more horizontal organizational structures, with a clear division of labor between problem areas.

The debate on the design of an integrated system of networks within a developmental pattern of its members'

scientific and technological capabilities should be enriched by the results of analyses of technological prospects, and of the legal and economic development of the technology generation, transfer and marketing process.

CONCLUSIONS

This paper has presented tentative conclusions and certain hypotheses regarding the effectiveness and viability of various inter-insitutional arrangements. These are all, in turn, partial illustrations of certain general propositions:

- There is a necessary correspondence between network objectives, their activities, their members' scientific and technological capability, and the organizational structures they adopt.
- Networks are based on the possibility of reaching collaborative agreements based on the division of labor, comparative advantages and complementation. They are attempts at achieving greater national, regional and international integration in agricultural research. The integration strategies should be incremental, non-balanced and aimed at achieving a progressive increase in scientific and technological capabilities.

- Organizational arrangements should be adjusted to the type of activity and the capability of network members. These arrangements should, in turn, vary as this capability grows.

These tentative conclusions do not, of course, exhaust all the issues raised. It has been argued that networks can be visualized as mechanisms for increasing scientific and technological capabilities, which are in turn developed through increased complexity of their activities and progressive integration of the national systems involved, even if this is not a necessary condition for their establishment. Ways of accelerating this growth, as well as the role played therein by various factors relating to the setting of objectives, resource availability, participant commitment and organizational arrangements adopted, should be the subject of further studies based on an analysis of the experience of some typical networks.

NOTES

1. For a review of the organizational literature, see Howard Aldrich and David A. Whetten, 'Organization-sets, action sets and networks: making the most of simplicity', in Paul C. Nystrom and William H. Starbuck, *Handbook of Organizational Design*, Vol. 1, N.Y., Oxford University Press, 1981.

2. An important reference for the treatment of the origins of networks is D.L. Plucknett and N.J.H. Smith, 'Networking in International Agricultural Research', *Science*, Vol. 25, pp. 989-993. For the experience of a particular international center, see D. Winkelmann, *Networking: some impressions from CIMMYT*, paper presented at the First International Meeting on National Systems of Agricultural Research, IFARD, Brasilia, 1986.

3. There seems to be a consensus on this point, as can be gathered from various papers on the subject. Of these, see those quoted by Plucknett and Smith, and Winkelmann. Also, and in particular, C. Valverde and K. Brown, 'Regional Research Networks: The experience of *PRECODEPA*', CIP/ISNAR, 1985.

4. As indicated in another section of the paper, the inter-institutional arrangements known as 'networks' are extraordinally numerous and diverse. Therefore, all attempts at ordering them runs the risk of being objected to, due to the presence of 'special cases' or particular modes adopted in specific circumstances. What is presented here is intended to clarify the problem and draw some generic consequences that have operational relevance.

5. The activities indicated have been used by SPAAR to draw up a network classification:
   - information exchange networks, which organize and facilitate the exchange of ideas and methodologies and the communication of research results (activity 1a);
   - consultation networks, which periodically gather together institute members to share experiences on independent research, thus progressing to a greater degree of coordination (activity 2a);
   - collaborative agricultural research networks, with joint planning, implementation and monitoring (activities 2b and c).

   By way of example, CARIS (Current Agricultural Research Information System) of the FAO, and RAIN (Rainfed Agricultural Information Network) can be placed in the first network category. Networks based on the testing of genetic materials are also included in this category.

   The consultation networks make greater demands on their members. CIMMYT's network on production

systems in Eastern and Southern Africa, and PCCMA in Central America, are of this type.

PANESA (Pasture Network for Eastern and Southern Africa), SACCAR (Southern African Center for Coordination in Agricultural Research), SAFGRAD (Semi-Arid Food Grains Research and Development) and PRECODEPA in Latin America could be included in the third category.

The typology presented is set out in detail in the report of a meeting held from 13 to 15 January 1986, in Belgium. See *Special Program for African Agricultural Research, Report of the Technical Group on Networking.*

6. See Margaret Sarles, *Agricultural Research in Latin America: Towards a Strategy of Institutional Development*, mimeograph, Research Advisory Council, 1985.

7. D. Winkelmann, op.cit.

8. The requirements for successful networking have been gathered, synthesized and enriched by Carlos Valverde. See his paper, *Collaborative Agricultural Research Networks: Network Development Characteristics*. ISNAR, mimeograph.

9. In this respect, Filemon Torres explains a particular way of determining these capabilities and distributing tasks in a network based on experiences in Tropical Africa. See his *Agroforestry Research Networks in Tropical Africa: An Ecozone Approach*, paper presented at the First International Conference on Agricultural Research Systems, Brasilia, September 1986.

10. Besides Carlos Valverde's work, see Plucknett and Smith, op.cit.; D.J. Greenland; E.T. Craswell and M. Dagg, *International Networks and Their Importance in Soil Management*, mimeograph, 1985, SPAAR, *op.cit.*; Valverde and Brown *op.cit.*, FAO, *Cooperative Research Networks in the Near East*, paper presented at the First Meeting of the Near East Regional Commission on Agriculture, Egypt, 1985, and H.G. Zandra, *Canadian Support to Agricultural Research for the Developing World*, paper presented to the CGIAR meeting, Ottowa, May 1986.

11. See Valverde and Brown, *op.cit.*

12. Winkelmann, *(op.cit.)* points out this necessary connection.

13. See J.C. Madamba, *Role and Status of National Research Systems for Agriculture, Forestry and Fisheries in the Asia-Pacific Region and How They May Relate with International Associations*, paper presented at the meeting to constitute APAARI, Thailand, October 1985.

14. The notion of selective leadership is developed by Valverde, *op.cit.*

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CHILE'S EXPERIENCE IN AGRICULTURAL RESEARCH NETWORKS

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Chile

INTRODUCTION

To avoid going too far back in time, this paper refers to developments since the Agricultural Research Institute (INIA) was created in 1964 as an autonomous private corporation, related to the government through the Ministry of Agriculture and mainly financed by public funds.

The Rockefeller Foundation played an important role in INIA's organization. The Institute benefitted greatly from the Foundation's experience in collaborative and joint research activities. Hence, INIA has had a rather large and rich experience in the complex field of networking.

It is difficult to identify all the conceptual implications and make a precise classification of the different types of agricultural research networks. However, the first requirement for networking is that every participating institution must have something to offer. Also, the more developed research institutions are, the more likely they are to get maximum benefits out of them.

NATIONAL NETWORK EXPERIENCE

The following three collaborative and integrative efforts within Chile may not completely fit the network definition discussed in this workshop. Nevertheless, they are an indispensable support to research in agriculture, although their activities may be of a rather tangential nature.

NATIONAL AGRICULTURAL INFORMATION SYSTEM

This system has operated since 1974. The network comprises a coordinating center, based at INIA, and several participating libraries in the agricultural sector, working in a coordinated way in the identification, processing, storage and diffusion of agricultural information.

Also in 1974, the Coordinating Center (INIA's Central Library) was appointed as the liaison center for the worldwide and regional systems AGRIS/AGRINTER.

INIA's Central Library improved the gathering of bibliographical control of documents by use of a computerized data-base in response to an increasing number of requests for information by the users. This improvement was made possible in 1981, thanks to a grant from the International Development Research Centre (IDRC) of Canada to INIA to start the Centro Nacional AGRINTER - CHILE.

There have been many accomplishments in a short time:

- 18,411 bibliographical citations published since 1960 have been recovered and edited in seven volumes as a 'Chilean Agricultural Bibliography'. The last three volumes are already incorporated in the computerized data-bank (BIBA).

- Compatible methods within the network and with other international systems have been adopted (especially those of AGRIS/AGRINTER).

- Retrospective searches and selective distribution of information (SDI) are being used.

The important characteristics of the collaborative effort are:

- It is a national network.

- It has a national coordinating center and acts as a liaison center for international systems.

- It has had international donors for specific projects.

PERMANENT GRADUATE PROGRAM IN AGRICULTURAL AND FORESTRY SCIENCES

Several Agriculture Faculties from Chile and from the Southern Zone of the Inter-American Institute for Cooperation Agriculture (IICA) have been interested in graduate training since the early 1960s.

The first graduate course (genetics and plant breeding) was offered by the Agronomy Faculty of the University of Chile and INIA in 1967. Many others followed.

These activities were institutionalized at the national level in October 1970, when a five-year Operational Agreement was signed by Chilean universities, INIA and IICA, to establish a Permanent Graduate Program (PPG). The agreement was renewed for another five years in 1976. The by-laws, a superior council, and executive committee, a coordinating unit and the academic structure were defined.

The coordinating system was highly effective. IICA provided an assistant coordinator from 1970 to 1979. The national participating institutions had to take over the management and funding. A re-organization of the higher education system in Chile took place in 1980. This change limited the financial support for the coordinating unit and reorientated professional specialization according to market demands. It was thought that the system would collapse, but all universities created graduate study programs. This gave more importance and continuity to the whole system than was initially expected. From 1967 to 1980, 405 students studied for master's degrees. Since 1980, 11 faculties and colleges from 5 universities have been involved in graduate training. The system has persisted, but the coordination is missing.

The important characteristics of this program are:

- The system constitutes a national network.
- It has an initial strong inter-institutional coordination.
- Complementary efforts are made by all participating institutions.
- The original model is exceeded, and agricultural graduate education is institutionalized by all universities.
- Present lack of coordination makes these acitivities less efficient.

WHEAT VARIETY COOPERATIVE TESTING TRIALS

The established objectives for the cooperative testing trials were:

- to determine the agronomic value of new wheat varieties under very different ecologic and management conditions, prior to their acceptance by the National Certification Program;
- to demonstrate that this type of cooperative testing method is efficient and cheap, and could be used as a model for the certification of other crops;
- to stimulate a wider collaboration among plant breeders in using better germplasm and to improve the efficiency of the resources spent on research.

There were four types of participants:
- the Technical Seed Unit of the Servicio Agricola y Ganadero (SAG) of the Ministry of Agriculture, which acts as a coordinating and supervising unit;
- INIA;
- four university experiment stations;
- three private experiment stations.

The methods, locations (about 25 sites), varieties included in each site, seed conditions and treatment, fertilization per site, observations to be taken, harvesting conditions, sampling, inspections and the way the results are to be published were all previously approved by the cooperating entities.

All data had to be sent to the Technical Seed Unit for processing and distribution among the cooperators.

The system has been operating continuously since 1976. Inter-institutional problems arose due to improper use of the generated information for propaganda and commercial purposes by some of the cooperators.

The characteristics of this cooperation are that:
- It is a complex national network including state institutions, universities and private enterprise.
- There is a control and coordinating agency.
- The problems arise by the use of data for unintended purposes.
- Some cooperating entities use the network to legitimate their enterprises.

INTERNATIONAL NETWORK EXPERIENCES

INIA's network experiences at the international level, both regional and worldwide, are more numerous and fruitful. All of these networks originated as inter-institutional agreements. Some will be briefly described, but others will only be referred to for purposes of contract.

COOPERATIVE PROGRAM FOR POTATO RESEARCH (PROCIPA)

PROCIPA was created by an agreement between the National Intitute for Agricultural Technology of Argentina (INTA), the Brazilian Enterprise for Agricultural Research (EMBRAPA), INIA (Chile), the Alberto Boerger Center for Agricultural Research of Uraguay (CIAAB), and the CIP (International Potato Center) in August 1982.

Its basic objective was:

- to create a permanent cooperation system between interested institutions for the generation and exchange of potato production (Solanum tuberosum L.), knowledge and technologies;
- not to substitute for national programs, but to complement and strengthen them.

It has several organizational levels:

- Executive Committee:	One representative from each participating institution.
- Technical Committee:	One representative from each national potato program plus one from CIP.
- Coordination:	Coordinator and Assistant Coordinator.
- Evaluation Committee:	Critical evaluation by groups of experts.
- Cooperative Projects:	A cooperative project based on problems common to all participant countries. Each project is coordinated by one or more institutions with recognized leadership in the subject. At present, Argentina coordinates three projects, Brazil three, Chile two, and Argentina/Brazil one.
- Funding:	CIP finances part of the operational costs of each of the nine projects and the cooperating countries supply the additional resources needed.

This network is a shared program, and its nature is based on a relatively good development of the participating institutions' technological and scientific capabilities.

LATIN AMERICAN MAIZE PROGRAM (LAMP)

This is a cooperative agreement between the Agricultural Research Service (ARS) of the U.S. Department of Agriculture, Chile (INIA) and 10 other countries interested in preserving and developing maize genetic resources for the benefit of all mankind. It was signed in 1986.

The program includes a systematic evaluation of the genetic diversity of maize in order to select better genotypes and make them easily available for the corn breeders of the world. It also considers the regeneration of native maize germplasm in each country.

Organizationally, it has a Program Director, an International Coordinator, and principal Researchers (National Coordinators)

This network has a different organization from that of PROCIPA. It is an international network with a coordinating level. ARS specifically allocates complementary resources to each participating country, and there is an annual joint evaluation meeting.

INTERNATIONAL AGRICULTURAL RESEARCH CENTERS NETWORKS

Chile participates in several of these collaborative efforts. They mostly deal with germplasm exchange and testing.

INIA is the Chilean counterpart institution for several nurseries and yield trials of:

CIMMYT	Wheat, triticale, maize, barley
CIAT	Beans
IRRI/CIAT	Rice
CIMMYT/ICARDA	Barley
CIP	Potatoes
ICRISAT	Chickpeas and lentils
ICARDA	Lentils, barley

Most of these networks probably do not fulfill the conceptual definition of a network, because these nurseries and trials are defined at the Center level, with very little, if any, interaction with the participant institutions.

FAO'S TECHINICAL COOPERATION NETWORKS

INIA participates in two of the technical cooperation networks organized and partially supported by FAO's Regional Office for Latin America and the Caribbean.

Technical Cooperation Network in Food Crop Production. This started as a Cooperative Network on Edible Legumes Production in 1982. The national and sub-regional coordinators decided to include other crops in 1987, changing the network to a Cooperative Network on Food Crop Production.

During 1987, training on beans and vegetables research and production was organized in Brazil, and on tropical roots and tubers in Cuba. Other topics include tomato, cassava, and yam.

The network includes more than 30 participating countries. There are four sub-regional coordinators and an FAO official with the responsibility for the whole region.

Technical Cooperation Network for Post-Harvest Technology for Grains. The Latin American Association for Post-Harvest Technology for Grains (ALAGRAN) was a very effective nucleus for the organization of the National Associations in Argentina, Colombia, Chile, Honduras, Mexico and Uruguay in a network on Post-Harvest. The network includes about 20 countries and undertakes training, workshops and consultations.

Regional Coordination has been assigned to the National Center for Storage Training (CENTREINAR) in Brazil. An FAO regional officer is also responsible foor the network.

COOPERATIVE PROGRAM FOR AGRICULTURAL RESEARCH IN THE SOUTHERN CONE, PROCISUR

Technical exchange and cooperation in agricultural research among the southern countries of Latin America started as an informal activity many years ago. There is no doubt that the IICA/Cono Sur/BID Cooperative Program operated quite successfully from 1980 to 1983, and this was the logical consequence of previous bilateral and multi-lateral exchanges between countries.

PROCISUR, a five-year program, is the second, consolidation stage of the IICA/Cono Sur/BID program and has been in operation since August 1984.

This two-stage program was agreed upon between Argentina, Brazil, Chile, Paraguay, Uruguay and Bolivia.

The program is financed by BID, IICA and the participating countries. IICA is, in addition, the administrating agency and uses its central structure in Costa Rica and the local office in each country.

INIA, as a national institution, has been fully identified with and highly committed to the program. The objectives are well-defined and of common interest to all the coutries. The institutional structure has been very effective. There is a Directive Commission for the program, formed by the agricultural research directors of the six participating countries. It has had appropriate external financial support, and has worked in collaboration with CIMMYT and CIAT.

PROCISUR is the most complex regional network in which Chile has ever participated. The program has had the ability to build solid structural mechanisms in spite of the differences in the scientific and technological capacities of the participating national systems and the many products involved.

The activities foreseen to accomplish the stated objectives are:

a) reciprocal cooperation, through sub-program coordination; annual coordination and technical meetings; seminars and professional exchanges (consultancy, observation and participation in congresses and other events);

b) international consultancy activities directly contracted by the program or through the IARCs;

c) training (in other institutions, short courses, in service training and graduate scholarships).

The ultimate objective of the program is to establish a permanent coordination and support system for reciprocal cooperation and exchange of knowledge about agricultural research through joint and cooperative activities among the participating countries.

This paper has no intention of making a detailed evaluation of PROCISUR. Several have already been done and more precise studies and analyses are expected. However, a few accomplishments must be pointed out, besides all those on training:

- Germplasm exchange has been very successful and has led to the strengthening and creation of several nurseries with the outstanding material of each country, such as:

LACOS	Advanced Wheat Line Nursery of the Southern Cone;
ERCOS	Wheat Variety Yield Trial of the Southern Cone;
ELAR	Latin American Wheat Rust Nursery;
REFCOSUR	Forage Evaluation Network of the Southern Cone, which has recently been implemented.

These activities may be considered as networks 'per se'.

DEVELOPMENT STAGE OF THE NETWORKS

INIA's experience indicates that in network development it is possible to indentify different stages, according to the activities being carried out.

a) *Gestation.* In our experience there is usually a promoter who normally is not a participant.

b) *Acquaintance and Information.* This is the time when the potential participants get together and ask questions of each other, like:

What do they do?
How well do they do it?
What can be obtained?
What can we offer?

It is a stage of informal transfer of information and material, prior to an organizational stage.

c) *Joint study and analysis of common problematic and methodological aspects.* These activities are practically independent of the environment.

d) *Coordinated Research* - PROCISUR
Collaborative Research - PROCIPA

Networks may start at any of these stages, but some of them may have been gone through voluntarily or involuntarily during previous activities.

When PROCIPA started, CIP had already gone through the early stages. On the other hand PROCISUR has been simultaneously going through all of them, but very little, if any, collaborative research is being carried out.

DETERMINING CONDITIONS FOR NETWORK EFFICIENCY

A number of factors seem to affect network efficiency. These include:

1. Homogeneity of the scientific and technological capacity of partipant programs. Owing to the large number of participants in some FAO networks, a common language to speak about the same problem is missing.

2. Clear objectives. In cooperative testing trial networks, what will the results be used for - prestige, efficiency, advertising or other purposes?

3. Clear goals. How many varieties will come out for certification from a cooperative testing trial?

4. Declared interest of the participants. There is usually a balance of what we can offer and what we can obtain.

5. Use of the research results only for the specific purposes of the network.

6. An institutional commitment to provide adequate resources to achieve the network objectives. There are three kinds:
   Financial - external funding, for coordination and execution of additional activities; internal funding, for execution of normal program activities;
   Human - training;
   Physical - facilities and equipment necessary for network activities.

7. Strong direction. Through regular meetings with high-level nacional directors and program coordinators.

8. Permanent training program. This is related to the scientific and technological capacity of national systems.

9. Easy transfer of information, ideas, germplasm.

QUESTIONS

From our experience two unanswered questions arise:

- Why is it easier to implement international than national technical cooperation networks?
- Why are there certain products with practically no networking? For example, horticultural crops (orchards and vegetables), animal production.

FUTURE OF NETWORKS

It is difficult for the ultimate beneficiaries - farmers - to perceive the many advantages of these mechanisms for the improvement of the efficiency of agricultural research, even if they are already using technology generated through networking. Beneficiaries cannot differentiate these technologies from those generated by the national systems. This suggests that we should not expect too much support from farmers.

To ensure the persistency of networks, it is necessary to continuously keep all levels of policy makers well informed, in spite of the often short time they spend in their jobs at the higher level. The Chilean experience shows that it really pays to continuously inform and make policy makers aware that they are also important participants. INIA usually does it at the following levels:

The Board of Directors (INIA); the Agricultural Planning Office (ODEPA); the National Planning Office (ODEPLAN); and the Ministry of Agriculture.

However, consolidation of these networks can only be achieved by full funding of the participant institutions by their countries. The present state of economies of the developing countries suggests that this possibility is rather difficult and remote; therefore, international support for international networks is essential.

MANAGEMENT INFORMATION SYSTEMS AND THEIR USES

Byron Mook
Senior Research Officer
ISNAR

INTRODUCTION AND DEFINITIONS

My presentation this morning will perhaps be a bit different from some of those with which you've been confronted in the first two days of this workshop. My emphasis will be less on the theoretical background to management practices, and more on PRACTICAL approaches to bringing about managerial change. Much of what I'll be talking about is based on work ISNAR has been doing in Indonesia.

Let me begin by saying just a few words about the phrase "Management Information System". These three words often sound a bit scary, I think, mainly because the phrase "MIS" has come to be associated with hi-tech approaches to management and, specifically, with computers. But none of us should be put off. One of the principal messages I hope to leave with you this morning is that we have to separate the idea of an MIS from the tools by which an MIS is implemented. Every one of the organizations represented in this room has some kind of a Management Information System already. It may be paper-and-pencil based and/or, in some cases, it may be be based largely on word-of-mouth. But it is an MIS. Information does exist, it does move (at least a bit), it is managed (more or less), and it is used (to some extent).

As a result, we should try this morning to think, not about the establishment of an MIS in your organization or mine, but rather about the evolution and improvement of the MISs we already have.

To make this point clear - and so that we all have a shared understanding of what we're talking about - let's begin with a simple definition of an MIS. I'd say that the usual MIS includes four main types of information and has four main procedural components. I'll go through these two lists quickly, since I don't want to spend too much time at the beginning on what I fear may seem like somewhat abstract definitions. Perhaps we'll come back to them later.

TYPES OF INFORMATION INCLUDED IN AN MIS

(1) On program content. In agricultural research, what projects are actually being carried out? What are their objectives, where are they taking place, when did they begin, when will they end, and what are their expected outputs?

(2) On personnel. Who is on the payroll? What are their educational and career backgrounds, where are they, and, most important, what projects are they working on?

(3) On finance. How much are different programs and projects actually costing? (As we'll discuss later, one of the big challenges to an MIS - and to one of its spinoffs, a Program Budgeting System - is to allocate the approximately 65% of budget which most research organizations spend on personnel to particular research projects.)

(4) On facilities What buildings and equipment do research organizations have available for carrying out their research programs?

PROCEDURAL COMPONENTS

(1) Information collection. What information exists on the four subjects mentioned above (i.e., program, personnel, finance, and facilities)?

(2) Information movement. Where is this information? Is it only at the stations or institutes - or only at the national headquarters, or both?

(3) Information management. How is this information handled? Who is responsible for information collection and movement? Are we talking about a largely paper-and-pencil operation, or are microcomputers being used, or do we have a combination of both?

(4) Information use. Obviously the most important of the four components, the reason-for-being of any MIS. Who uses whatever information exists and for what purposes?

The obvious answer to this last question should be planning, monitoring, and evaluation - of program, personnel, finance, and facilities.

BACKGROUND TO ISNAR WORK IN INDONESIA

The NARS with which ISNAR has been working most closely on MIS issues is that in Indonesia. I myself have been, and continue to be, heavily involved in this cooperative program. As a result, many of the generalizations I will make this morning will undoubtedly be influenced by what ISNAR and AARD (the Indonesian Agency for Agricultural Research and Development) have been doing together.

Just a few words of background at the beginning... As at least some of you in this room will know, AARD and ISNAR are entering their seventh year of cooperation. Indonesia was actually one of the first three NARS with which ISNAR began to work. Way back in '981, we did one of our first country reviews in Indonesia, and, since that time, we have contributed to ten other program/institute reviews. As you can imagine, therefore, the stack of ISNAR and ISNAR-related plans, recommendations, proposals, and publications on Indonesia is formidable.

The latest stage in our cooperation with AARD began last year, when we concluded an agreement to assist in what many people are today calling "second-generation institutional development problems". Such work is a logical follow-on to the system and program/institute reviews which I have just mentioned. A major theme in all these reviews has been the importance of management issues.

What are "second-generation institutional development" problems? I think that this phrase is almost certainly relevant to most of the NARS represented in this room. Not too long ago, most NARS in Asia, Africa, and Latin America had an acute shortage of men and material (i.e., a "first-generation institutional development" problem). But over the past 10-15-20 years, these NARS have made considerable investments in both physical and human resources (e.g. buildings/equipment and Ph.D./M.Sc.). Now much such investment is in place, buildings are finished and trainees have returned, and the challenge now is to mold these resources into an efficient and effective research program.

In Indonesia, the most pressing management issue for AARD is that the tools available to senior officials for oversight of such a large organization are little changed from what they were ten years ago. (And the organization is large, larger than any represented in this room except the Indian one. Approximately 10,000 total employees, of which approximately 2,000 are graduates and 400 are Ph.D.s. Spread out in more than 25 major centers/institutes, more than 100 stations and sub-stations, over a country 5000 kilometers long.) Most information on projects, personnel, finance, and facilities are updated irregularly. Those data which do arrive at the AARD secretariat in Jakarta are often in forms which make use by senior managers difficult. Aggregation of information from different centers and stations is time-consuming.

In short, the information necessary for either the central secretariat or the centers/institutes to allocate resources rationally or to monitor and evaluate progress is very weak.

SAMPLE OUTPUT FROM THE AARD MIS

I've distributed to you this morning several types of product from the early days of the AARD MIS. Let's look quickly at each of them, to give you a flavor of what one might expect from an MIS. If you'd like to come back to any of them in the discussion period, we can do so. (The following Exhibits are all collected at the end of this paper).

(1) Here we have one page from a list of all research projects at one research institute. The number in the left hand column identifies the institute, the project itself, the research program of which the project is a part, and the fiscal year.

You can see, for example, that the research program on hybrid rice is composed of six discrete research projects.

(2) Here we see what the cost of each of these six projects is and the total for the entire hybrid rice program. We can discuss later, if you wish, how these cost figures are arrived at. I SHOULD

EMPHASIZE THAT THEY ARE *NOT* THE GOVERNMENT BUDGET FIGURES; INSTEAD, THEY ARE ACTUAL USE FIGURES.

(3) Here we see those cost figures broken down into various categories of use: e.g., personnel, materials, equipment, travel, and overhead.

(4) Now we shift to personnel. Here we see what each person is doing. How much of his total time is he spending on research, how much on administration, and how much on training? Within research, which particular projects is he working on?

(5) Here we cut these same personnel data another way, to look at the project first. Who is working on it and what percentage of his/her time is he spending?

(6) Here we look at the total cost of research work on a particular commodity, in this case legumes.

(7) Here we look by discipline, in this case economics.

(8) And finally, here we look at resources devoted to a particular problem, in this case brown planthopper.

USES OF THIS OUTPUT

Now what does (or can) a research manager do with such information? Obviously the payoff from an MIS comes in the use, and not in the methodology.

Let's look at *policy issues* first. The next four exhibits contain information which should be of use to four different levels of research policy maker and manager.

(9) For top policy makers. The research institute from which these data come has the national mandate for irrigated rice. And yet, as you can see from the figures presented here, its budget is small compared to the place of rice in the national economy, a large percentage of its work is not directly related to rice, it does most of its work in one geographic area, it pays modest attention to a major pest problem, and its staff structure is changing rapidly.

(10) For AARD management. Here we see that breeding and agronomy get most attention at this institute, and that pathology and economics get almost none.

(11) For institute management. Here we see that the biggest program at the institute is in rice mechanization and post-harvest technology, and that 13% of institute resources goes for legumes, maize, and wheat.

(12) And finally, one more level down, for program management. The example here is from the rice breeding program. Four projects out of 14 consume more than 50% of resources available to the program.

And finally, let's look at *personnel issues.* Exhibit 4 above, which shows what each person is doing, is clearly and excellent tool for managers responsible for staff evaluation. And Exhibits 5 and 8 give managers a means of monitoring quickly all scientists working on particular research problems.

GETTING STARTED ON AN MIS

Now how did AARD and ISNAR go about getting started on the development and improvement of the AARD MIS? The first step, an early decision, was that we should do an intensive analysis of information available for planning, monitoring, and evaluation at one institute. We had three objectives in doing such a case study:

(1) To find out what information the secretariat in Jakarta had available on program, finance, and personnel at the institute chosen.

(2) To find out what information the institute itself had available.

(3) To analyze how such information was organized, and how it moved (or did not move) between the institute and the secretariat.

As secretariat staff, institute staff, and ISNAR staff worked together on this case study, we all quickly became aware that there were multiple lists of projects supposedly being carried out, that personnel lists were generally out-of-date, and that there were minimal financial monitoring procedures. A considerable amount of information was missing, and much of what did exist was of questionable validity and reliability.

As a result of this case study, AARD and ISNAR staff worked together to develop procedures for collecting the kinds of information everyone agreed was needed,

for moving it from institutes to the secretariat (and, in some cases, the other way), for managing it (mostly using microcomputers), and - most important - for using it.

LESSONS LEARNED

What have we learned?

I believe that the lessons fall into two broad categories: considerations regarding the design of an MIS, and awareness of management constraints to the development and improvement of an MIS.

Design considerations

Here there are at least three sub-lessons.

(1) The need for *flexibility* with regard to objectives, content, and uses/users.

Such a statement may surprise some of you. Certainly the academic literature on MIS gives considerable attention to the need to be precise about objectives, content, and uses/users AT THE BEGINNING.

But over the course of the past year, we have continually changed the content of the information being collected, the way in which it is managed, and the forms in which it is presented.

The approach, in other words, has really been a "bottom-up" one. We've preferred to let the system grow, rather than to start with a preconceived notion (or model) of what should be included and what should be accomplished.

(2) The importance of *starting small*. Such a strategy is obviously a natural corollary of a "bottom-up" approach. Our preference for modesty has two implications.

(a) We have tried to include only *minimal, essential information* in the first stage of the expanded MIS. An example regarding information on personnel will illustrate this point.

When we began, some AARD officials advised that we should try to include all information on personnel now contained in individual files at the secretariat and at the institutes. Had we taken this advice, however, we would have wound up with more than 100 variables on educational background, career, civil service status, etc. Instead, we pared such a "wish list" down to 22 variables which most officials seemed to agree were most useful for manpower and training planning.

In other words, lots of things might be interesting to know, but we have had to ask hard hard questions about our ability to collect data, to move it, to manage it, and - again, most important - to use it.

(b) Similarly, we have moved slowly on increasing the geographic coverage of the MIS. Once again, some officials advised that we should try to include all institutes, centers, and stations in the first year. In fact, we covered only about 30% in 1986-87 - and were continually conscious of the need to get as many of our methods and procedures as correct as possible as early as possible.
Now our target for this second year, 1987-88, is to increase this coverage to about 70%.

(3) The need to encourage *multiple uses and users*. We have continually faced the very real danger that institutes and centers will see the whole MIS enterprise as a ploy to encourage policy and management centralization. As a result, we've tried to involve such institutes/centers to the maximum extent possible from the beginning. Two activities are important.

(a) Tailoring the output from the MIS to the needs of center and institute managers.

(b) Setting up the various MIS databases at the institutes/centers themselves, so that the units of AARD become not only the providers of information but also the primary users of it.

Management Constraints

Here again there are at least two types of lessons learned.

(1) Management attitudes may not be supportive. Do senior managers understand the need for an MIS as an input to planning, monitoring, and evaluation? And - even more important - do they really want good information?

AARD and ISNAR have discovered that the answer to the first question is not as obvious as we had thought. Managers at different levels of the system

have over time developed their own procedures for planning, monitoring, and evaluation (PME) and/or, quite often, they have developed mechanisms to avoid performing such functions altogether. The idea that PME depends on good information is not always accepted.

Nor may the basic idea of an MIS be acceptable... Managers may not want to know about the details of their research projects, personnel, and finance, and/or, almost certainly more important, they may not want others to know. Some of the types of sample output which I've handed out to you clearly have the potential for making some people uncomfortable.

(2) The resources required for an MIS may be in short supply. Here I am talking primarily about people and, at least in some of the bigger NARS, about microcomputers.

The demands on staff time in developing and improving an MIS are not small. In Indonesia, for example, the MIS team at the secretariat level consists of people from the Program Formulation Division, the Personnel Division, the Finance Division, and the Center for Agricultural Data Processing - all of whom, in turn, depend on people from the centers and institutes.
Part-time staff commitments, such as the ones which have been made in Indonesia, are almost certainly appropriate for the early stages of MIS work. But in the long term, full-time assignments are essential. The logical home for such staff is in units concerned with planning, monitoring, and evaluation.

With regard to micros, I hesitate to make generalizations, though I recognize that issues of new technologies for management are important ones. Clearly the sheer volume of information generated in a big NARS like the Indonesian one requires management and analysis by computer. In addition, AARD is fortunate to have substantial numbers of scientists and managers with at least some computer experience. But let me stress again, as I did at the outset, that an MIS does not depend on computers. In fact, in a small NARS, in which the volume of information required is not great, perhaps the most efficient and effective way to begin is with a good paper-and-pencil system.

As in all of research management, the substance is more important than the procedure.

EXHIBIT 1.

LIST OF PROJECTS AT SAMPLE RESEARCH INSTITUTE 1986/1987

Project Number	Project Name	Program of which Project is Part
3024018687	Studi Pewarisan Sifat Komponen Produksi	Pembentukan Varietas Padi Unggul dan Pewarisan Sifat
3025018687	Studi Pewarisan Sifat Cere dan Bulu	Pembentukan Varietas Padi Unggul dan Pewarisan Sifat
3026018687	Studi Keragaman Sifat Tanan Blas Pada Beberapa Varietas Padi Gogo Lokal	Pembentukan Varietas Padi Unggul dan Pewarisan Sifat
3027028687	Pertananam Sumber Persilangan	Pembentukan Varietas Padi Hibrida
3028028687	Pertanaman Test Cross dan Back Cross	Pembentukan Varietas Padi Hibrida
3029028687	Evaluasi dan Perbanyakan Cms, Maintainer dan Restorer	Pembentukan Varietas Padi Hibrida
3030028687	Studi Genetik	Pembentukan Varietas Padi Hibrida
3031028687	Perbanyakan Benih Hibirida	Pembentukan Varietas Padi Hibrida
3032028687	Uji Daya Hasil	Pembentukan Varietas Padi Hibrida
3033038687	Pemupukan NPK Jangka Panjang Padi Sawah	Cara bercocok Tanam dan Pemupukan Padi Untuk Memantapkan Hasil
3034038687	Pupuk Azolla Jangka Panjang	Cara Bercocok Tanam dan Pemupukan Padi Untuk Memantapkan Hasil

EXHIBIT 2.

LIST AND TOTAL COST OF PROJECTS (BY PROGRAM)
AT SAMPLE RESEARCH INSTITUTE, 1986-87

Project Number	Project Name	Cost (Rp 000)
3013018687	Daya Hasil Lanjutan Padi Gogo Rancah	6152
3015018687	Breeder Seed	11771
3017018687	Perbanyakan Galur Harapan Padi Gogo	5875
Subtotal		268932
02		
3027028687	Pertanam Sumber Persilangan	6692
3028028687	Pertanam Test Cross dan Back Cross	7181
3029028687	Evaluasi dan Perbanyakan Cms, Maintainer dan Restorer	9399
3030028687	Studi Genetik	9370
3031028687	Perbanyakan Benih Hibrida	7306
3032028687	Uji Daya Hasil	7154
Subtotal		47102
03		
3033038687	Pemupukan NPK Jangka Panjang Padi Sawah	13904
3034038687	Pupuk Azolla Jangka Panjang	7193
3035038687	Penggunaan Bahan Organik Pada Padi Sawah	8427
3036038687	Cara Pemberian P Pada Padi Gogo	5017
3037038687	Respons Varietas Terhadap P	4162
3046038687	Pengendalian Gulma Pada Tanaman Gogo Dilahan PMK Sumatera Selatan	4318

EXHIBIT 3.

BUDGET ALLOCATION BY PROGRAM AND PROJECT AT SAMPLE RESEARCH INSTITUTE

Project Number	Scientist Cost	Other Personnel Costs	Supplies	Equipment	Travel	Overhead	Total
Pembentukan Varietas Padi Unggul dan Pewarisan Sitat							
(....)	(.....)	(....)	(....)	(....)	(.....)	(.....)	(.....)
3003018687	2,665.73	698.00	278.00	71.00	694.00	8,969.00	13,375.73
3005018687	1,102.39	347.00	132.00	36.00	347.00	4,484.00	6,448.39
3007018687	2,000.05	698.00	265.00	71.00	694.00	8,969.00	12,697.05
3009018687	596.25	1,744.00	662.00	178.00	1,734.00	22,422.00	27,336.25
3011018687	1,157.77	2,084.00	794.00	214.00	2,081.00	26,907.00	33,237.77
3013018687	800.02	350.00	132.00	39.00	347.00	4,484.00	6,152.02
3015018687	1,076.98	695.00	265.00	71.00	694.00	8,969.00	11,770.98
3017018687	519.26	356.00	132.00	37.00	347.00	4,484.00	5,875.26
86	38,439.85	15,334.00	5,868.00	1,548.00	14,919.00	192,824.00	268,932.85
Pembentukan Varietas Padi Hibrida							
3027028687	1,123.04	484.00	205.00	49.00	347.00	4,484.00	6,692.04
3028028687	1,600.33	477.00	205.00	68.00	347.00	4,484.00	7,181.33
3029028687	4,106.11	277.00	142.00	43.00	347.00	4,484.00	9,399.11
3030028687	2,484.73	1,384.00	559.00	111.00	347.00	4,484.00	9,369.73
3031028687	1,951.28	311.00	164.00	49.00	347.00	4,484.00	7,306.28
3032028687	1,719.65	381.00	173.00	49.00	347.00	4,484.00	7,153.65
12	12,985.14	3,314.00	1,448.00	369.00	2,082.00	26,904.00	47,102.14
Cara Berocock Tanam dan Pemupukan Padi Untuk Memantapkan Hasil							
3033038687	7,937.27	830.00	273.00	33.00	347.00	4,484.00	13,904.27
3034038687	1,197.29	830.00	273.00	62.00	347.00	4,484.00	7,193.29
3035038687	2,343.66	969.00	221.00	62.00	347.00	4,484.00	8,426.66
3036038687	2,002.02	415.00	123.00	62.00	173.00	2,242.00	5,017.02
3037038687	1,171.83	415.00	123.00	37.00	173.00	2,242.00	4,161.83
3046038687	1,303.12	415.00	123.00	62.00	173.00	2,242.00	4,318.12
3039038687	1,824.35	415.00	123.00	62.00	173.00	2,242.00	4,839.35
(....)	(.....)	(.....)	(....)	(.....)	(.....)	(.....)	(.....)

EXHIBIT 4.

STAFF (BY PROJECT) AT SAMPLE RESEARCH INSTITUTE

Name	Grade	Unit Cost	Project Number	Res Time (%)	Res Cost R'000	Admin Time (%)	Admin Cost R'000	Sht.Trm Time (%)	Sht.Trm. Cost R'000	Lng.Trm Time (%)	Lng.Trm Cost R'000	Work Out (%)	Work In Cost R'000	Total Time (%)
Dr.M.Sudjadi Sudjono	p	10481	3426008687	15.0	1572	0	0	0.0	0	0.0	0.00	0	0.00	15.0
	p	10481	3112168687	10.0	1048	0	0	0.0	0	0.0	0.00	0	0.00	10.0
	p	10481	3152228687	20.0	2096	0	0	0.0	0	0.0	0.00	0	0.00	20.0
	p	10481	3115168687	10.0	1048	0	0	0.0	0	0.0	0.00	0	0.00	10.0
	p	10481	3113168687	15.0	1572	0	0	0.0	0	0.0	0.00	0	0.00	15.0
	p	10481	3153228687	20.0	2096	0	0	0.0	0	0.0	0.00	0	0.00	20.0
	p	10481	3901008687	0.0	0	5	524	0.0	0	0.0	0.00	0	0.00	5.0
	p	10481	3902008687	0.0	0	0	0	5.0	524	0.0	0.00	0	0.00	5.0
Subtotal				90.0	9433	5	524	5.0	524	0.0	0.00	0	0.00	100.0
Dr.Moch.Sultoni Arifin	ajp	3994	3905008687	0.0	0	0	0	0.0	0	0.0	0.00	100	3994.00	0.0
Subtotal				0.0	0	0	0	0.0	0	0.0	0.00	100	3994.00	0.0
Dr.Moh.Fathan Muhadjir	ajp	9308	3064058687	12.0	1117	0	0	0.0	0	0.0	0.00	0	0.00	12.0
	ajp	9308	3902008687	0.0	0	0	0	10.0	931	0.0	0.00	0	0.00	10.0
	ajp	9308	3425008687	10.0	931	0	0	0.0	0	0.0	0.00	0	0.00	10.0
	ajp	9308	3423008687	10.0	931	0	0	0.0	0	0.0	0.00	0	0.00	10.0
	ajp	9308	3172278687	12.0	1117	0	0	0.0	0	0.0	0.00	0	0.00	12.0
	ajp	9308	3901008687	0.0	0	10	931	0.0	0	0.0	0.00	0	0.00	10.0
	ajp	9308	3183318687	12.0	1117	0	0	0.0	0	0.0	0.00	0	0.00	12.0
	ajp	9308	3403008687	12.0	1117	0	0	0.0	0.	0.0	0.00	0	0.00	12.0
	ajp	9308	3107138687	12.0	1117	0	0	0.0	0	0.0	0.00	0	0.00	12.0
Subtotal				80.0	7446	10	931	10.0	931	0.0	0.00	0	0.00	100.0
Dr.Moh.Kosim Kardin	s	7019	3902008687	0.0	0	0	0	100.0	7019	0.0	0.00	0	0.00	100.0
Subtotal				0.0	0	0	0	100.0	7019	0.0	0.00	0	0.00	100.0
Dr.Moh. Fatchurochim M.	asp	5314	3141208687	15.0	797	0	0	0.0	0	0.0	0.00	0	0.00	15.0
	asp	5314	3138208687	30.0	1594	0	0	0.0	0	0.0	0.00	0	0.00	30.0
	asp	5314	3140208687	15.0	797	0	0	0.0	0	0.0	0.00	0	0.00	15.0
	asp	5314	3904008687	0.0	0	0	0	0.0	0	0.0	0.00	0	0.00	0.0
	asp	5314	3204408687	20.0	1063	0	0	0.0	0	0.0	0.00	0	0.00	20.0
	asp	5314	3205418687	20.0	1063	0	0	0.0	0	0.0	0.00	0	0.00	20.0

(....)

EXHIBIT 5.

PROJECTS (BY STAFF INPUTS AND COSTS) AT SAMPLE RESEARCH INSTITUTE

Project Number	Name	Grade	Unit Cost	Res.Time %	Res.Cost Rp. 000	Adm.Time %	Adm. Cost Rp. 000
3431008687	Ir. Harnoto	ajp	9308	23.40	2178.07	0.00	0.00
3431008687	Ir. Henny Mayrowani	s	7019	45.00	3158.55	0.00	0.00
				74.40	5895.10	0.00	0.00
Potential and Constraints of Maize Production in Upland Areas of Java Indonesia (ESCAP)							
3432008687	Ir. Aman Djauhari	ajp	9308	15.60	1452.05	0.00	0.00
3432008687	Ir. Adimesra Djulin	s	7019	51.00	3579.69	0.00	0.00
3432008687	Ir. Sari Sutiyo Rini	s	7019	36.00	2526.84	0.00	0.00
				102.60	7558.58	0.00	0.00
Evaluasi Kendala Pemantaalan Kredit Tenaga Ternak di Daerah Transmigrasi (Diljen Peternakan Projek IFAD)							
3433008687	Ir. Aman Djauhari	ajp	9308	15.60	1452.05	0.00	0.00
				15.60	1452.05	0.00	0.00
Pemangkasan Tanaman Kedele Terhadap Kualitas Biji							
3434008687	Dr.Ir.Abdul Karim Makarim	ajp	9308	4.00	372.32	0.00	0.00
				4.00	372.32	0.00	0.00
Identifikasi Usahatani Di Hulu Daerah Aliran Sungai							
3435008687	Ir. Al Sri Bagyo	asp	8076	45.00	3634.20	0.00	0.00
				45.00	3634.20	0.00	0.00
Penelitian Soybean (Biaya Sadikin Somaatmadja Sendiri)							
3438008687	Sadikin Somaatmadja	ap	11,925	70.00	8347.50	0.00	0.00
				70.00	8347.50	0.00	0.00
No Kegiatan	**Name**						
3901008687	Ir.Achmad Husni Malian	s	7019	0.00	0.00	10.00	701.90
3901008687	Ir.Widhiati Adil Hadi	s	7019	0.00	0.00	10.00	701.90
3901008687	Ir.Jaleng Sulaiman	asp	8076	0.00	0.00	2.00	161.52
3901008687	Dr. Subandi	ap	11,925	0.00	0.00	20.00	2385.00
3901008687	Ir. Endang Suhartatik	asp	8076	0.00	0.00	5.00	403.80
3901008687	Ir. Sup apto Hardjo Sumadi	ajp	9308	0.00	0.00	75.00	6981.00
3901008687	Adiono Pa.Bso	s	7019	0.00	0.00	100.00	7019.00
3901008687	Ir. Hendrik Virgilius	asp	8076	0.00	0.00	3.00	242.28
3901008687	Dr. Zainuddin Harahap	ap	11,925	0.00	0.00	30.00	3577.00
(.....)							

EXHIBIT 6.

LIST AND COST OF PROJECTS BY COMMODITY AT SAMPLE RESEARCH INSTITUTE 1986-87

Project Number	Project Name	Cost (Rp 000)
(.....)	(.....)	(.....)
3108138687	Root Distribution and Nutrient Uptakes	6953
3114168687	Metodologi Uji Ketahanan Varietas Jagung dan Sorghum Terhadap Penyakit Utama (Bulai, Karat dll)	3955
3432008687	Potential and Constraints of Maize Production in Upland Areas of Java, Indonesia (ESCAP)	9801
Subtotal		208,818
Kacang		
3436008687	Respon Kacang-Kacangan Dalam Kerapatan Populasi Tinggi Terhadap Perlakuan Zat Penghambat Tumbuh (PGR)	2242
3191348687	Pertanam Koleksi Kacang-Kacangan	6844
3155238687	Penelitian Evaluasi	11,989
3154228687	Penelitian Penyakit Bakteri Kacang-Kacangan	11,871
3401008687	Legume Cultivar Selection for Condition After Lowland Rice and Acid Soil (1984-1987)(Canada)	4452
3409008687	Food, Legume and Course Grain (1982-1987)(FAO/UNDP)	2958
3406008687	Pigeon Pea Improvement Phase II (ACIAR-8567) (1985-1988)(Australia/ACIAR)	2714
Subtotal		43,070
Kacang hijau		
3119188687	Hibridisasi Kacang Hijau	4546
3122188687	Seleksi Pembentukan Kacang Hijau	4246
3129188687	Uji Daya Hasil Pendahuluan Galur-Galur Kacang Hijau	7990
(.....)	(.....)	(....)

EXHIBIT 7.

LIST AND COST OF PROJECTS BY DISCIPLINE AT SAMPLE RESEARCH INSTITUTE 1986-1987

Project Number	Project Name	Cost (Rp 000)
(.....)	(.....)	(.....)
3167268687	Penelitian Daya Guna dan Hasil Guna Jasad Renik (Mycorrhihiza)	4342
3168268687	Pengaruh Cara Pengendalian Gulma Pada Ubi Kayu	3793
3169268687	Penampilan Sifat Agronomis Klon Harapan Ubi Kayu	5460
Subtotal		424,835
Ekonomi		
3197378687	Evaluasi Program Pengapuran Dalam Rangka Peningkatan Produksi Kedelai	24,555
3433008687	Evaluasi Kendala Pemanfaalan Kredit Tenaga Ternak di Daerah Transmigrasi (Ditjen Peternakan - Projek IFAD)	3694
3196368687	Pengaruh Penetapan Mutu Gabah/Beras Yang Dibeli BULOG Terhadap Pendapatan Petani Padi	15,369
3195358687	Dampak Program Pencetakan Sawah Terhadap Peningkatan Pendapatan	4876
Subtotal		48,494
Fisiologi		
3180318687	Pengaruh Curah Hujan Pada Stadia Pemasalahan Polong Terhadap Mutu Benih Kedelai	7874
3107138687	Pengaruh Pemakaian Mulsa Terhadap Pertumbuhan dan Hasil Jagung di Lahan Kering	4037
3183318687	Effect of Edaphic and Field Environment on Seed Quality (Kerjasama JICA)	9976
(.....)	(.....)	(.....)

EXHIBIT 8.

LIST AND COST OF PROJECTS (BY STAFF IMPUTS) ON BROWN PLANT HOPPER AT SAMPLE RESEARCH INSTITUTE

Project Number	JUDUL RPTP (Title of the Program) JUDUL KEGIATAN (Title of the Project)	Percentage of Time Spent	TOTAL BIAYA (Budget Rp 000)
3068068687	Jud.RPTP: Penelitian Pengendalian Hama Padi/Penelitian Ekobiologi Hama Padi Jud.Keg.: Hibridisasi dan Perkembangan Biotipe Wereng Coklat		9,880.0
	Pelaksana: Dr. Ir. Ida Nyoman Oka	12	
	Ir. Bahagiawati A.H.	16	
	Ir. R.S. Djatnika Kilin	9	
3418008687	Jud.RPTP: Kerjasama/Swasta Jud.Keg.: Penelitian, Penaggulangan Hama Padi Wereng Coklat dan Virus Lainnya (Inpres 3) 1986 (Direktorat Jenderal Pertanian Tanaman Pangan)		13,061.0
	Pelaksana: Dr.Ir. Ida Nyoman Oka	6	
	Dr.Ir. Justinus Soejitno	7	
	Ir. Arifin Kartohardjono	37	
	Ir. Jumanto Hardjosudarmo	9	
	Ir. R.S. Djatnika Kilin	36	
	Ir. Soewito Tjokrowidjojo	20	
3074068687	Jud.RPTP: Penelitian Pengendalian Hama Padi/Penelitian Ekobiologi Hama Padi Jud.Keg.: Hibridisasi dan Diskriminasi Inang Wereng Hijau		13,728.0
	Pelaksana: Dr.Ir. Sri Suharni Siwi	40	
	Ir. I. Gusti Putu Alit	57	
3073068687	Jud.RPTP: Penelitian Pengendalian Hama Padi/Penelitian Ekobiologi Hama Padi Jud.Keg.: Skrining Wereng Hijau		11,747.0
	Pelaksana: Ir. Arifin Kartohardjono	37	
	Ir. I. Gusti Putu Alit	38	
3420008687	Jud.RPTP: Kerjasama/Swasta Jud.Keg.: Pengujian Insektisida Gusodrin 15 wcc Terhadap Wereng Coklat (P.T. Alfa Abadi Pestisida Industri)		3,185.0
	Pelaksana: Panudju Pudjokaryono	9	
Total Budget:			51,601.0

EXHIBIT 9.

Data From One Sample Research Institute

Issues For TOP POLICY MAKERS

This institute has the national mandate for irrigated rice.

(1) Its budget is 3% of the total AARD budget. Wetland rice contributes 20% of AGDP.

(2) 35% of the institute budget goes for research on palawija crops and cropping systems.

(3) 89% of the budget is spent within 50 kilometers of the main station.

(4) 3% of the budget goes for research on brown plant hopper.

(5) 28% of the current graduate staff are on training. When they return, approximately 25% of the graduate staff will have Ph.D.'s and 25% will have M.Sc.'s.

EXHIBIT 10.

Data From One Sample Research Institute

Issues for AARD MANAGEMENT

Research Program Areas By Discipline

Plant Breeding	34%
Agronomy	26%
Agricultural Engineering	18%
Pest Management	9%
Cropping Systems	9%
Plant Diseases	4%
Agricultural Economics	0%

EXHIBIT 11.

Data From One Sample Research Institute
Issues for INSTITUTE MANAGEMENT

Research Program Areas

Rice Mechanization and Post-Harvest Technology	22%
Rice Breeding	16%
Rice Pests and Diseases	11%
Hybrid Rice	10%
Irrigation and FSR	10%
Rice Agronomy and Fertilizers	1%
Grain Legume Breeding	6%
Hybrid Maize Breeding	4%
Wheat Breeding	3%
Other	8%

EXHIBIT 12.

Data From One Sample Research Institute
Issues For PROGRAM MANAGEMENT

The Rice Breeding Program consists of 14 research activities.

Perbanyakan Benih CMS dan Benih Hibrida	17.6%
Verifikasi/Uji Adaptasi Galur Harapan	12.3%
Penelitian Sumber Bahan dan Pembuatan Persilangan	11.9%
Observasi Daya Hasil	9.8%
	51.6%
TEN other activities	48.4%

RESEARCH INFORMATION SYSTEMS FOR AGRICULTURE AND NATURAL RESOURCES IN THE PHILIPPINES

Ramon V. Valmayor
Executive Director, PCARRD
and
Cynthia R. Mamon
Chief, MIS
The Philippines

When the Philippine Council for Agriculture Research (PCAR) was created on November 10, 1972, one of its mandates was to establish a repository for research information in agriculture. When it was renamed the Philippine Council for Agriculture and Resources Research and Development (PCARRD), the development function was added, and its scope was extended not only to cover agriculture but natural resources as well.

ESTABLISHMENT OF THE MANAGEMENT INFORMATION SERVICES (MIS) UNIT

Aware of the critical importance of research program planning, monitoring, and evaluation, PCARRD made initial attempts in 1974 to computerize the compilation of research projects that pass through PCARRD's evaluation mechanism. To provide a proper organization to develop the agency's information systems to support its operations, the Management Information Services (MIS) Unit was established in 1977 with the following objectives:

* to provide updated and relevant information for effective planning and decision-making;
* to analyze the information needs of the PCARRD Secretariat and the national network of research centers and stations;
* to develop manual and computerized information systems and databases for efficient information storage, processing, and retrieval;
* to act as the central electronic data processing (EDP) unit of PCARRD and provide computer processing services to PCARRD researchers, scholars, and other users;
* to strengthen the functional linkages of research centers and stations through a systematic and effective information network;
* to generate and analyze management and statistical reports to support PCARRD operations and internal control activities;
* to develop PCARRD MIS masterplan, hardware development, and EDP organization programs;
* to act as liaison to various computer/information centers.

To provide for the agency's data processing requirements, PCARRD has installed two multi-user Altos microcomputer systems, Model 986-40, with 13 terminals distributed among the various technical divisions, the MIS Unit, the Office of the Executive Director, and the Deputy Executive Director for Research.

CURRENT INFORMATION SYSTEMS AND COMPUTER APPLICATIONS

To date, PCARRD's MIS has developed seven information systems. They are:

I. Research Management Information System (RMIS)

The RMIS is the information processing support for the research program planning and monitoring functions of PCARRD. This provides a computer-assisted system to create files of proposed, new, and on-going research projects, support the preparation and integration of the national research program, consolidate budgetary plans, and maintain files of approved research projects for monitoring and evaluation. This supports on-line data entry for updating and inquiry about the research programs and/or about any record in the files.

This system provides the only comprehensive database of on-going research in agriculture and

natural resources in the country. The RMIS database also provides inputs to the FAO-developed global database called the Current Agricultural Research Information System (CARIS).

2. Research Information Storage and Retrieval System (RETRES)

This system was designed to establish a databank of terminal reports of completed research projects, publications, monographs, and other library materials and develop a query system that facilitates literature searches. This system will assist selective dissemination of information (SDI) and provide the system interface between the computer and the manual library system at the Scientific Literature Services (SLS) Unit.

This complements the RMIS which deals with on-going research, while RETRES concerns itself with bibliographic abstracts, research publications, and technical reports of completed research. RETRES also provides inputs to another FAO-developed global database called AGRIS - the International Information System for Agricultural Sciences and Technology.

3. Equipment Infrastructure Management System (EIMS)

Based on the results obtained in the resources surveys, EIMS provides a computer-based inventory of all equipment and infrastructure resources of agencies in the National Research and Development Network. This system covers information on the location, distribution, and utilization of all research equipment in the country and provides the necessary information for equipment acquisition and maintenance programs of the Institutional Development Department (IDD).

4. Manpower Management System (MMS)

A computer-based system, the MMS provides complete information on all researchers involved in agricultural and natural resources research. The main output is the Directory of Research Manpower Resources in Agriculture, Forestry, Fisheries and Mines. It also provides information on the location, distribution, and specialization of the research manpower resources in the National Research and Development Network (NRDN).
It has a sub-system, the Personnel Information System, which provides a database on the bio-data of all PCARRD Secretariat personnel.

5. Financial Management System (FMS)

This system provides management with financial indicators to formulate operating plans and institute financial control. It is currently being tested to run on the Altos 986-40 microcomputer to assist in the monitoring of PCARRD-GIA-funded projects. The system provides management reports showing a comparative analysis of approved, recommended buget vis-a-vis actual releases, disbursements, and liquidations of individual project funds.

6. Publications Mailing System

7. Administrative Support Information System (ADSIS)

PLANS FOR THE FUTURE

Although PCARRD has made some notable achievements in the development of comprehensive agricultural and resources research information systems, further work is planned to support the National Research and Development Network. This includes the creation of specialized commodity databases, i.e., a banana germplasm data bank and the agro-crop-climatic soils databases necessary for technology transfer activities.

We also intend to bring the RMIS and RETRES systems into the regions so that the benefits of these databases will not be confined to the national level. However, to achieve this, we need financial support to provide hardware and software resources to the National Research and Development Centers. Given the support, we hope to establish in the National Research and Development Centers the data processing capability that they need so that all information in PCARRD's databases will be made available and accessible to them through diskette exchange. We also hope to upgrade our existing computer systems so that the archival concept in storing agriculture and resources research information will be achieved. At present, our computer system can only accommodate an annual national research program due to limited storage capabilities.

Internationally, although we are a major contributor to the CARIS and AGRIS systems, we hope to achieve information exchange with other international agencies

so that the benefits of our information systems will be shared with our Asian neighbors and other developing countries.

PROGRAM FORMULATION AND PROGRAM BUDGETING

Paul Marcotte
Visiting Research Fellow
ISNAR

INTRODUCTION

The purpose of this paper is to describe program formulation and program budgeting as components of a larger process. This larger process is illustrated in Figure 1, as an example of a rational, decision-making model of a national agricultural research system (NARS).

In this rational model, the activities required for a functioning organization take place at discrete decision levels (national, institutional, and professional/operational), over time. While decisions are made independently at the various levels, the levels are connected by the flow of information downward through the system, and by feedback loops transmitting the results of the research endeavor.

In this rational system, the outputs from one level become the inputs for another. For example, at the national level, the goal is priority setting for the research enterprise. The inputs necessary at this level are the national development objectives, which are formulated by an interactive group of politicians, advisors, and interested groups. The outputs at the national level are research priorities and resource allocation.

The outputs from the national level become the inputs for the institutional level. The objectives at this point are to create a long-term plan with respect to the prescribed inputs and to interpret the directives. This is accomplished by research directors and advisory groups, such as senior staff and regional committees. The specific outputs from this level are research objectives, program/project prioritization, and resource planning.

Note: The author wishes to acknowledge that he drew upon the works of several ISNAR staff in the preparation of this presentation, in particular that of Matthew Dagg and René Devred.

This, then, becomes the input for the professional-operational level. At this level, heads of departments and researchers design the short-term program to align capabilities, facilities, and research problems. The output is the approval of experiment proposals.

This becomes the annual program and budget at the researcher level.
The output is scientific information. This information can be systematically fed back on each or all of the decision levels, and passed on to the client/user groups.

It is this linkage, the integration of the program and the budget, which is of particular importance for this program. This is a critical point in the model, as it is at this juncture that the prioritization and selection of programs is connected to the research implementation and information generation phases of the process.

PROGRAM FORMULATION PROCESS

It is essential at the outset of implementing a program formulation process that an understanding of the parameters of the process and its component parts be established. To begin, it is necessary to define the stages of the process.

Research planning is the stage in which development objectives and strategies are transformed into research objectives, priorities, and long-, medium-, and short-term strategies, and into which resources are allocated to major program thrusts reflecting these priorities and strategies.

Research programming is the stage in which coherent sets of research activities are defined at different levels of disaggregation corresponding with increasing specificity of objectives (programs, projects, operations, experiments), arranged in a well-defined time frame,

and organized in such a way as to match with existing human, physical, and financial resources.

PBS provides information to the framework within which this prioritization and allocation process can take place. Initially, the main priorities for research and the allocation of resources are set at a policy level. The long-term program of the institution is decided by senior scientists and administrators on the basis of constraints to be overcome and opportunities to be exploited. It requires stability and continuity, as research problem selection is based on: (a) immediate significance but execution of long duration; or (b) research that must be initiated at present in order to be ready for future needs.

The short-term or annual research program is usually determined on the basis of current staff and facilities, within the guidelines of the long-term program. It is this short-term process that is the specific program formulation concern, as it is by definition dynamic, adaptable to changing conditions, and incorporates the realities of the agricultural research workers within a given system.

THE GOAL OF PROGRAM FORMULATION

The goal of program formulation is to establish an effective and efficient short-term (annual) research program to facilitate national development. This goal can be realized by creating a research-user partnership which rests upon the principle that a publicly funded research organization should be programmatically and fiscally accountable, and at the same time, should have a responsibility to meet the needs of the country.

The characteristics of the final programmatic selection should be the following:

* *Appropriate* -- the program experiments and studies are appropriate to the country in terms of size and sophistication; and realistic in relation to its environment and resource availability.

* *Relevant* -- the program selected from a wide range of experiments and treatments is relevant to the client groups as targeted within the adopted criteria for performance.

* *Quality* -- the program consists of quality experiments that penetrate to the core of the problem with minimal effort, and are designed with scientific and statistical care so valid conclusions can be drawn.

* *Clear* -- the program elements are clearly defined to facilitate audience understanding.

* *Fiscally responsible* -- the program reflects a realistic budget for key research within limited resources.

PROGRAM FORMULATION INPUTS

Elements necessary to delineate the program formulation process are:

* *Long-term plan* -- the long-term planning which is performed by the upper levels of management provides the parameters within which to orient the short-term planning at the researcher level.

* *Criteria for assessing priorities* -- the policy criteria for prioritization should be provided by government and senior management in order to assure objectivity and appropriateness.

* *Research Personnel* -- well-trained research and technical staff are essential inputs at the institutional and research levels.

* *Facilities* -- work plans must be based on facilities that are currently available.

* *Funds* -- proposals, ranked by priority, should be prepared based on preliminary funding estimates. This budget constraint and proposal prioritization will allow for unworthy projects to be terminated. Experiments and studies requiring funds in addition to the budget estimate should be prepared in anticipation of budget supplements or entrepreneurial funding. This will allow for marginal resources to shift from one sector to another if there is a clear demonstration of research importance.

* *Information on the user to be served* -- there needs to be an information flow from the community served to the researcher proposing and conducting experiments (a researcher-user partnership) so that experiments will be designed to serve the primary clients.

* *Information on Service/Development agencies* -- research-generated benefits depend upon appropriate inputs, infrastructure, and institutions. Because capabilities are limited, the research that development agencies are likely to support are an important influence on the scientific experiment or treatment selection.

* *Appropriate body* -- an appropriate body is necessary for reaching decisions on alternative choices of experiments.

At this point the desired characteristics and the program formulation inputs are synthesized into the short-term (annual) plan. The mechanism which facilitates this synthesis depends on the size, sophistication, and type of management which is in place. While it is not possible to describe all the types, because each is dependent upon unique conditions, there are general types. For example, it is characteristic of research organizations for the individual researchers to have greater technical expertise than the managers. In this case the individual scientist's judgement may be adequate for assessing priorities of experiments. Thus, a collegial style of management is appropriate.

However, depending on the program criteria established at the upper levels, in order to assure objectivity, senior management may need to establish a program committee. This provides a wider viewpoint and assures that the program is both effective and efficient concerning the adopted criteria. The institutionalization and/or permanence of this committee system depends on the needs of the managers and planners.

THE FRAMEWORK

The process by which program formulation goals and inputs interact is highlighted in Figure 1: Rational Decision Model. While this process is hierarchical, decisions on allocations and resource utilization are made discretely at the various levels. This recognizes that while general administration functions of the management structure can be performed hierarchically, program formulation requires a collegial style (first among equals), with leadership replacing authority.

The National Level

At the national level, the decisions made are concerned with priority setting for a national development policy and the resources required for implementation. Usually, in the agricultural sector, resources are allocated to the sector as a whole rather than to the individual subsectors such as research and extension. The task at this level is to provide directives on: research priorities; research objectives; and target groups. Of necessity, at this level it is a broad conceptualization and strategic in nature rather than specific. It is at this level that the synthesis of supply and demand of research needs and capabilities should occur. Ideally, the supply of information on scientific programs submitted from the institutional level to the policy makers should match the demands and requirements of the demand sector: i.e., the clients, such as commodity groups, consumers, and farmers. The participants intervening at this level are the political decision makers, a national research council, a scientific and technical committee, ministry senior staff, and political influence groups, such as: commodity lobbies; agriculture faculties; advisory committees; and agro-industry groups. Depending on the specific history and sophistication of the research endeavor, it is recognized that not all of these participants at this level may be in existence or assume an active role. It is also understood at this level that clients will have different and possibly conflicting demands within the limited national resource potential, so establishing client interaction is necessary. For example, an export-oriented commodity association may be specifically interested only in its commodity despite the fact that it may be in direct competition for land required for production for consumption. Thus, the interactive group, with interests and vision beyond the immediate, can negotiate a compromise.

The Institution Level

It is at the institutional level where the detailed agricultural research planning is accomplished. At this level, a research strategy is developed to address the national priorities, as well as support its request for an adequate share of the sector total. The task is to interpret the directives established at the national level and synthesize the disciplines available at the institution in the direction dictated by the strategy. Specifically, the tasks are to design a research program within the guidelines established, and to prioritize and implement the research program. In the program design the following concerns must be addressed: 1) the attainment of goals that have been set at the national level; 2) maintenance of high scientific standards; and 3) science must be oriented to practical goals.

Essential to the process at this point is the clarification and understanding of the downward flow of information to orient the program design and the upward flow from the scientific contingent to provide assessment capabilities.

The Professional-Operational Level

At the professional-operational level, decisions are taken on the approaches necessary for achieving the priority objectives through programs and projects. It is at this level that the local and individual scientist's knowledge is utilized to decide the best approaches to the accomplishment of specific research objectives.

The area of participation at this level is the allocation of research problems to departments and scientists with the intention of proposal preparation, experimentation, and monitoring and evaluation of the individual projects.

Functional responsibilities are clearly defined between the administrators and the practitioners at this level. The role of the administrators is to see that the resources needed for conducting the scientific experiments are available and to ensure that the resources are efficiently used for the purposes for which they were provided. For the researcher, the role is to provide outputs that can be used by the different groups of clients. Specifically for the scientist, this requires the identification of needs and opportunities within agreed priority areas, the formulation and implementation of scientific projects, and reports on these projects. The form that this reporting process takes is described in the next section: Program Budgeting.

PROGRAM BUDGETING

A Program Budgeting System (PBS) for research is the process by which research activities, with well-defined program objectives, are aligned with available resources. As an organizational tool, PBS is a formal system for collecting information on the programs, sub-programs, projects, and sub-projects that have been selected and their attendant budget and personnel allocations. It is a project-based management tool to facilitate programming, budgeting, and accounting. As such it improves the overall process of management by ensuring that all activities have a measurable and sustained impact of program development. By providing detailed costs of the component activities, as outlined in the program formulation process, it enables managers to monitor program versus plan, and evaluate progress towards goals.

The ideal program budgeting process presupposes the existence of commodity and regional priorities. It includes the following components:

- designation of the year's provisional budget;
- a clear statement of experimental objectives, justification, and methods;
- a breakdown into operations and activities that can be costed on a standard basis (e.g., time od researchers, support staff, transportation, etc.) within the constraints imposed by the existing financial and human resources;
- an appropriate presentation for formulation of aggregated programs and investment;
- receipt of a balanced program and budget approved with respect to the expressed objectives.

PROGRAMS, PROJECTS, OPERATIONS, ACTIVITIES

To accomplish the program budgeting process as described above, a sample set of data collection forms has been designed. It should be understood that while these forms are in fact being utilized in an ongoing PBS process, they are merely for discussion purposes in the context of this paper. The actual PBS tool needs to be designed specifically to fit particular situations.

Prior to the explanation of the specifics of the process, it is essential that definitions for the different levels of programming be adopted. Programs, projects, operations, and activities are aggregated from highest to lowest degree according to objectives.

"Program" is the term given to the highest level of aggregation of research activities at different levels of organization in an institution. The names ascribed to the component parts of a program budgeting system as described here are as follows: "programs" are disaggregated into "projects"; "projects" into "operations"; and "operations" into "activities". For each of the following, the term will be defined and the information collection instrument will be described beginning with "activities" as this is the smallest unit of aggregation.

Activities

An activity is the most elementary research action performed within an operation and the smallest usefully identifiable unit of research action recording quantifiable data related to manpower time and direct operation costs.

For each activity (e.g., travel, installation of an experiment, interpretation of results, reports) all quantifiable data related to personnel time (time of the scientist and the technicians) and to all direct operational costs are recorded.

The Personal Time Allocation Data Sheet (PTS) is filled in by all individual research staff (scientists and technicians) each year. It includes only data concerned with the total effective work time spent by each staff member on research activities. Details of time allocated by staff to all research activities must be entered, including research operations, seminars, teaching, study tours, etc. The PTS serves as a check that staff are not

unduly over- or under-committed for good, realistic performance.

Operations

An operation is the aggregation of the activities performed by a single scientist or in a single task in a specific discipline or field of specialization. Since many research projects are of a multidisciplinary nature, they involve two or more scientists and therefore two or more operations.

The research worker in charge of an operation records, one by one, all "activities" and experiments conducted under the operation. All the activities conducted in one operation constitute the workplan of that operation.

The summary data and specific information collection document for operations is the *Operation Data Sheet* (ODS). The ODS information includes: the identification, objectives, and geographic location of the operation; the staff work time allotted to the operation; the operational inputs (travel, person days, etc.); and experimental inputs (fertilizer, chemical products, water for irrigation, etc.).

Projects

The term "project" is utilized here only within the organizational context described in the paper and should not be confused with or mistaken for project-type funding from donor agencies.

A project is a coherent set of "operations" with a goal, a rationale, a clearly defined set of objectives, a plan of action for achieving those objectives, a limited time frame for execution, specific outputs which can be measured against initial objectives, and a budget defining human resource inputs (personnel time), and direct operation costs (recurrent expenditure including all inputs required for project implementation).
A project is often a multidisciplinary undertaking involving a number of scientists and technicians trained in different disciplines or fields of specialization, assembled in a team, working within the same work plan and under the supervision of one of themselves.

Summary data and specific information on each project are recorded on a *Project Data Sheet* (PDS).

The information on the PDS includes: identification of a project; research and development objectives; development and target group impacts; linkages with other projects, programs, and institutions; and scientific staff requirements.

Programs

A program is a coherent set of projects in one specific area of research. Program scope and size may vary considerably according to the level of disaggregation and specificity of objectives.

Programs can be grouped in three categories:

- *Commodity programs* assemble all projects related to specific commodities, groups of commodities (e.g., cereals, forage crops, livestock, vegetable crops, fruit crops) or groups of products (e.g. grains, tubers, fruit, milk, butter, skins).

- *Thematic programs* comprise all projects related to individual or interrelated production factors, the resource base, disciplinary or multidisciplinary themes (e.g., soil-water-plant relationships, soil-vegetation correlations and land-use planning, fertilizer and herbicide application, trace elements, etiology of specific plant or animal diseases).

- *Systems-based programs* involve all projects related to agro-systems, farming systems, or region-specific production or cropping systems (e.g., mountain agro-systems, rainfed farming systems, irrigation, farming systems, orchard plantation systems).

Several classifications exist, and each country should adopt the mode of classification which best fits its specific needs; for example, major program (food crops); program (cereals); sub-program (coarse grains); project (millet). Of course, depending on the size and sophistication of the research effort, this classification may change. For instance, in a smaller country with limited research resources, a major commodity program may be only one or two grains, with all activities, operations, and projects aimed towards solving specific problems of that particular grain.

All activities of a research institution can be combined into projects and aggregated into programs. Complex programs, grouping several sub-programs in different regions or involving interlinked projects, can be supervised by a program coordinator responsible for planning, budgeting, coordinating, and monitoring all projects under the program.

Computerized System

A program budgeting system can be operated using standard clerical procedures. However, if the research system is large, a computerized system gives the management tool greater flexibility.

A PBS has been developed by ISNAR, and training sessions on the PBS methodology have been conducted in Morocco, Syria, and The Gambia. However, the PBS computer software was developed for one specific application. For use elsewhere, the PBS software would need to be redesigned. For example, coding files would have to be customized to the existing system and the structure of data sheets would have to be consistent with forms in operation. The following description is of a PBS in which these designs have already been developed. The Project Data Sheet, Operation Data Sheet, and Personal Time Allocation Sheet have been designed to facilitate input of the information into an appropriate microcomputer data base.

To accomplish this task it was necessary to develop a coding manual to identify the different classifications efficiently: including codes for commodities, thematic and system program classifications; for research personnel, research centers, stations and experiment sites; for provinces and geographical regions; and for research and development objectives.

Once the information has been computerized, printouts can be made available at different breakdowns of research activities aggregated by activities, operations, projects, and programs. The use of a microcomputer allows data (objectives, targets, manpower, costs, etc.) tracking and retrieving at different levels of aggregation or disaggregation.

Useful Outputs

Different cross-sections of data can be provided, depending on the combination of variables requested by users, in particular policy makers, planners, managers, scientists, and farmers. Breakdowns of personnel time or cost, as well as direct operational costs, given in real figures, relative percentages or bloc-diagrams, can be provided by commodities, thematic or system programs, by field of specialization, by disciplines, by development or research objectives, by client groups or by research workers. The breakdown of outputs can also be provided by regional stations, geographic or natural regions, by any sort of linkages with other research or development projects, as well as by specific budgetary items.

The specific outputs that could be utilized by the individual research scientist would be the actual budget and quarterly expenditure reports, and YTD (year to date) time allocations. Past PBS workshop participants have indicated that worktime budgeting is a key element in research management, for both scientists and supervisors.

A listing of the research objectives, as defined for the individual projects on the ODS, allows the scientists to focus on the prioritized research issues.

The benefits accruing to the manager at the institutional level are that information is provided by budget and category cost by scientist and by programs/projects. This helps maintain a realistic ratio of operating costs to salary and permits making the case for realistic funding for the program elements. While individual progress can be monitored on a quarterly or yearly basis with this information, these reports also provide management with time series data which can be used during the planning process to relate programs to development objectives.

Specific examples of reports that can be generated by PBS are aggregation of budgets by scientists, and aggregation of budgets by programs and projects. This kind of budget breakdown was considered essential by managers at the previous workshops.

The specific benefits accruing to the various advisory boards and committees at the national management level are that facts are provided to aid the decision process. Accurate information is provided on research programs according to government-defined development objectives and research programs by target groups. This assures the capability to monitor the programs and individual projects in a timely, accurate, and consistent fashion. For example, outputs from the PTS and the ODS identify resource position (scientist time and expenditure) and work accomplished to date. Thus progress can be checked on the implementation of programs, and factors that assist or impede the work can be identified. Corrective action can be prescribed, or decisions on alternative programs can be considered if it is determined that projects and programs are not meeting goals.

These various uses and benefits of the information generated by a PBS are described in Figure 2: Potential Output and Use of PBS. Of specific interest is the multiplicity of uses at the different levels: scientist, manager, and national as the key to a functioning PBS is

a benefit (and thus a vested interest) of those involved in the process.

SUMMARY

The need for the synthesis of program formulation and budgeting into a formalized process has been recognized. However, it has been a difficult task to accomplish. Systemic failure, thus far, has occurred due to the type of information collected, the models within which the information was used, and the process (or lack thereof) through which the information was filtered for decisions.

Assuming that these problems are continuous, the process described in this paper has attempted to identify key characters and information in existence (or that can be generated easily and efficiently) and can use the intuitive judgement of those involved in an interactive process.

Briefly, the planning formulation section describes how directives were set at national levels, how these directives are integrated and prioritized programmatically at the institution level, and how they are operationalized at the scientific-professional level.

An integral part of the program formulation process is a tool with which to collect information. The specific information collection instrument described in the program budgeting section consists of forms that identify scientific activities, categorical costs, and progress towards programmatic objectives. When this information is included in the upward flow of planning formulation, it provides the basis for objective judgment regarding programs and projects and enables the institutional and national levels to evaluate progress towards the long-range goals.

Figure 1. RATIONAL DECISION MODEL - NARS.

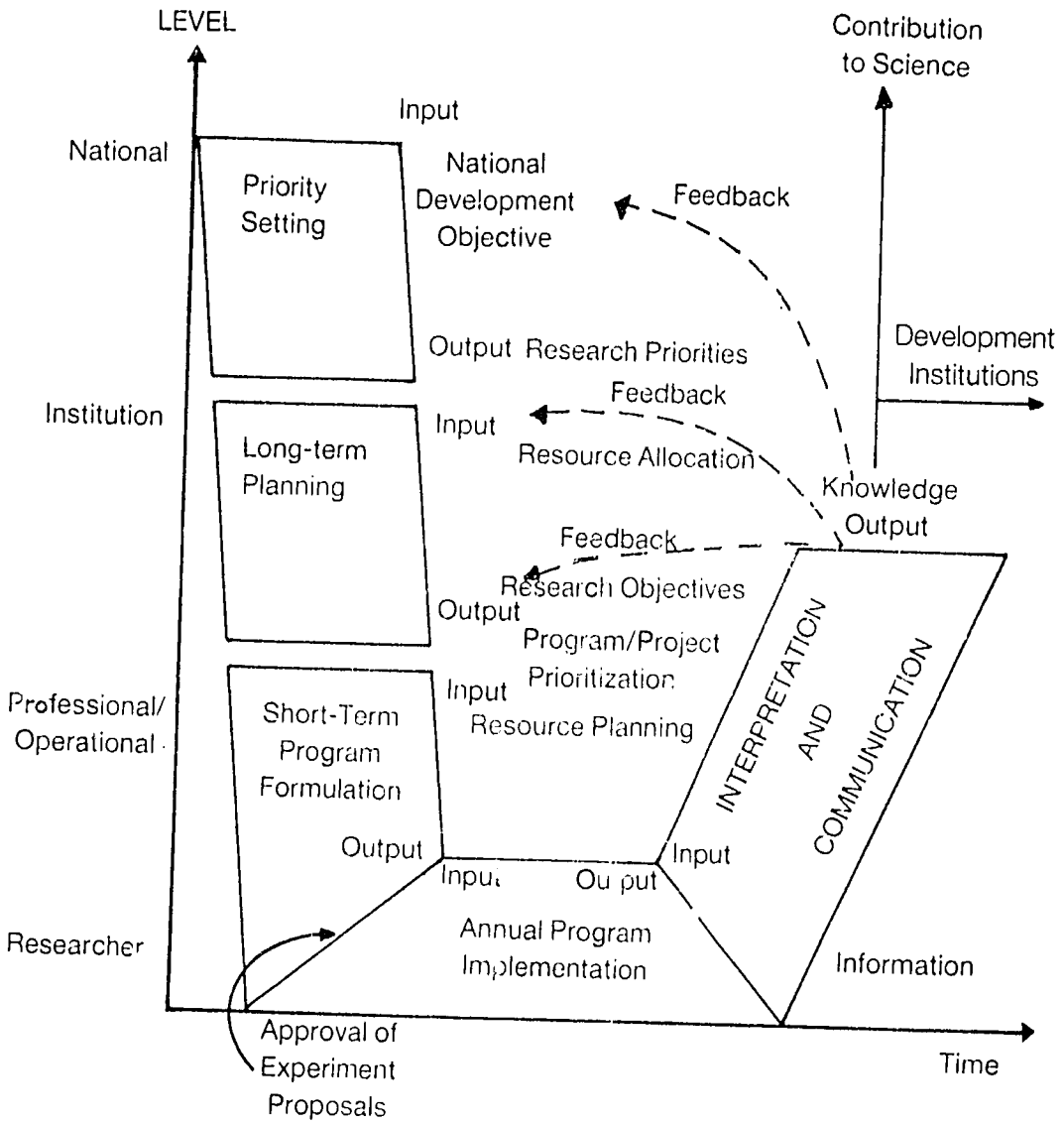

Figure 2. POTENTIAL OUTPUT AND USE OF PBS.

Output	Type of Information	Information From	Use by Scientists - Manager - National Level
Time and Financial Budget Breakdowns	Time and finances allocated to science endeavors broken down by operations project, discipline, regions, centers, commodities, and themes.	Personnel Time Allocation Data Sheet Accounting	Scientist: can assess progress towards objectives regarding time defined objectives for assessment Manager: can identify activities and operations (by individual scientist or in aggregate) that are out of synch or can identify problems for corrective action National: aggregate commodity, thematic and system information, and regional data will provide information for perspective regarding original goals and objectives.
Personnel: time cost	Information by personnel category matched to budget	Personnel Time Allocation Data Sheet Employment/Personnel forms.	Scientist: If overloaded can request supplemental or entreprenurial funds - can identify expertise needs. Manager: can identify if personnel is being over or under utilized - can identify training needs for those in service - can identify gaps in capability for future training needs. National: assist in setting goals and objectives within capabilities or authorize new thrusts and attendant needs.
Variable Aggregation	Development and research objectives target groups	Operation Data Sheet Project Data Sheet Accounting Extension Feedback	Scientist: feedback from client groups on applicability and adaptability can allow corrective action. Manager: information can assist in the prioritization of research projects in light of objectives from national level. National: aggregation on utilization of scientific product by target groups will provide information on goal attainment so can assess correctness of goals and service capability.
Direct Operating Costs (DOC)	Utilization and costs of experimental and operational inputs	Operation Data Sheet Accounting	Scientist: can assess if original proposal request for inputs was accounted Manager: can assess if limited DOC is being over utilized by specific projects or scientists. National: can determine if DOC/ Personal allocation is sufficient to provide staff and research.
Institutional Linkage	Linkage with other research projects: internal, other institute, from technical assistance, and from development institutes	PDS	Scientist: is provided additional information for incorporation into project/experiment. Manager: can facilitate efficiency of projects by incorporating information and minimizing duplication. National: can make decisions for selection of institutes or regions for specialization or cooperation.

PROGRAM BUDGETING IN THE GAMBIA

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INTRODUCTION

This paper provides a brief overview of ISNAR's current work with Program Budgeting Systems. I will discuss the status of the ISNAR demonstration Program Budgeting System program, pointing out some of the primary features and highlighting differences between the ISNAR tool and a more complete Program Budgeting System. These differences result partly from the modified definition of Program Budgeting System that ISNAR is using. I will then describe our experience in The Gambia briefly, concentrating on the goals, results, and further work required. Finally, I will present some of the lessons we have learned to date about Program Budgeting Systems.

This discussion draws on experiences from ISNAR's work in Program Budgeting in many places. These include Morocco, Sudan, Syria, Madagasgar, and The Gambia. Our most recent work, and that with which I am most familiar, has been in The Gambia. I will therefore use that experience to highlight some of the major points I wish to emphasize.

THE SOFTWARE

Over the past two years ISNAR has developed a software tool for use in Morocco in conjunction with the implementation of a Program Budgeting System in that country. While this tool is often called a Program Budgeting System, it is really only a small subset of a complete Program Budgeting System. For countries other than Morocco, the best use of the program is as a demonstration tool.

The ISNAR demonstration software serves to point out some of the benefits possible when moving to a Program Budgeting System. However, it is *not* a fully implemented Program Budgeting System; it is a limited and tightly constrained demonstration of some features of a Program Budgeting System. It serves mainly to systematically organize information. Its two primary functions as a demonstration tool are to illustrate:

- *Consistent Information.* The tool forces the organization of information about projects into a consistent framework.
- *Reporting Facilities.* It demonstrates, in a limited fashion, some of the ways in which the information entered into the computer can be extracted in a useful way.

Consistent Information

The creation of an effective and efficient agricultural research program requires the examination of projects (discrete research activities) in a consistent manner. The minimum essential information required for each project is limited to the objectives of the project - both development and research, the plan of action required to achieve those objectives, and the resources required for that plan of action; human, financial, and other.

The program facilitates gathering the required information about each project and entering it in a consistent fashion. Objectives for each project are required; these must be drawn from an 'approved' list, encouraging the design of projects targeted specifically to satisfy the desired goals. The operations required for each project are then entered and the program builds a project budget from that data. This process also allocates individual scientists to specific projects.

Reporting Facilities

A variety of reports can be generated using the project data. These include reports grouping the projects by objectives, by location, by program, or by scientists

involved. Project budgets can be listed as well as aggregated, into budgets by program. Workplans for individual scientists can be created to reveal under- or over-programming of scientists' time.

While many NARS do not yet have software with the capabilities of the demonstration program, the ISNAR software must not be viewed as a ready-made Program Budgeting System. There are several fundamental differences between the ISNAR demonstration software and a complete programming tool:

Ranking or Prioritizing. Ranking projects by objectives after priorities have been set and the ability to change priorities is not currently possible with the ISNAR tool.

Program Aggregation. A project is assigned to a particular program when the data are first entered. A complete programming tool will have the ability to re-aggregate projects into different programs in the planning process.

Data Consolidation. All but the smallest research systems will have several research centers. The programming tool should have the ability to consolidate data from several research centers into one central data base for use by the planning commission.

Budget Consolidation. A key advantage to a full Program Budgeting System is the ability to consolidate project budgets into existing standard line-item budget categories used in Accounts. This is referred to as a crosswalk. A crosswalk requires a flexible translation process that groups the budget items used in the project budgets with the more traditional line items used in the national accounts. The ISNAR system does not have this capability.

Monitoring. A fully implemented Program Budgeting System will have a formal link to Accounts in order to provide up-to-date reports to both planners and managers of the status of projects. There will also be some standard mechanism to evaluate progress towards goals (considered as Monitoring and Evaluation by ISNAR).

Countries interested in implementing a Program Budgeting System, therefore, should view the ISNAR software simply as a demonstration and educational tool. After use in discussions and training workshops, the software serves to guide the design of software appropriate to the specific situation. The ISNAR software, as an existing package, has the seductive appeal of a rapid and easy implementation of a Program Budgeting System. However, attempting to adopt the existing program as a rudimentary Program Budgeting System can result in an inappropriate and ineffective Program Budgeting System. A Program Budgeting System must be tailored to the specific circumstances of use.

A CASE STUDY: THE GAMBIA

ISNAR has provided advice to The Gambia, currently in the process of implementing a Program Budgeting System. The following section, providing a brief description of the ongoing process, serves as a useful framework for discussion of some of the important issues in any Program Budgeting System.

The Setting

The Gambia is a small (10,690 sq. km.), densely populated (over 65 persons/km2) country on the western coast of Africa. It follows the lower watercourse of the Gambia river and, except for the seacoast, is completely surrounded by Senegal. The estimated population in 1985 was 740,000, with an annual growth rate of 3.2%. Agriculture accounts for 35-40% of the GDP, as well as 80% of employment. Groudnuts occupy 50% of the land under cultivation and are the principal source of export earnings. The principal food crops are rice, sorghum, millet, and maize. Per capita food production has been declining for the last 5-7 years, and local production is currently less than 60% of domestic consumption. The existing agricultural research establishment comprises about 25 scientist-years. This number is not expected to increase greatly in the near future.

In 1985, USAID initiated a long-term, US$ 18,000,000 project to achieve food self-reliance in The Gambia. The project is using a two-pronged approach involving: "..(1) the long-term institutionalization of an effective, applied agricultural research system, and (2) the development, promotion and adoption by farmers of improved agricultural technologies as early as possible."

ISNAR's Role

ISNAR was asked to participate in one of the fundamental components of the project; the establishment of an Agricultural Research Management System (ARMS). The goal of ARMS is to set agricultural research priorities in the light of farmers' needs, researchers' recommendations, and the Government of The Gambia (GOTG) policy objectives and available human and financial resources. A National Agricultural

Research Board (NARB) would group important participants of the agriculture system in order to provide a forum for the establishment of research priorities. ARMS will enforce these priorities through procedures by which research programs will be designed, reviewed, and funded. ISNAR's work in The Gambia was initiated in 1985/86 in conjuction with the Working Group on ARMS and the Working Group for Financial and Administration Research Management Systems (FARMS). Both of these working groups were organized by the GOTG with support of USAID under the Gambia Agricultural Research and Diversification Project (GARD). M. Dagg was the primary ISNAR staff member involved in this work.

The recommendations of both the ARMS and FARMS indicated the need for the selective introduction of planning, programming, and budgeting procedures for the research program on a trial/demonstration basis. The first step was to introduce the concepts of Program Budgeting through a workshop targeting interested personnel involved in the agricultural research process in The Gambia.

PBS Workshop

ISNAR conducted the first workshop on Program Budgeting in The Gambia in late April of this year. The workshop was not designed to implement a Program Budgeting System in The Gambia. Rather, we wanted to describe a system previously designed in the context of a complex NARS (Morocco) and to expose the agricultural research scientists of The Gambia to some alternative methods and procedures for a Program Budgeting System. This preliminary work is necessary before an appropriate Program Budgeting System can be designed and implemented. Both the software part of the system (if it is to be computerized) and the instruments designed for priority-setting and planning (such as the NARB) must be appropriate to the country.

The structure of the workshop was typical of most of our preliminary workshops on Program Budgeting. There were 21 local participants, 14 from the Gambian Government, and 7 from the USAID GARD Project. Participants ranged from scientific researchers to the Deputy Director of Agricultural Research. The Director, Administrator, and Accountant for the GARD Project were also present.

We used the demonstration software, originally developed for Morocco, to illustrate the concepts of a Program Budgeting System. We then described ISNAR's project management system, a modified form of program budgeting. This took two days. The next three days were spent compiling information on three existing projects in the form required for the Program Budgeting System. This, in turn, required the creation of standard sets of research and development objectives, personnel files, other resource files, and standard budgets. The next two days were spent introducing the participants to the actual software and entering the data for the three projects into the computer. The final days were spent discussing the Program Budgeting System process, the benefits to The Gambia, the design of a system for The Gambia, and the procedure for implementation.

Conclusions of the Workshop

The participants of the workshop confronted many of the fundamental issues involved in introducing a Program Budgeting System into a national agricultural research system. Some of the major issues discussed are presented below and, while set in the Gambian framework, are relevant to any Program Budgeting System introduction.

1) There was unanimous agreement among the participants in the workshop that a Program Budgeting System would be useful, perhaps even required, for The Gambia. This Program Budgeting System should fulfill two major functions:

a) Encourage the presentation of projects, in standard format, by objectives and budgets in order to allow rational selection of the most worthy projects for funding. This standardized information should also help prevent over- and under-budgeting of staff time.
b) The Program Budgeting System should fill a monitoring role in order to provide scientists and management with information on the progress of individual projects.

This agreement is essential for providing the motivation necessary for introducing the major changes implied by a Program Budgeting System.

2) To accomplish these two functions, the participants realized that the Program Budgeting System would have to cut across all levels of the research system; national, institutional, and professional. The basic functions of these three levels would be: a) project creation by the scientists, b) program creation by the Institute, and c) advice and review by the national level.

3) The workshop identified the primary participants, users, and beneficiaries of the system. The desired

outputs and basic report formats of the Program Budgeting System were described.

4) The measuring of the outputs of the scientists and projects was believed to be a fundamental part of the Gambian Program Budgeting System. In recognition of the difficulties involved and the sensitivity of the issue, the participants decided that the measuring must be conducted by the scientists themselves, with guidance from the Director of Research.

5) The workshop defined the formal linkages to Accounts that would be necessary for the system to perform its monitoring function, and procedures were suggested to implement them.

6) The elements of the programming cycle, and the participants, were defined. It was recognized, however, that this is not a discrete process with a start and end. Rather, it is a continuous, annual, process.

7) The major elements of the software design were discussed. ISNAR's demonstration tool proved to be extremely useful as a reference framework but was inappropriate for The Gambia for several reasons.

The tool incorporates many assumptions about the structure of the agricultural research system that may not be valid for all countries. For instance, as noted before, within the Demonstration Program Budgeting System, projects are composed of operations, each of which represents the action of one scientist on that project. The projects, then, become scientist based. In The Gambia, an alternative formation was adopted. Operations were eliminated. Projects are composed only of Activities, the tasks required for sucessful completion of the project. Each activity can have several scientists working on it. Projects are task based. This does not, of course, prevent aggregating or extracting information by scientist. Additionally, the required number of forms was significantly reduced.

8) Finally, an initial plan of action was developed, along with a tentative schedule for implementation. This plan defined the major steps required, estimated the resources needed, and described the qualifications necessary for the person assigned the responsibility for the development and implementation of the Program Budgeting System. This plan was accepted as workable, although tentative and subject to change.

CURRENT STATUS

A successful workshop does not guarantee that a workable Program Budgeting System will be created on schedule. While initial plans called for a Program Budgeting System to be implemented in time for the the 1988/89 budget year, this will not be possible. A few of the constraints currently operating in The Gambia slowing the implementation are listed below. These should be concerns of any NARS attempting to implement a Program Budgeting System.

Financial Considerations

A strong impetus for scientists to adopt the Program Budgeting System is the use of the system to justify budgets during periods of constrained or diminishing funds. The system serves as evidence of the planning and importance of projects that have been approved. Currently, in The Gambia, this motivation is lacking. There are no actual budgetary constraints. Money, coming from the GARD project, is effectively infinite. Thus, while 80 to 90% of the agricultural research activities have been put into the Program Budgeting System format, little use of the system is made for financial control. Budgets are updated (increased) every six months with very little limitation.

Manpower Constraints

Several different manpower constraints operate to delay Program Budgeting System implementation. The planning workshop envisaged that one full-time person would be required to oversee the initial implementation. This person does not exist, nor has any particular person been charged with that responsibility.

During the operation of the system, the Director of Research must conduct regular progress discussions with the project leaders. As many autonomous activities are subsumed under several big projects, these discussions should actually be conducted on the Activity level. Currently, there are about 40 different seperately budgeted activities. Obviously, the Director cannot conduct frequent reviews of 40 activities. A final constraint is the demand for computer expertise. The people originally allocated to develop the software and integrate the budgets with Accounts are occupied almost full-time with analyzing research results. What little time they have left over is spent on the main GARD budget.

Organizational Constraints

The National Agricultural Research Board (NARB) was designed to decide on priorities and review and approve the research program constructed at the institution level. This setting of priorities and review of

the annual program are a basic function of a Program Budgeting System. The primary justification for putting projects in the Program Budgeting System format is to provide consistent information for this process. However, to date, no NARB nor ARMS has been created. This is primarily due to political circumstances related to the recent elections. Thus, a system exists without the original organizational structure envisaged to use it. The fall-back plan has been to use the Interim Project Committee (IPC) of the GARD Project to fill the role of the NARB.

LESSONS

ISNAR's strength lies in proposing and modifying a framework for a Program Budgeting System in the country. This framework includes program formulation, project definition and selection, and monitoring and evaluation. These are all parts of the original concept of Program Budgeting. ISNAR can bring to this endeavor a cross-country perspective that helps minimize poorly designed, unworkable systems.

This conceptual development is best undertaken through a series of workshops with NARS personnel. Initial introduction of the concepts can occur at ISNAR, but further development should occur in the country in order to benefit from local expertise and knowledge. The people who will be most affected by the Program Budgeting System, the scientists, research directors, and the planners, must participate in these initial stages.

ISNAR can help draw up specific plans for the implementation of a Program Budgeting System. These plans should set a realistic timetable for implementation and serve as benchmarks from which to measure progress. The scope of these plans can range from specifying the structure and composition of national advisory boards and procedures for formulating long-range plans down to specifying the purpose and expected outputs of a computerized program to help the Program Budgeting System implementation.

ISNAR, however, has *no* comparative advantage in actual software development. The creation of custom software is best conducted in the country by local personnel. A less favored alternative is for the country, itself, to hire consultants as programmers. Two points argue strongly for this division. The first is reduced dependence of the NARS on ISNAR. Any software system as complex as a Program Budgeting System will be subject to evolutionary improvements. These can be simple error corrections as well as the incorporation of added features or the redesign of the system to reflect organizational changes in the NARS. If ISNAR is the software developer, the country will be dependent on the ability of ISNAR to respond quickly to that country's requests for help. With a limited staff and budget, ISNAR will have to defer many of these requests.

The second point, transferring expertise to the NARS, is related. The benefits accruing to a NARS by increasing the computer expertise of its staff are significant. If a NARS has no people qualified to develop the required software, ISNAR can serve to identify consultants, set up training workshops, and advise on other aspects of introducing computer technology.

Computer literacy is often required and not always available. Workshops and training sessions for the Program Budgeting System should be preceded, if required, by a one- or two-day course on computer basics.

CONCLUSIONS

The successful and rapid introduction of a Program Budgeting System depends on many factors. An analysis of our experiences in The Gambia and other countries has identified some of the most important:

1) There must be an effective priority-setting capacity with enough power to actively guide agricultural research.

2) Only minimal changes should be required in the organizational structure of the agriculture research system. Major structural changes usually involve unforeseen subsidiary effects. These will often delay the structural changes themselves and will usually delay the Program Budgeting System implementation.

3) Detailed advance planning of the actual implementation procedures must be carried out. This planning should identify all interested and affected personnel.

4) Affected personnel must be introduced to the concepts early in the process. Every effort should be made to build consensus within this group on the value of a Program Budgeting System.

5) Perceived benefits, such as budget security, by the affected scientists will speed adoption. These benefits should be identified and advertised. If benefits *cannot* be identified, implementation of the Program Budgeting System should be reconsidered.

6) The development and implementation of the system should be evolutionary, with the benefits of each component readily apparent. The complete, immediate implementation of a full-fledged system is usually unworkable. The design of the later stages is partially dependent on the successful adoption and modification of the early steps.

7) A generic Program Budgeting System software program, designed to demonstrate concepts, is not an adequate tool for implementing a NARS-specific system. Effective software for a particular country should be created by local trained personnel. This software should take advantage of existing expertise and can be built from many types of commercial software applications, such as spreadsheets and/or database managers. The design is obviously dependent on the local conditions, the structure of the NARS, and the available resources.

IMPLICATIONS FOR ISNAR

Much work remains for ISNAR. Specifically, in terms of the ISNAR software, we have three major tasks:

1) The flexibility and simplicity of the demonstration tool must be increased. The increased flexibility will allow a greater diversity of NARS to benefit from use of the tool. The role of the software as a demonstration and training tool must be emphasized, and the perception of the software as a generic Program Budgeting System must be avoided.

2) The key areas of a Program Budgeting System that have to be modified for successful adoption by a NARS should be identified. Possible variants for key structures of a Program Budgeting System should be explored and tested. The converse is also required. We must identify those parts of a Program Budgeting System that are absolutely essential for successful operation.

3) ISNAR must consistently acquaint potential users with the preconditions for establishing a workable Program Budgeting System. The resources required to implement an effective Program Budgeting System are significant, and the benefits of the system must be weighed against these costs.

MONITORING AND EVALUATION IN NARS

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This paper is addressed to agricultural research directors who wish to build monitoring and evaluation (M/E) mechanisms into ongoing operations of their organizations. It is the first in a series of papers on the broader topic of monitoring and evaluation, which includes evaluation for planning purposes (ex ante), ongoing program evaluation, final program evaluation (ex post), and impact evaluation. ISNAR has chosen to concentrate first on the monitoring and evaluation of research in progress. Because ISNAR is attempting to develop practical materials for research managers, this paper does not present a detailed review of the extensive existing literature on theories of evaluation. Neither do we attempt to present detailed aspects of personnel evaluation, or financial and physical resources management.

This paper will (1) provide a general introduction to monitoring and evaluation, including a brief definition of terms, and examples of the roles M/E play in planning and managing research; (2) describe ISNAR's approach for developing subsequent materials in monitoring and evaluation; and (3) provide information on how to introduce monitoring and evaluating into ongoing research programs and activities.

Your feedback as research managers is very important to ISNAR's process of developing relevant and practical materials for use in national agricultural research systems. ISNAR seeks your views on the ideas and techniques presented in this paper, as well as the approach ISNAR proposes to take in the development of further M/E materials.

WHY IS MONITORING AND EVALUATION IMPORTANT TO RESEARCH SYSTEMS?

Monitoring and evaluation (M/E) procedures are intrinsic to good research management. Monitoring provides information on activities in progress, enabling a manager to adjust a research program during its implementation; this is particularly important in research systems where resources - human, financial, and physical - are in short supply. Evaluation, which deals more with longer-term issues of quality and relevance, can enable a research institute to assess research programs and methodologies, identify productive staff, and identify and respond to constraints, such as unforeseen budget cuts. Both monitoring and evaluation provide the factual basis for making research planning at all levels of the system more effective, and for justifying further investments in research to national policymakers and donors.

Research managers can greatly benefit from integrating even limited monitoring and evaluation activities into day-to-day procedures. When used in a positive manner, these activities can bring management and staff together on a common understanding of the objectives of research and the performance expected.

Research is intrinsically uncertain in its timing, and research programs must be kept flexible. It is precisely because research is so uncertain that research managers should pay more attention to monitoring and evaluation. Decisions are continually being made to adapt or reorient activities as circumstances and new information require. Much of this information comes from good monitoring and evaluation.

WHAT IS MONITORING AND EVALUATION?

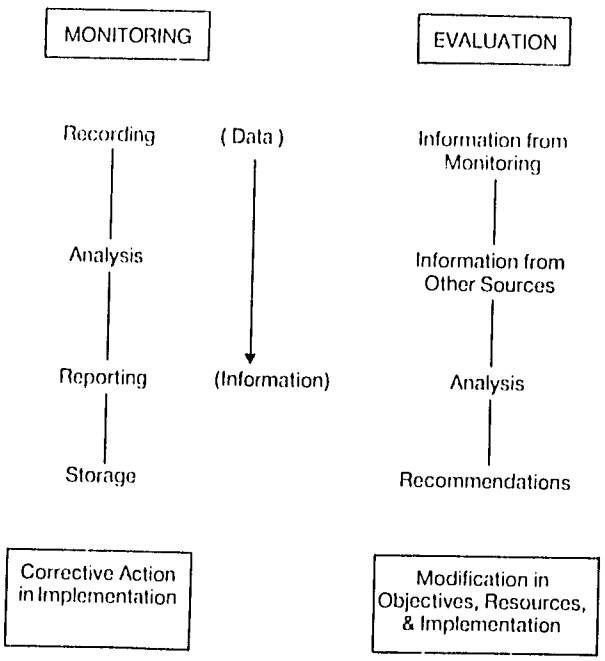
Most research managers have been exposed to some aspects of monitoring and evaluation. Oftentimes this has been through an association with a donor-funded project or for a national planning exercise. The concepts

of M/E presented here are more comprehensive and can be integrated into the day-to-day management of research. They focus upon systems as well as projects, and become part of research planning and the management of resources at all levels in the system. Most M/E is conducted by the researchers, station heads, program leadership, and directorate.

Monitoring

Monitoring is the ongoing process of recording, analyzing, reporting, and storing data during the implementation of an activity (Figure 1). The purpose of monitoring is to determine whether an activity is proceeding according to plan. It provides feedback to management at all levels. This permits management to compare the progress of work against planned objectives, detect deviations, identify bottlenecks, and take corrective actions in the course of research implementation. It is an internal activity and is part of the management information system.

Managers must ensure that the monitoring system is not more time consuming than the benefits justify, that no superfluous data are collected, that data analysis, interpretation, and feedback are timely, and that researchers perceive it as useful. Monitoring provides much of the data necessary for comprehensive evaluation at a later date.



Evaluation

Evaluation is an analytical process, needed in research planning and implementation, and to assess the impact of past activities. Evaluation is based on both qualitative and quantitative information. Much of the information used in evaluations is gathered through routine monitoring. Whereas monitoring would address whether an activity is proceeding as planned, evaluation would ask whether the original plan was appropriate or in need of modification. Evaluations usually result in a set of recommendations.

The term "evaluation" is used to describe distinctly different processes, which can cause confusion when discussing the topic. Any assessment, appraisal, analysis, or review is in the broader sense evaluative. However, in defining evaluation as a management tool, we have assumed that certain basic criteria exist:

- It is important to define targets well in advance and to set up systematic monitoring procedures; this usually takes the form of a time series of well-chosen observations.
- Evaluations must consider the institutional, political, social, and economic context in which they are conducted.
- A differentiation must be made between research results and the contribution they make to national development objectives. The latter is also influenced by national infrastructure, economic policies, extension possibilities, environmental factors, etc.

Figure 1. Relationship of monitoring to evaluation.

An *ex ante evaluation* is a comprehensive analysis of the potential impact of an activity *before* implementation. It serves to set target objectives, and is used in priority setting and resource allocation. It defines the baseline against which progress toward planned objectives would be measured in subsequent evaluations. For a NARS, ex ante evaluation, which leads to improved research planning, may be the single most important evaluative activity.

Monitoring and *ongoing evaluation* involve the collection of data on key indicators and the analysis of this and other information *during* the implementation of an activity. Comparing achieved with expected results in a given time frame is the most prevalent and useful form of evaluation for management purposes; it indicates how efficiently resources are used and identifies problems in original planning and management.

An *ex post evaluation* is an assessment of performance immediately *after* activity completion; it is used to determine whether the program objectives were attained, and the causes of any discrepancies. The lessons learned can be incorporated into subsequent planning and implementation.

Impact evaluation of research attempts to determine the extent to which an activity addressed larger development goals, such as increased domestic farm production or food self-sufficiency. It has a time frame of 10 or more years after activity completion and is, therefore, not an effective management tool. Impact evaluations are often used to justify to policymakers why resources should be allocated to research.

PLANNING MONITORING AND EVALUATION ACTIVITIES

Questions to Ask in Advance

Monitoring and evaluation are successful only if they can be used to maintain and improve the quality of research. They should not become ends in themselves. Before installing new monitoring and evaluation procedures into a particular activity, several questions should be asked:

* *What are the components or functions of the system which need to be managed more efficiently and effectively?* In some NARS the entire system may need improvement, from planning to implementation.

* *What are the defined objectives of these components or functions?* M/E cannot compare performance to objectives if these objectives do not exist or are ambiguous. At each level of research, from planning to execution, objectives should be defined which are consistent with the level of effort required.

  Are new M/E procedures necessary? Is there a less formal approach in process which works, or which could be modified to work better?

* *Who needs the information, for what purpose, and in what time frame?* It is essential when planning M/E activities to clearly determine who will use the results and for what purpose, and to construct the analysis for this audience. Timely corrective action may require that authority be delegated to middle-level managers to take corrective actions in the necessary time frame.

* *What are the simplest M/E procedures which could do the job?* Once objectives have been defined, indicators of performance must be selected, and the methods of measurement determined. Only essential information should be collected.

* *Are the data to be collected objective and verifiable?* Objective in the sense that the same information collected by several different people would be consistent; verifiable in that recorded data exist to back-up any conclusions made.

* *Are personnel and funds available to do the work?* This implies a commitment at all levels to keep records and a capacity to analyse and synthesize data as they are passed through the system.

Roles of Monitoring and Evaluation

Information from evaluations is used for monitoring different levels of leadership (Table 1). Some evaluations may occur only once in 10-15 years, others are required on a more regular basis. In national agricultural research systems, monitoring and evaluation can play a role in improving research programs (1) by contributing information to the processes of priority setting and resource allocation, long-term planning and program formulation, (2) by assessing program formulation procedures and program leadership, (3) by assuring through monitoring that day-to-day activities at research installations are implemented according to schedule, (4) by assessing the potential success of research through early feedback from clients of research while research is ongoing, (5) by evaluating ex post the output of research at the completion of an activity, (6) by evaluating the ultimate impact of an activity well after

completion to estimate the contribution of research to development.

ISNAR's APPROACH TO DEVELOPING M/E MATERIALS

In the previous section we described the many contributions to research planning and management to be made by a monitoring and evaluation system. Because of the extent and diversity of these contributions, ISNAR is taking an evolutionary approach to the development of M/E materials for use in national agricultural research systems. The dearth of practical M/E materials for research management has led ISNAR to approach the task in the following manner.

The first objective is to develop techniques for monitoring and evaluating *ongoing* research activities. The primary focus is on evaluating the quality and performance of the research program, including decision-making procedures, program leadership, and the adherence of scientists to accepted standards of research execution and reporting.

There are also important associated elements of personnel management and physical resource management which will be presented in other ISNAR documents. For this presentation of M/E, we must assume that adequate procedures for research priority setting and planning have been followed in developing the research programs.

The second objective will be to develop materials for *ex ante* evaluation, which is fundamental to the planning processes of research. Because planning is probably the single most important management activity of a research manager, ISNAR is preparing a separate analysis of different planning techniques, to which ex ante evaluation contributes. Ex ante evaluation defines the potential impact of different activities and establishes the baseline for subsequent evaluations.

The third objective will be to develop materials for *ex post* evaluation, the measurement of achieved results from a completed research project or program. This is an integral part of subsequent program formulation, and provides valuable lessons learned to researchers and research managers.

The final task will be to develop materials for *impact* evaluation of research programs. This is not considered a priority concentration, since it is a long-term endeavor more appropriate for the justification of research programs to policymakers than for research managers.

MONITORING AND EVALUATING ONGOING RESEARCH PROGRAMS

Definitions of Terms and Concepts

In this document, the term "program" refers to coordinated research activities whose scientific output contributes to a national research objective. Programs are composed of projects, which address specific research problems. Each project in turn comprises a number of specific operations or experiments. Objectives must be determined for each level of the research hierarchy. In turn, each experiment, project, and program will be evaluated in reference to these objectives.

Relationship Between Planning and Evaluation

At every level of research planning and program formulation there should be clear definitions of goals and objectives, identifiable inputs and expected outputs, and some notion of time frame. It is during these exercises that performance indicators are identified.

One of the ways research programs can be designed and key indicators for monitoring identified is through the use of a logical framework. The "logframe" provides a matrix of logical reasoning which defines inputs, outputs, purposes, and goals of a program or activity. The logframe is just one technique which has been successfully used by planners. Whether or not this technique is used, the basic information it provides is essential to adequate planning. The logframe specifies the data collection and reporting requirements (monitoring), and it defines from the outset of an activity the standard against which actual results will be measured (evaluation).

Table 2 summarizes some of the sources of data suitable for research program M/E and their means of verification. This table is by no means exhaustive; it is suggested as a list which may guide research managers in defining an appropriate list for their systems.

Monitoring Ongoing Research

Monitoring is primarily focused on the implementation of inputs and on achievement of the outputs. Most data used in monitoring research activities are recorded by researchers themselves. They are compiled and analyzed

Table 1

Expectations from Evaluations of Agricultural Research at Different Levels of Management in the System

Level of management	Category	Methodology	Frequency	Use
1. Cabinet	Impact	Socioeconomic survey	5-15 yrs	Guide investment level
2. National agricultural ministries	Impact	Socioeconomic survey	5-15 yrs	Guide balance of investment in research/development institutions
	Ex-post	Technical Review	2-5 yrs	
3. National agricultural research (council)	Ex-ante	Technical and socioeconomic analysis	2-5 yrs	Determine potential impact of research initiatives
	Ex-post	Technical review Diagnostic studies	2-5 yrs	Guide allocations to research institutions
4. Research institutions	Ex-ante	Technical and socioeconomic analysis	2-5 yrs	Determine potential impact of research initiatives; justify/ allocate resources to divisions/programs
	Monitoring	Physical/financial organizational; Beneficiary contact	annual 1-5 yrs	Improve efficiency of management of research institution
	Ongoing	Annual research reports	annual	Improve research implementation and planning
	Ex-post	Technical review	2-5 yrs	Balance of programs Justification of resources
	Ex-post	Personnel evaluation	annual	Assessment/ assignment of personnel
5. Research stations	Monitoring	Physical/financial organizational	annual	Improve station management
		Annual review and reports		Short-term (annual) program
		Personnel evaluation		Personnel management
6. Programs	Monitoring and ongoing	Quarterly progress, annual and final reports Annual review	quarterly and annual	Guide short-term programs; improve program planning and management
7. Projects	Monitoring and ongoing	Quarterly progress reports Annual report Annual review	quarterly and annual	Guide to modify projects
	Ex-post	Final report	3-5 yrs	Guide for future projects
8. Researcher	Monitoring and ongoing	Quarterly progress reports Annual reports Annual review	quarterly and annual	Guide research execution and planning
		Personnel evaluation	annual	Assessment of performance

progressively through the hierarchy from project leaders, to program heads, to the research directorate. In the case of research inputs and services, the hierarchy involves management and administration from station to directorate levels. At each level there should be clear assignments of responsibility for the supervision of data collection, analysis, and reporting, and for remedial action.

The functions of a monitoring system should be agreed upon by the people implementing the system. Several criteria should be kept in mind when designing a monitoring system:

- Who needs the information and for what purpose?

- What is the simplest means possible of collecting this information? Can it be obtained from existing sources? If the information is not available, can it be collected at reasonable cost in relation to its usefulness?

- Can the information be presented in a straightforward format for timely use in decision-making?

- Can the information be stored in a format compatible with data from other sources, so findings from similar activities can be compared?

Recording data on key indicators. Most monitored data are available from existing or easily installed procedures, such as lab/field notes, staff time sheets, monthly or quarterly budgets, and procurement records. Monitoring need not be complicated or extensive, but rather it should become part of the routine of day-to-day management. Desired information, such as that on resources delineated in the PBS workplan, can be summarized in quarterly and annual progress reports.

Another form of monitoring keeps track of the technical direction of research. Both on-farm research and beneficiary contact monitoring are methods used to determine if ongoing research is appropriate to local conditions.

Analysis. It is not sufficient to record data. They must be analyzed to be useful to management. Each functional level should perform some analysis and present a synthesis to the next higher level. This analysis is important when considering both the flow of resources and technical information. Good research requires ongoing surveillance and final statistical analysis - the transformation of data into information. This does not always occur in NARS, either through a lack of time or capability on the part of the researchers.

It should be stressed that analysis of research programs and component projects and operations is not a solitary activity. At many levels in the hierarchy, scientists rely on peer review, both formal and informal, to test their logic, methods, and ideas. This collaborative sharing of intellectual ideas and experience is valuable to all scientists, but is indispensable to younger, less-experienced researchers.

Reporting. Managers at all levels of a monitoring system should consider reporting as a two-way process. While information about implementation is primarily communicated upwards to higher levels of management, it is essential that the people who contribute to the monitoring system know that their efforts are being used.

Researchers should accept the responsibility of routine reporting to technical and administrative supervisors. Quarterly progress reports and annual/final reports are standard in many research systems. The quarterly reports are primarily used to safeguard the resources available to research, to identify problems within the yearly activity; annual reports summarize resources used and technical progress, both valuable to subsequent planning and budgeting exercises. Project and program leaders must, in turn, review these periodic reports and summarize the information for the next highest level of research management.

Another important form of reporting is the periodic requirement for oral presentations on research proposed or in progress. Whether organized by station, program or technical discipline, seminars provide a visibility over research which can prompt valuable feedback from peers. Seminars generally involve a wider audience than is involved in the formal reporting process. This can be particularly important when conducting multi-disciplinary research, for it provides a forum for discussion.

And, finally, program leadership should organize an annual program review, for the evaluation of the past year's results and for planning and fine-tuning the next year's research program. Project leaders in this forum should be able to summarize the activities carried out in their projects and discuss and defend their rationale for the coming year. These meetings should be monitored through minutes, and an annual program report should result.

Table 2

Examples of Research Program Indicators

Levels of achievement	*Possible indicator*	*Means of verification*	*Responsibility for data collection*
INPUTS - Determined by projects, based on operation workplans:			
- program	stated objectives	program report	program head
- personnel	scientific and support time	time sheets	individual reports
- funding	expenditures	accounting data	accounting office
- facilities	construction or acquisition	on-site report procurement data	institute engineer accounting office
- equipment & supplies	acquisition actual use	procurement data lab/station logs	accounting office lab/station manager
- leadership	project meetings program meetings	meeting reports meeting reports	project head program head
- training	courses completed	training records	training officer
OUTPUTS - Considered both by projects and by programs:			
- preliminary research results	research data from experiments	research reports publications and surveys	scientist project head
- completed research results	program committee recommendations	program records annual reports	program head NARS director
- research capacity improved	trained personnel & improved facilities	training records administration records	training officer administrator
PURPOSE - Contribution of knowledge from research programs to research, development and policymaking bodies:			
- new knowledge of interest to research, extension & policy makers	released technology or recommendations	program records certification res/extension communications on policy	program head national body extension service NARS director
GOAL - Research relationship to national development objectives:			
- increased crop production	production data	farm surveys	statistics dept.
- intensified land-use	changes in crop patterns & inputs	input statistics	devel. ministry
- conservation & land-use	reduced erosion resource planning	survey methods planning document	land-use body planning body
- increased income	per capita change increased spending	national data village surveys	statistics dept. devel. ministry
- improved nutrition	decreased disease & mortality	nutrition surveys	national health service

Storage. Whether a manual or computerized data collection and storage system is used, information should be accessible and retrievable by managers at different levels of the system. A thoroughly centralized system of data storage can cause unnecessary delays at outlying stations if information is unavailable. Likewise, backup documentation in the detail required at the station level need not be in central files. When deciding where to store information, the need for information, the facility of movement, and the security of data storage should all be considered.

Evaluating Ongoing Research

Role of peer review. Research evaluation involves looking at the relevance achieved through research planning and programming, and the correct execution of research activities. Both require an assessment of the technical judgement and skill of both researchers and program leadership and are best accomplished through peer review. Peer review is the approach most often taken in annual program reviews, comprehensive program reviews, and personnel performance evaluation.

It must be stressed here that no M/E system can make up for a lack of key scientific leadership in a NARS. That scientific staff are largely young and inexperienced is a widely recognized problem in developing countries. The important role of program leadership cannot be stressed enough when one considers the absolute importance of the peer review process to quality experimentation. Peer review of proposed experiments, including a discussion of activity objectives, rationale, methodology, analysis, and interpretation should involve all researchers as part of the annual review process. The role of senior scientists is crucial to structuring the discussion and to offering alternative ideas and methods.

Peer review can play a role in evaluating research activities by determining:

- the degree to which program, project, or activity objectives have been achieved;

- the extent to which objectives have been modified or activities proposed in light of new information, primarily from clients;

- the extent to which activities are on schedule;

- the timeliness and effectiveness of communications;

- the capability of staff to accomplish their objectives;

- the extent of constructive interactions with other national and international research institutes;

- the degree of success achieved in resolving resource constraints, whether funding, facilities, or manpower;

- the successful development of interdisciplinary teams for implementation and analysis.

Annual program review. Each program should conduct an annual internal evaluation to analyze the past year's research results and review the forthcoming year's proposals. This review should be institutionalized as a part of routine management in a research organization. Preparation for and participation in these technical reviews should constitute part of a researcher's job responsibilities and, therefore, should become part of the employee performance evaluation process. Likewise, the quality of project and program leadership and management should be assessed in this process.

Comprehensive program review. Periodically, say every three to five years, it is also important to organize evaluations at the project or program level to address questions of original objectives, progress, and lessons learned. This comprehensive program review often involves bringing together a group of senior researchers for a more in-depth analysis than occurs during the annual program reviews. Whether a group is pulled together to evaluate a particular research program, or the ensemble of programs which comprise the ongoing research system, the boundaries of their task and the utility of it must be clearly defined in advance. The boundaries of the evaluation are usually outlined in a scope of work prepared beforehand.

Advance planning of a comprehensive evaluation should include precise plans on documentation to obtain, people to interview, and sites to visit, allowing sufficient flexibility should a different line of inquiry be suggested from preliminary analysis. Some supplemental information may need to be gathered through surveys or interviews. Most evaluation teams use a blend of interviews, field visits, observations, and report reading. An evaluation must place the program in the institutional, political, social, and economic context in which it is implemented. Beyond a comparison of achieved and expected results, an evaluation should try to clarify the internal and external factors affecting these results. Even technically sound and competently implemented programs sometimes do not achieve their objectives, due to such extrinsic factors as staffing changes, funding cuts, or a lack of fuel for transport.

An evaluation culminates in recommendations; for a research program this might be suggestions for the revision of its objectives, workplan, and schedule, or the suggested termination of a program or component of it. Constraints to implementation are identified and solutions recommended. Recommendations for program changes should be discussed with the researchers and program leaders prior to the submission of the final report. This gives both the researchers involved and the team a chance to exchange ideas and test each other's logic in an informal setting.

Estimating Costs of Monitoring and Evaluation

When monitoring is carried out through normal management channels, very few extra resources are needed. Time, however, must be allocated for coordinating and tabulating data at the program and directorate levels. Unless the research system is undertaking very extensive data collection and analysis, a specialist in evaluation should not be necessary.

There are more extraneous costs associated with evaluations when external assistance is brought in. There are pros and cons to using external evaluators, for more complex or controversial research programs, collaboration with external specialists may be valuable. Costs should be budgeted in advance, based on the type of evaluation required, the expertise sought, transportation and support needs, and the time required. Should additional data collection be required, the costs of these activities should be built into the research program budgets. Evaluation should become a part of routine programming and implementation, and be incorporated as an expense of conducting research.

CONCLUDING REMARKS

This paper has tried to illustrate the importance of integrating even a minimal package of monitoring and evaluation activities into day-to-day management practices in national research organizations. It concentrates on the internal monitoring and evaluation which should take place for ongoing research, and focuses primarily on the necessary reporting requirements of the researchers themselves. Setting up M/E procedures in a research system should be seen as a tool for better management and not as an auditing exercise.

ISNAR will be testing some of these ideas and methods in national agricultural research systems over the coming year. It is our intention to more fully develop methods for ongoing research program monitoring and evaluation before moving into the other broader areas of evaluation described earlier: ex ante, ex post and impact. We welcome your feedback on both the information presented here and the approach ISNAR proposes to take in developing subsequent M/E materials.

Finally, I want to thank my colleagues, Matthew Dagg, Peter Goldsworthy, and Ghazi Hariri, and former ISNAR staff member, Josette Murphy, for their contributions to this paper. Much of the material is theirs.

ORGANIZATION AND IMPLEMENTATION OF RESEARCH EVALUATION AND MONITORING IN THE ICAR RESEARCH SYSTEM

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INTRODUCTION

The Indian Council of Agricultural Research (ICAR) is an autonomous registered society set up by the Government of India to undertake, aid, promote, and coordinate agricultural and animal husbandry research, education, and the transfer of technology. Over 85% of its funds come from government grants but the Agricultural Produce Cess Fund, the US-India Fund, bilateral cooperation, and foreign assistance also contribute to its resources. The annual budget is around Rs. 1,800 million, excluding AP Cess, US-India, World Bank loans, and external assistance.

The Council functions through:

- its headquarters, which is an administrative and national evaluation facility;
- its research units, which comprise 40 research institutes, 6 national research centers, 6 project directorates, 4 national bureaus, and the National Academy of Agricultural Research Management.

These institutes and centers cover all the crops, livestock species, fish production systems, agricultural engineering, processing technologies, agriculture statistics, and economic and natural resources related to agriculture.

There is a network of 72 multi-disciplinary and multi-locational problem-orientated All-India Coordinated Research Projects (AICRPs). ICAR also supports individual scientist-oriented AP Cess and US-India funded ad hoc research and also implements bilateral cooperative and foreign-aided research. The Council employs around 6000 scientists and, along with the 26 agricultural universities, is perhaps the largest agricutural research system in the world. The ICAR is headed by a senior science manager, the Director General, and is assisted by deputy directors general who are heads of respective technical divisions and who in turn are assisted by assistant directors general and senior scientists, etc. There is a separate hierarchical set-up for administrative and financial services.

NATIONAL EVALUATION SYSTEM

A national evaluation system exists. A planning commission group on agricultural research and education is constituted every five years to consider the five-year plan proposals. Furthermore, the ICAR headquarters has the main responsibility for evaluation and monitoring. Here, in addition to seven subject-matter divisions, specialized evaluation units, such as the Project Implementation and Monitoring Unit (PIM), also exist for the planning of projects.

POLICY FOR EVALUATION

There is a formal policy on evaluation, especially of the ICAR institutes, coordinated research projects, and ad hoc schemes. Although there is no set policy, the whole system is also subjected to an external review from time to time.

RESPONSIBILITY CENTERS AND EVALUATION SYSTEMS

I. ICAR Research System

When the five-year plans are made, a large working group on agricultural research and education is appointed by the Planning Commission which evaluates the implemetation of the program envisaged in the previous plan, identifies research and educational priorities for the next, and indicates the strengthening or expansion of the research system and the financial resources required. In

evaluating the effectiveness of program implementation, the utilization of research results, and their impact on the improvement of production and productivity of major agricultural products is considered.

2. Components

(a) *Institutes*

The institutes are the major units of the ICAR research system and have an internal evaluation and monitoring system. Research projects are formulated by individual researchers or a group of researchers in well-structured Research Project File (RPF) proformas which provide objectives, technical programs, evaluation measures, and funds required. These are subjected to ex-ante evaluation by the project leader and the head of the division before they are approved by the Divisional/Institute Staff Research Council (SRC).

The SRC's comprise the head of the division and scientists of the division at the divisional level, and the director, head of divisions, and senior scientists at the institute level. The divisional SRC's exist only in the National Institutes (the three largest institutes with considerable postgraduate teaching responsibilities). There is a continuous monitoring of the research projects through the quarterly meetings of the SRC and submission of brief reports every quarter and at the end of the year in RPF. These reports are examined by the project leader/ head of the division and the director. The final reports of the projects in RPF are also subjected to *ex-post* evaluation. The institutes are subjected to external evaluation every five years (Quinquennial Review). The review involves the institute, ICAR headquarters, and an external expert team. Each of the institutes also has a Management Board or Committee to broaden the base of decision making on research programs and resource allocation, and this meets quarterly.

(b) *All-India Coordinated Research Projects (AICRPs)*

The AICRPs are monitored regularly by full-time senior scientists - the Project Coordinators - and are subjected to evaluation at annual workshops which involve not only the scientists engaged in the projects but also scientists from ICAR headquarters and some senior research scientists from outside the system. These projects are also subjected to external evaluation every 5 to 10 years.

(c) *Ad hoc Projects*

Ad hoc projects are subjected to evaluation by the ICAR headquarters' scientists, external referees and scientific panels of 15 to 20 eminent scientists drawn from within and outside the ICAR research system.

(d) *Foreign-Aided Projects*

The evaluation is done jointly by scientists at ICAR headquarters and representatives of the donor agencies.

CATEGORY OF EVALUATION

As indicated above, ex-ante monitoring and ex-post evaluations are carried out. There is no selection of research projects for evaluation except by the Quinquennial Review Teams (QRTs) and the mid-term appraisal committee, both of which evaluate the major programs.

TYPE OF EVALUATION

Evaluation is primarily designed to examine the effectiveness of the implementation of the technical program and achievement of the envisaged objectives. Little emphasis is laid on efficiency in terms of cost: benefit ratio or the impact on production or productivity of a particular crop/livestock species in the country in general. The quinquennial reviews of the institutes and of the system, however, do keep in view the results obtained in relation to inputs and the impact the results have made on production.

METHODS OF EVALUATION

Peer review based on presentation of the reports in the SRC meetings at the institute, annual workshops of the AICRPs, and examination of reports are the major methods of evaluation.

USE OF EVALUATION FINDINGS

The evaluation findings have been used for restructuring the system, e.g., adding new institutes/research units and projects, redefining the mandate of different research units, and making changes in their programs and structures.

RESULTS OF AN EVALUATION OF THE ICAR RESEARCH SYSTEM

A critical study of the evaluation and monitoring system in ICAR was carried out as part of a country report on the Role of Evaluation in National Agricultural

Research Systems (NARS) prepared for the International Development Research Centre (IDRC) of Canada last year. It was based on responses to questionnaires sent to the institute directors, heads of divisions and project coordinators, and personal discussions with senior officers at ICAR headquarters, directors, and heads of divisions of 18 selected institutes. Other documents related to the evaluations carried out by QRTs of the institutes and mid-term appraisal committees of AICRPs were also examined.

The results showed that a small technical section existed in each institute to help the director in research project evaluation and maintenance of research project files. On average, two meetings of the SRC per year were held, and the progress of 70 projects was monitored, the final reports of 18 projects were evaluated, and 24 new proposals were considered, giving an overall average of 110 projects evaluated. The SRC meetings were held over an average of three days making almost 25 projects considered each day. The meetings were slightly longer in the National Institutes; however, the time available for evaluation of each project was insufficient. Outside experts participated in about one-third of the SRC meetings.

Although the SRC was considered highly effective by the majority of the respondents, the time spent for evaluation would not suggest any real efficiency. The examination of the RPFs in most of the institutes involved in the study revealed a lack of seriousness by project leaders, heads of divisions, and directors in evaluating the project proposals or their annual/final reports and in communicating these evaluation findings to the scientists to allow them to improve their performance. There was little funding of individual projects. Instead, the divisions/centers were given budget allocations without any serious consideration of the needs of the projects being carried out.

The responses of the Project Coordinators (PCs) about the effectiveness of the research evaluation of AICRPs suggested that effective monitoring of these projects did exist through the visits of the PCs to the units and through the annual workshops. Most evaluation is, however, about effectiveness in implementing the technical program and is primarily based on the peer review at the workshop. The major constraint in the evaluation was the delay in the submission of the reports. It has been suggested that to make the evaluation more effective, the PC units should be strengthened and the external review of the work be done every five years. The PCs visited each center on average once a year and communicated their observations to the center and the ICAR headquarters. Similarly, on average, one workshop was held each year, except in some projects where it was once in two years. The recommendations made at the workshop, as well as those of the mid-term appraisal committee, were fully implemented.

The ad hoc research projects funded out of the AP Cess fund and US-India fund which were subjected to evaluation in 1985/86 numbered 1172 and 92, respectively. Out of the 1172 AP Cess-funded projects, 696 were actually operating during the year. A total of Rs. 174 million and 86 million were spent on the two sets of schemes. These schemes were monitored by 21 scientific panels.

WEAKNESSES IN THE EVALUATION SYSTEM

In spite of the well-laid system of research evaluation, there is a general lack of appreciation of the need for and role of research evaluation. Three major factors, the centralized and generalized recruitment and placement system of scientists, rotation of heads of divisions, and five-yearly assessment of scientists for their career advancement, appear to have led to lack of seriousness in planning, evaluation, and monitoring of research projects. There has also been a general decline in the standards of research performance, a lack of research leadership, and a tendency to take more individual-oriented projects and projects which are likely to yield a large number of publications. The size of some of the institutes has also become unmanageable.

There is a need for a strong program planning, monitoring, and control center at the ICAR headquarters. This should have the major role in evaluation and monitoring, with an in-built system for the flow of the information required for evaluation from the institutes, AICRPs, and other projects. The evaluation should involve authorities which have the power to modify or redirect programs and re-allocate the resources.

A number of factors have led to weakness in the role of the ICAR headquarters in evaluation and monitoring of ICAR institutes' research programs. These include:

- the dichotomy of administrative and technical wings at the ICAR headquarters;
- three major national institutes which involve one-third of the personnel and funds of the system reporting to the Director General and not to the Deputy Directors General, who are heads of the technical divisions at headquarters;

- non-involvement of the Assistant Directors General in evaluation and monitoring of the institutes' research programs;
- little technical/administrative support to the DDGs for servicing the institutes.

In addition to correcting these anomalies, involving external experts in research evaluation of the institute programs may help. In addition to effectiveness, the programs should also be evaluated for:

- efficiency, especially the output in relation to efforts made and manpower and infrastructure facilities invested; and
- the impact of production technologies/new varieties developed on the increase in production or productivity per unit area/time.

The present career advancement system, through assessment of the research output (primarily through evaluation of the new varieties and the publication of papers) of individual scientists, should be delinked from the evaluation of the research projects. Greater efforts should also be made to encourage a multidisciplinary approach to research, since a major objective in agricultural research is to solve problems related to production and productivity.

HUMAN RESOURCES PLANNING AND MANAGEMENT: A REVIEW OF ISNAR ACTIVITY

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This paper will briefly review ISNAR's work concerning human resources planning and management (HRPM) during the last twelve months. The main focus will be on the analysis and recommendations contained in NARS reviews undertaken during this period.

Three key HRPM subject areas will be addressed, namely, planning, staffing and development, and utilization. The following discussion will describe in general terms how these different aspects of HRPM have been dealt with in recent ISNAR reviews of national agricultural research systems and will consider some of the main conclusions and recommendations that have emerged from these exercises.

HUMAN RESOURCES PLANNING

Human resources planning is concerned with the assessment and provision of the types and amounts of skills required for the attainment of predetermined tasks over a specified time period in the most cost-effective manner. In simple terms, this planning process can be divided into two main parts: one which is concerned with the question - what human resources will be required?, and the other, which focuses on - what human resources will be available?
The level of detail and sophistication in dealing with human resources planning issues has varied from one review to another. To a large extent this is mainly due to differences in the precise terms of reference of the review mission and the extent to which they worked with research managers and scientists (sometimes constituted as task forces) in developing estimates of human resource requirements for the future.

ISNAR's recent work in Tunisia is a good example of the benefits that can be derived from working closely with a team of national consultants, each of whom has specialized expertize in certain clearly defined areas. In the Tunisian report, research needs by commodity and disciplinary areas are specified in considerable detail, using professional researcher full time equivalents (f.t.e.). A ten-year planning period is adopted, and two sets of first and second order research priority needs are presented (See Table 1). It is noticeable that no sophisticated manpower planning methodology has been used to determine these priority needs. Instead, they have been derived as an integral part of the overall research planning process. This once again underlines the point that human resource requirements for agricultural research personnel can only be estimated on the basis of carefully formulated national research strategies and program objectives. There is no human resource methodology that can circumvent the necessity of undertaking this detailed planning and programming of agricultural research activities.

By expressing future research needs in terms of scientific full-time equivalents, the Tunisian team can make a comprehensive assessment of human resource requirements which is independent of the present organizational structure of agricultural research in Tunisia. Once requirements have been established, it is then appropriate to consider what the most appropriate organizational structure should be. It also encourages a national system perspective by implicitly taking into account all relevant scientific professional personnel in the country. Finally, it helps to ensure that new physical investments for agricultural research are planned so that they serve in a precise manner the needs of professional personnel for research facilities. Too often in the past, research infrastructure has been developed without a clear conception of its future utilization by research personnel.

On the basis of a rigorous examination of agricultural research needs in Tunisia, the team estimates that a total of 248 f.t.e. researchers will be required in 1996 in order

to meet first-order research priorities, and 318 f.t.e. researchers to meet second-order research priorities. Given that there were approximately 245 f.t.e. professionals already engaged in agricultural research activities in 1985, this means that the 10-year research plan elaborated by the team could be implemented *without any increase in the overall numbers of researchers*. Furthermore, the team also concludes that if the experiment station network is rationalized in accordance with their recommendations, then financial resource requirements in 1996 would be no higher than at present. The second-order priority needs require only a 20% net increase in professional research personnel over a ten-year period. While research expenditure would need to increase on average by 2.6% per annum to ensure that these additional researchers are utilized effectively, total agricultural research expenditure in 1996 would remain at the mid 1980s figure of 1.6% of agricultural gross domestic product.

The limited increases in research personnel recommended by the Tunisian team should be contrasted with the very large increases in research personnel which are frequently recommended in national agricultural research plans. Clearly, in some instances, these increases are justifiable, both in terms of actual research needs and in the likely availability of resources, but very often over-inflated estimates of human resource requirements are produced which are only tenuously related to the overall research planning process. When this happens, human resource plans are little more than 'wish lists'. The adverse consequences of this approach to human resource planning are well known. A very similar human resources planning methodology was adopted in the Niger review, again with heavy reliance being placed on collaboration with national research personnel in developing personnel requirement estimates.

The Zimbabwe review adopted a more aggregated approach to determining human resource requirements than was the case in Tunisia. The team recommended that government financial support to the Department of Research and Specialist Services (DR & SS) should increase in real terms by 5.0% per annum during the next 5-6 years, which is in line with the targeted growth of the agricultural sector under the present Five-Year National Development Plan. Under this particular financial scenario, the team calculated that the Department could effectively employ approximately 195 professional staff by 1992, compared with the 140-150 who are currently employed. On the supply side, it was concluded that given current and projected outputs of agriculture and science graduates from domestic and overseas training institutions, DR & SS should be able to recruit the required number of high-quality graduates to attain the projected net increases in professional and sub-professional staff, taking also into account additional recruitment to make up for the attrition of existing staff. The key resource constraint identified by the team is the likely availability of experienced researchers in DR & SS who have an essential role to play in supervising inexperienced staff. It was recommended, therefore, that DR & SS employ sufficient numbers of expatriate scientific staff as a stop-gap measure during the next 5-10 years.

On the basis of an examination of the main commodities, factors and production systems in Zimbabwe, the team allocated the projected professional staff complement of 195 among the proposed research programs and research services activities. Again, it should be noted that it is the research program (measured in full-time equivalent research person years) that provides the essential building block of the human resources planning exercise.

The review of the Institute of Agricultural Research in Ethiopia was centrally concerned with analyzing the feasibility of a comprehensive manpower development plan developed by the Institute. This calls for a doubling of professional research staff during a nine-year period. While the team believed that IAR's projected human resource estimates were well reasoned, concern was expressed about the availability of university and other graduates to meet recruitment targets. In general, the overall demand for these personnel from government agencies is much greater than the supply. Another set of concerns expressed by the team focused on the ability of IAR to train and effectively deploy such a large increase in mainly inexperienced staff across a much enlarged network of research stations. The team recommended that IAR should set up a Manpower Development Unit which would have the main responsibility for the implementation and monitoring of the manpower development plan.

During 1987, ISNAR staff participated in a review of the NARS in Pakistan. With regard to human resources planning, the mission report noted that further planning should concentrate on improving the efficiency of *existing* research staff, with fewer additions of staff, concentrated on carefully chosen high-priority research problems and that clearly delineated research programs must form the basis of human resources planning. The lack of a well-developed human resources computerized information system was identified as an important factor impeding the production of a long-term operational research plan. In all NARS, but especially relatively

large and decentralized ones such as in Pakistan, research managers must have comprehensive, up-to-date information on all key aspects of the utilization of human resources. This will be dealt with in some detail in the presentations on management information systems and program budgeting.

STAFFING AND DEVELOPMENT

Control over the recruitment process is a prerequisite for effective HRPM. With the exception of Tunisia, research systems reviewed by ISNAR missions during the last year have had sufficient control over the recruitment of researchers and other key categories of personnel. Furthermore, they have generally been able to attract higher-quality recruits, although again, relatively poor conditions of service in the ministry research organizations in Tunisia have militated against this.

With regard to training, considerable emphasis is placed on the need for carefully programmed on-the-job and formal training for researchers and other support personnel. Recommendations in this area are relatively uncontentious, given the widespread recognition by senior research managers in the NARS concerning the importance of training. However, this is sometimes not the case at the senior policy-making levels and among government agencies responsible for approving training activities.

An important issue is the extent to which a formal apprenticeship for graduate researchers should be instituted. In the Zimbabwe and Uruguay reports, 4-5 year apprenticeships are recommended, composed of two years of closely supervised and structured on-the-job training, followed by master's degree training (or equivalent) in research methodology and an appropriate specialization.

All the review countries, with the exception of Pakistan, continue to be heavily dependent on overseas institutions for most postgraduate training, which has given rise to many of the well-known problems of cost, relevance and duration.

In those countries where very large increases in the research cadre are planned (Ethiopia, Uruguay), the formulation and implementation of comprehensive training strategies pose a major challenge. This is not simply a question of costs, but equally significant are the problems associated with the sequencing of formal postgraduate degree training and the selection of overseas universities.

Given the large investments in training by many NARS, the need to evaluate the effectiveness of training activities becomes increasingly important. ISNAR will need to give more attention to this in the future.

Training requirements for technical and administrative support personnel are given relatively limited attention in the review reports. This is symptomatic of preoccupation with professional personnel requirements, and development and utilization issues in NARS. Again, this imbalance in treatment needs to be rectified.

HUMAN RESOURCES UTILIZATION

A multitude of factors collectively influence the efficiency with which agricultural research personnel are utilized. This, after all, is what agricultural research planning and management is all about. However, two particular issues have preoccupied recent ISNAR reviews: the level of staff morale and motivation, and closely linked to this, the availability of operational resources.

Concerns about motivation take one to the heart of what is conventionally known as organizational behavior theory. This focuses on the behavior of the individual in an organization and looks in particular at his/her specific needs and responses to incentives, pressures and influences in the work environment. The review reports generally identify poor conditions of service for researchers and other staff as being the major cause of poor motivation. Incomes are not only very low in an absolute sense but also in relation to what is paid to equivalent personnel in other public and private organizations. This is identified as 'the major problem' in Tunisia, where senior university professionals earn up to twice as much as equivalent research personnel employed in the Ministry of Agriculture.

The Uruguay and Zimbabwe reports make comprehensive recommendations about the grading and pay structures of researchers and technicians. In the case of Uruguay, the establishment of a new semi-autonomous agricultural research organization (to be called Instituto Uruguayo de Tecnologia Agropecuaria) has provided the opportunity for a thorough reappraisal of the existing conditions of service.

The median experience-income profile for agricultural researchers in Uruguay is flat, with very compressed income differentials between staff with different levels of experience. It is possible to analyze the extent to which incomes are dispersed around the median values.

This dispersion is limited in Uruguay, which indicates that seniority tends to be the most important determinant of professional income.

The Uruguay report recommends that the existing grade and salary schemes should be replaced by new ones which will effectively meet the motivational and overall career needs of IUTA professionals in addition to other staff categories. The report states that the new schemes should be based on the following principles:

* Simple in conception so that they can be easly understood by all employees and implemented in a straightforward manner. Thus, the existing system of multiple income additions and allowances (for total dedication, seniority, family situation, etc.) should whenever possible be consolidated into a single salary.

* Effective promotion and financial incentives throughout the entire career of the staff member. There should therefore be regular opportunities for significant promotion, which should be linked with relatively sizeable percentage increases in remuneration.

* For each staff category, a set of job titles which readily convey the competence and/or seniority of the staff member and also help to provide a clear sense of career progression. The recommended new job grading scheme for researchers comprises: Assistant Researchers, Researcher I, Researcher II, Senior Researcher, Principal Researcher and Chief Researcher.

* Well-specified promotion criteria which place primary reliance on demonstrated job performance but, where appropriate, give adequate recognition to the attainment of job-relevant qualifications. Simple seniority criteria should generally only play a limited role.

* There should be dual administrative and scientific career ladders for professional staff. Thus the competent professional who wants to remain a practicing scientist throughout his/her career can do so, while at the same time receiving an income which is equal to or even greater than that of management staff.

* Closely related to merit promotion criteria and the dual ladder, promotion to higher job positions should not be subject to the availability of vacancies in fixed establishments but simply on whether the individual fulfills the specified performance and service requirements for promotion.

* Provision for accelerated advancement of a specially competent and highly motivated staff who make exceptionally valuable contributions to research activities. Without this flexibility there is the likelihood that 'high flyers' will leave to take up more attractive jobs elsewhere.

* An income growth curve that corresponds with the underlying relationship between the age (or experience) of researchers and their level and rate of growth of individual productivity. This curve should normally be 'S' shaped, with low productivity growth during the early stages of the professional's career, while new skills are being acquired, followed by a period of relatively rapid growth which gradually tapers off as the researcher reaches the latter stage of his/her career.

* Full-time employment but with some opportunities for professional staff to supplement their incomes through outside consultancies.

On the basis of these principles, new grade and salary schemes for professionals in INTA are proposed in the report.
The existing grade and salary schemes for researchers and technicians employed by DR & SS of Zimbabwe conform to a much greater extent to the above principles than in Uruguay. Consequently, the report's recommendations are generally more limited, being confined to making slight adjustments in the typical length of time spent by a researcher in each grade and ensuring that the researcher enjoys steady career progression for at least 30-35 years.

AGRICULTURAL RESEARCH IN ALGERIA AND ITS HUMAN RESOURCES

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Translated from the original French

INTRODUCTION

In Algeria, agricultural development, with its consequences for the improvement of the socio-economic standing of rural populations, is a basic priority in national development programs.

The agriculture and fisheries sector, in close cooperation with the hydraulics sector, has started various activities over the past three years designed to intensify agricultural production under local conditions and to improve the productive potential.

Priority in improving efficiency has been given to:

- cereals, dry leguminous and forage crops;
- horticutural crops and potatoes;
- tree crops: olives, vines, date palm;
- intensive cattle production for milk and meat, and upland cattle rearing;
- sheep rearing in the savannah;
- poultry production;
- seeds and seedlings.

This production intensification program is supported by specific activities in:
- professional agricultural training;
- retraining and improving the qualifications of executives;
- implementing and strengthening extension services;
- strengthening applied research and developing basic research.

AGRICULTURAL RESEARCH

Directives

Agricultural research is considered as an essential and necessary function for quantitative and qualitative improvement of agricultural production in Algeria. It is *directed research*, giving absolute priority to applied research without ignoring basic research.

On the basis of the wide priorities of agricultural development indicated above, the operational programs of the national research and development establishment cover:

- knowledge of the environment: soil, water; wildlife, livestock and pasture resources;
- development of phytogenetic resources; cereals, forage, dry leguminous crops, date palm;
- knowledge, improvement, and development of local zootechnical resources, and improvement of livestock production: sheep, cattle, goats, etc.;
- optimization of production factors: water, fertilizer, seeds, etc.;
- protection of crops and agricultural products, and better veterinary care of livestock;
- developing plant byproducts, for use as animal food and/or as fertilizer.

Organization

The research and development establishment is, at the national level, coordinated by a High Commissioner for Research and, at the sectoral level, it falls under the control of the Research Directorates of the interested ministries (mainly Agriculture, Fisheries and Hydraulics, Forestry, Environment, and Higher Education). It is a complex system, in which two large groups are apparent
The first group consists of technical research institutes and national institutes in the economic sectors of Agriculture-Fisheries and Hydraulics-Forestry-Environment. The national institutes in agriculture deal with agricultural research (INRA); crop protection, animal health, and soils, irrigation and drainage, while

the technical institutes cover major crops, industrial and market crops, trees and vines, sheep and cattle, small livestock, and the development of Saharan agriculture. These institutes, which report to the Directorate of Training, Research and Extension, implement programs which have previously been submitted to the Scientific Council for Research and Development, the secretariat of which is provided by INRA.

The other national institutes outside the Agriculture Ministry deal with forestry research, water resources, and environmental protection.

The second group consists of the different units and training laboratories of university research.

We will only mention those that have a close working relationship with agricultural research carried out by the agricultural sector. These are the National Agricultural Institute, the Research Unit for Arid Zones, and the Research Unit for Biological Terrestrial Resources.

The means

Mainly, we discuss here the means to deal with the operational structures of agricultural research (stations and laboratories), finance, and principally, the scientific and technical staff.

Stations and laboratories

There are 45 research-experiment stations in the "Research-Development" network, distributed throughout all the agro-pedoclimatic zones, excepting the mountain zone. There are 10 laboratories, usually sited at headquarters or central stations.

Finance

Operating resources. Operating resources mainly come from the state budget and are distributed in the form of equipment and operation subsidies.

Globally, the operation subsidy granted in 1987 to scientific and technical activities in all sectors was approximately 560 million DA, i.e., 0.9 percent of the state general budget devoted to operations.

Credits reserved for agricultural research in all sectors reached 187 million DA, i.e., 33 percent, of this research budget, of which 24 million DA (12%) are for INRA.

For 1988, operating budget for agricultural research (all sectors) is planned at 210 million DA, of which 21 million, (10%) go to INRA.

Equipment budget. Since they were created, the Institutes for Training, Development, and Research under the aegis of the Ministry of Agriculture and Fisheries have managed a large number of investment operations. In 1986, their list included 92 operations resulting from previous investment programs. This list has been shortened in 1987, owing to the closure of several operations. Presently, these institutes manage 43 ongoing projects, with a total program authorization of 602,923,000 DA.

The human potential in agricultural research.
In 1986, the Commission for Research began an evaluation, at the national level, of the human resources available for agricultural research. These were estimated at 600 permanent and associated researchers. About 450 of these reside in the University. Some 10% are professors and associate professors, 70% assistant professors, and 20% engineers.
In the production sectors, the scientific potential is only 150. These are mainly agricultural engineers, of whom about 25% have some postgraduate education.
In INRA, all scientific and technical personnel work on research; there are 51 researchers, seven with postgraduate degrees, and 14 are studying for the doctorate.

Thus, this manpower represents a third of the production sector's total and 12% of the national total.

PLANNING AND MANAGING HUMAN RESOURCES

The analysis of human resources shows some weaknesses, characteristic of the recent operation of the research and development establishment, and of the support provided by higher education. These include:

- The diversity of research programs initiated by staff, frequently with duplication, fragmentation, and without any precise objective in agricultural development.
- Agricultural training, at the national level, which is mainly theoretical and divorced from the concrete technical problems facing the farmers. There is a lack of experimental farms, of fields for practical work, of organized links between higher education and agriculture.
- A real distortion in the way graduates are used. This is characterized by priority recruitment into education, a

sector with a high level of attraction resulting from its financial status.

In 1981, a national seminar on scientific and technical research defined the main trends and priorities of research in Algeria. These were repeated and confirmed by various instructions from the Government and by the objectives stated in the ongoing development plan for 1985-1989.

Generally speaking, these trends required:

- definition of a national program of priority agricultural research, taking into account the socio-economic concerns of the country;
- rational and organized use of the existing human scientific potential, if possible structuring multidisciplinary units (programming by objectives) around a common direction of research;
- decentralization of financial and administrative management of research units (stations, laboratories, etc.);
- coordination, evaluation and monitoring of research activities inside the High Commission for Research, so as to ensure that research is adapted to the socio-economic concerns of the country;
- harmonization, between the various sectors, of recruitment conditions and of the use of human scientific potential.

This plan of action, begun in 1985, allowed for Government investigation and approval of ad hoc programs, particularly as regards research priorities, organization of the implementing body, and coordination of activities.

Finally, a statute modifying the operation of reasearch structures, particularly for INRA and the technical institutes, as well as agricultural research personnel, is being studied by the ministries concerned.

Conditions bearing on planning and management of human resources

The main conditions are research priorities set at the national level, with the aim of reaching food self-sufficiency in the medium to long terms.

They try to exploit, as rationally as possible, all the means available or mobilizable (installations, finances, manpower, etc.) in the national research and development establishment.

The present organization, with technical institutes specialized by product, or institutes of the "horizontal" type, ensures that, given a better coordination, programming by objectives will be implemented, aiming at priorities previously defined.

The main program items are:

- phytogenetic resources: collection, identification, characterization, gene banks;
- cultivar creation;
- producing and developing rapid production techniques for plant material;
- zootechnical resources and animal selection;
- evolution and rational use of natural resources: water, soils;
- mastering climatic parameters which determine the development of crops, livestock, and rural construction;
- rural socio-economics;
- biometrics and informatics.

Human resources and their planning

The planning of human resources, as presently conducted, satisfies only the immediate requirements resulting from current activities. This seems to result from an insufficiently defined programming by objectives. A current study will shortly establish the human resource needs and the distribution per subprogram and per research operation.

The following programs are already being considered:

- cereals, dry leguminous crops, forage crops (product);
- cereals, sheep (system);
- intensive cattle production for meat and milk (product);
- cattle, upland pasture (system);
- tree crops, mountain viticulture (product and system);
- date palm (product);
- saharan agriculture (system).

Support by the training system

The numerous institutes of agricultural training are a powerful support for agricultural research, if the teaching is oriented to agricultural reality and completed by taking into account, at various levels, the scientific or technical problems facing agriculture.

This principle has been implemented very recently (1986). On the basis of the accepted priority research program, it already allows research for engineering projects or master's theses to be conducted in the

research stations of the agricultural sector and, in particular, INRA.

Doctoral education overseas is acceptable only if it provides an initiation to research, followed by research work devoted to a national problem and conducted inside the national structures.

Given that researchers in technical institutes are also engaged in development or extension activities, it is clear that the productive sectors still do not have enough human resources to fully implement their research programs. It is an absolute necessity to ensure an organized contribution from higher education. Moreover, this human national scientific potential is unequally distributed in the various fields of research activity, because of the lack of general directives which characterized past research and education (engineers' memoirs and doctoral theses).

A brief analysis of its components shows that there is a relative shortage of cadres in research fields as important as knowledge and exploitation of national resources (pedology, hydraulics, agrometeorology, distributing, and combatting desertification).

Conditions of researcher evaluation

This concerns the main elements affecting the operational efficiency of a researcher. Whatever the existing research system and its operation, it is difficult to ignore or minimize the importance of:

- career and remuneration statutes, which should be harmonized throughout all sectors and even, we think, preferential for the agricultural research sector;
- necessary access to scientific and technical information on a regular basis, the lack of which may leave the researcher bypassed or even isolated (documentation, seminars, congresses, colloquia, etc.).

CONCLUSIONS

Planning and management of human resources in the agricultural research sector is a very complex endeavor because:

- it addresses a field frequently affected by changes or reorganization imposed by agricultural development worries, inducing research programs in the short, medium and long term;
- it bears on a fundamental component, people, but these are specialized technicians and scientists;
- it deals with a living world, calling on all scientific disciplines, frequently in a cooperative way.

Definition and implementation of a priority research program, planned by disciplines or objectives, using multi-disciplinary teams with sufficient management autonomy, and means to attain the set goals, are the essential conditions for successful agricultural research. Identifying set goals within research programs and subprograms with appropriate time planning, is a fundamental component of human resources planning, organization, implementation, and management. The experience acquired in this field by ISNAR and the World Bank should allow the development of concepts and methodologies for evaluating, implementing, and planning human resources, that we could utilize.

GENERAL STRATEGY FOR PHYSICAL RESOURCES PLANNING AND DEVELOPMENT: GUIDELINES

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INTRODUCTION

Successful agricultural research depends upon the effective planning and development of human, financial, and physical resources required for carrying out research activities. It is therefore essential for agricultural research leaders to develop the knowledge and skills that will enable them to maximize the efficiency and effectiveness of these scarce resources. The availability and maintenance of physical resources to conduct laboratory and field experiments and studies is a sine qua non for agricultural research.

Development of good research physical resources is an extremely complex process. Physical resource planning and development systems exist to support scientists and their investigations. The consistency and quality with which they receive such support has a great influence on the quality of research output. The inadequacy of research physical resources, especially land areas of significant size and suitably located for field experiments, is a limitation to effective agricultural research in many developing countries, of significance equal to the shortage of human resources.

The tendency to neglect physical resource planning and development will harm research output and destroy creative climate. Diagnosing the problems in planning and development of physical resources which commonly disrupt the activities of the research program and impair its effectiveness and efficiency should be one of the important tasks of research management.

This presentation examines the main issues in physical resource planning and development for agricultural research which will assist agricultural research leaders in their efforts to improve physical resource management and development. It deals with the planning of a national infrastructure, taking into account national policy objectives and research priority setting and resource allocation by major regions, commodities, and human and financial resource development; and with the planning and management of physical resources at the institutional level.

DEVELOPING A NATIONAL PLAN FOR AGRICULTURAL RESEARCH PHYSICAL RESOURCES

The planning of physical resources has been defined as: 'assessing the requirements, and the availability,of suitable functioning physical resources, which are needed for the research program implementation to attain research objectives over a specified time period in the most cost-effective manner'. Hence the physical resource plan brings together the research plan, the financial resources, and the physical resources available for the scientists to carry out, within an appropriate organizational structure, their research activities efficiently.

Physical resource planning helps in establishing new stations, or consolidating old stations, and enhances the efficient servicing, maintenance, and utilization of buildings, land, equipment, and personnel. This requires attention to service facilities and spare parts; local and foreign currency for buying what is needed; utilities (notably power and water supply); well-trained technical assistants; and efficient supply and purchasing procedures.

Planning and development of a NARS's physical resources are not done in isolation. They are closely related to such factors as the system's program needs, and its financial and human resource bases. In making decisions about the type and number of research stations, support services, and equipment, a fundamental consideration is sustainability, over time,

from national resources. Recent trends towards shrinking real research budgets for many national agricultural research systems (NARS) have led to an enormous drain by the recurrent costs of supporting a large infrastructure on NARS budgets, often at the expense of human resource development or adequate operating funds. In the face of declining budgets, therefore, consolidating research stations to a reasonable number and spread may be desirable.

Once research priorities are determined, long-term plans for developing human, physical, and financial resources can help ensure continuity in research, adherence to established priorities, and rational development of resources. Long-term plans help to maintain research priorities and define research agendas more realistically than can be done through annual planning alone.

Since planning is concerned with establishing broad research objectives and specifying overall resource allocation to each program, station and expertise requirements should be expressed as aggregated estimates of the human and physical resources required for each program over a certain time period -- medium and/or long-term, from 5 to 10 years. Once future resource availabilities are known, more detailed planning must be undertaken in order to allocate these resources to activities within research programs.

PRIORITY INDICATORS OF THE NEED FOR NEW RESEARCH STATIONS

Setting priorities in the distribution of resources likely to be devoted to research priorities for the duration of the research plan is essentially a political decision. However, this decision must be based on information collected and presented by agro-economists, planners, and biophysical scientists.

The principal priority indicators to be considered for establishing research stations are:

a. geographic level of research priorities;
b. availability of professional and support personnel to carry out research priorities;
c. availability of financial resources needed for implementing research priorities;
d. sufficient and adequate operating funds to maintain implementation of research priorities.

Research stations in a country, whether multipurpose or commodity, may be located in terms of scope of operations, at three levels:

- national;
- administrative regions and/or districts;
- according to agro-ecological zones.

Research priorities at the national level may require stations capable of dealing with broad problems and able to integrate research efforts to solve these problems. Establishing stations for homogeneous agro-ecological zones, may facilitate researchers grasping the social and economic constraints and potentials and may aid implementing research findings. Establishing stations at the level of the administrative region and/or district is likely to help in improving formal and informal interaction with policymakers, extension services, development organizations, and farmers.

Once the need for a research station has been decided, the research system must ensure that financial resources are available for establishing the station, the required professional and support personnel for carrying out research priorities are available, and operating funds are sufficient and adequate, and available on time. Therefore, the need for financial and human resources plans to match the physical resource plan is obvious.

PLANNING OF PHYSICAL RESOURCES FOR EXISTING RESEARCH STATIONS

Research managers and other decision-makers in the government must decide the optimum allocation of resources among the various possible research programs, given overall national and agricultural development objectives, and likely resource availability in the future. It is necessary to emphasize the distinction between strategic and long-term program planning. The strategic plan is concerned with establishing broad research objectives and specifying overall resource allocation to each program over a given time period. Thus, at this level of planning, physical resource requirements are expressed as aggregated estimates of the cost of physical resources for each research station.

Once future resource availability is known, more detailed planning must be undertaken in order to allocate these resources to programs within the research station.

Estimation of the costs of new items and operation of physical resources are accompanied by the estimation of the appropriate kinds and levels of skills of researchers and other personnel available at present and required in the future. These estimations must be done on a careful analysis of the capacity of the research system or organization to productively utilize these resources in

the future. Thus, precise estimates should be made for capital, salaries, and operational requirements for implementing research programs. The cost can vary from one type of research program to another and thus can strongly influence the numbers of researchers who could be productively employed by the research system or organization, and may influence the amount of investment needed for physical resources.

MONITORING AND REVIEWING PHYSICAL RESOURCES

Physical resource monitoring is essential for efficient implementation of the research program. Performance depends upon the efficiency with which the resources are deployed and activities executed in order to achieve research objectives within a given time frame. A primary aspect of the research monitoring process is review of the physical resources which are to be the source of program benefits and the means of achieving program objectives. This review requires the generation of physical resource information, at varying frequencies, for various levels of the management hierarchy, relating to the availability and development of staff; the availability and development of equipment, including servicing; progress in constructing or maintaining buildings and land, the availability and distribution of inputs (e.g., office, laboratory, farm, and workshop inputs), taking into account the requirements of appropriate supply/demand balance and timing; and cash flow and budget provisions and expenditures.

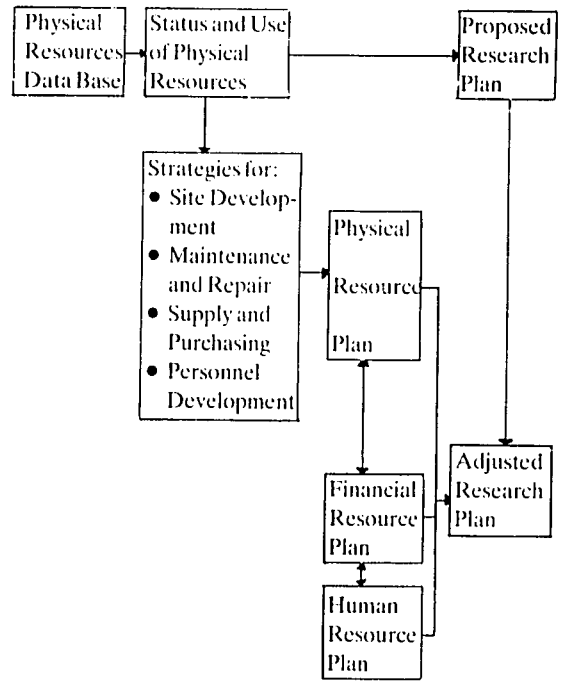
PLANNING AND OPERATION AT THE RESEARCH STATION LEVEL

Buildings, land, equipment, and other components of research station physical resources will deteriorate and become eventually non-functional without a strategy for physical resources planning and maintenance. For instance, non-functioning equipment should be repaired in a timely fashion or disposed of. Research support services, supply and purchasing, maintenance and repairs, publication and information, etc., can actually enhance research effort if they are properly planned, organized, and run. Site and equipment development should be the main responsibility of research management, to ensure that research will have the benefit of adequate equipment and facilities. Centralizing services and sharing equipment and facilities will maximize the use of physical resources.

PHYSICAL RESOURCES PLAN

As discussed earlier, the physical resource plan brings together the research plan, the funds requested, and the physical resources required for scientists to carry out their research efficiently. The following steps could be considered when developing such a plan (figure 1).

Figure 1. Physical Resources Plan



1. Begin with the proposed long-term research program for the next five or so years. What do you want to accomplish? How much? Over what time span? Use the physical resource data base and show that physical resources status and use have been considered in developing the proposed long-term research program. What physical resources do you have? What quantity? Quality? Where are they?

2. Develop strategies for site development, maintenance and repair, equipment development, capital/assets and expendable supplies, centralized services, physical resource personnel development, and policies and procedures for managing physical resources.

3. Prepare long-term plans for funding available and anticipated physical resources. Do you have enough physical resources to do the work? What are the needed items? How much will these items cost to buy and maintain? What are the foreign exchange requirements? Long-term factors to be estimated:

- costs of site development (land and buildings: existing and/or new); develop *a site development and use plan;*
- costs of maintenance and repair for available and anticipated physical resources; develop *a maintenance and repair plan;*
- costs of supply -- capital/assets and expendables -- in local and foreign currency for items to be imported; and develop *a supply and purchasing plan;*
- costs of training people associated with physical resources -- in planning and/or operating physical resources -- for in-country and in-service training, and for abroad and in-service training; develop a *physical resources personnel development plan.*

4. Develop a *physical resource long-term plan* which encompasses the plans for site development and use, maintenance and repair, supply and purchasing, and physical resource personnel development. The physical resource plan should be congruent with the financial and human resource long-term plans. Furthermore, the physical resource plan should take into consideration the research mandate of the institute or station, the agroecological resource base, the agricultural production situation, the nature, level, and scope of research programs, and the current and future activities.

5. Adjust the long-term research program, if there are unanticipated changes in financial, human, and physical resources.

Issues to be considered while developing a long-term plan for physical resources:

- a data base on physical resources should be available and current;
- it should show what is needed as new supplies;
- it should show what is needed for the development of old and new sites, i.e., new stations and/or substations;
- it should show what is needed for centralized services;
- it should show the funding available and its allocation to purchasing of supplies, maintaining and repairing of physical resources, developing buildings, land and other components of the research site, and training of physical resource personnel;
- it should show the existing in-country capabilities to supply the needed new items;
- it should estimate the foreign currency needed for supplies, e.g., equipment, chemicals, books and journals, and others, and for foreign training of personnel;
- it should develop monitoring procedures for the use of physical resources.

STATION OPERATION AND MANAGEMENT

It is essential that all station activities should be designed to implement the research program efficiently. Strategies must be considered for developing and use of buildings and land, maintaining and repairing, developing equipment, supplying and purchasing, developing physical resources personnel, and centralizing services at national and research station levels.

Site development and use (land and buildings). Agricultural research needs to have a consistent long-term land and buildings use strategy to function effectively.

In agricultural research we may perhaps work with inadequate buildings and library, but certainly not with a poor research field facility. Having a vast complex of expensive buildings, paved roads, houses, and laboratory facilities does not contribute much to good field research. The research needs should dictate the design of land and buildings as well as other physical resources and services.

The specific needs of buildings and land may vary with the country and location, but the pattern of development remains basically the same. The selection and initial development of the physical plant -- land and buildings -- is extremely important, however.

In field design, the field research facilities should come first, with buildings and other physical needs to be fitted into the design. In the development of many stations, unfortunately, dwellings and offices occupy the choice sites, and research fields are fitted around them. As a general rule, critical research cannot be carried out within about 50 meters of dwellings. Experience has shown that a very firm stand is required to prevent encroachment of buildings, roads, electrical lines, and other facilities on research fields. It is essential to keep in mind the primary purpose of the station: field research. The development pattern thus requires that research people, and field scientists in particular, serve prominently on station planning and development committees.

The main issues to be considered for establishing a research station are site selection, master plans, and the overall plan for research fields and laboratories.

Maintenance and repair. Availability and maintenance of physical resources for conducting research are crucial for agricultural research. The maintenance and repair of physical resources can never be overlooked. In most research institutions maintenance and repair of physical resources receives the lowest priority in budget allocation. Funds for maintenance are usually the first to suffer in budget shortfalls. In cases where considerable investment has been made in buildings, land, equipment, and supplies there is no concomitant provision for maintenance. As a matter of fact, capital investment should be accompanied by an increase in the operational budget to some 20 percent of this investment. Maintenance can and should be programmed into the long-term plan, with financial provisions as a high-priority budget item.

The first step in developing a strategy for maintenance and repair of the research institute's physical resources is to estimate the capacity of the institute's services to meet maintenance needs. The establishment of operation and support of an institutional maintenance service represents its own set of specific management challenges. Maintenance and repair staff, with their particular management requirements, differ from those of the scientific and administrative staff. They need special training, organizing, and support, with specific policies, procedures, and repair equipment. In the case where institutes cannot afford to establish maintenance and repair units for sophisticated and advanced scientific instruments and equipment, it is proposed to establish this unit at the research system level.

The second step is to estimate the current and future need for supplies, spare parts, and special equipment for the maintenance and repair services.

Successful maintenance depends on available parts inventories. Thus, the third step is to develop physical resource inventories.

Supply and purchasing. It is impossible to keep buildings, land, equipment, and supplies running without a supply and purchasing system that can provide the necessary inputs for operations, maintenance, and repairs in a timely fashion. Typical problems keeping supply and purchasing from functioning effectively, for instance, are:

- The lack of foreign exchange prevents libraries from continuing subscriptions to scientific journals and current books. The rapidly increasing cost of maintaining traditional documentation systems points to a need for the consideration of systems based on modern technology; i.e., computers
- Import policies and lack of foreign exchange prevent research institutes from importing the required equipment and expendable supplies, e.g., laboratory chemicals and glasses, most of which are made in industrial countries.
- Tedious lengthy administrative procedures are required to assure availability of supplies and materials at the right time at the research institutes.

Centralized specific services and sharing facilities. Support systems should be consolidated whenever possible. Resources may be sufficient for a shared facility and insufficient if two facilities are created. Sharing and centralizing some facilities, where possible, should be adopted to maximize the use of physical resources. To do so, inventory the existing physical resources to promote inter-institutional and inter-departmental use of such resources, make accessible and facilitate the use of sophisticated and expensive equipment in the institutes of the NARS, and study the feasibility of centralizing some facilities and services at the national and institute levels.

Personnel development and training. One of the major constraints to productive agricultural research is the lack of qualified research support staff -- administrative and service. It is estimated that an average of 10 research support specialists, including physical resource staff, are required to support each agricultural scientist. This figure varies from situation to situation, depending on the institute's research mandate, availability of equipment, facilities, local services, and the capacity of scientists and support staff.

The requirement for development and training is not only for research managers, but for the entire spectrum of physical resource staff. This encompasses managers and operators of physical plant services, purchase and supply staff, field and laboratory technicians, and maintenance and repair staff.

Physical resource planning, the people associated with planning, and their responsibilities can be summarized as in the following table.

Table 1: Responsibilities of staff associated with physical resource planning and development

Staff \ Physical Resource Subplans	Site Development	Maintenance and Repair	Supply and Purchasing	Physical Resource Personnel Training
1. Scientists	• suggest development needs at station level	• maintain physical resources the use, and requests for development	• requests for specific supplies	• identify training needs
2. Managers (Directors of Station, Heads of programs, Admin. Officers, Farm Managers)	• plan at station level	• plan at station level	• plan at station level	• assess and plan at station level
3. Physical Resource Operators (including Farm Managers)	• suggest development needs at station level	• maintain and repair, within their capaci-cities, and requests for development	• requests for fixed supplies	• assess and request training
4. Policy Makers (e.g., director of research or planning at ministry level)	• plan at national level	• plant at national level	• plant at national level	• plan at national level

It is clear from the above table that planning of physical resources at the institute level is mainly the responsibility of managers of the institute -- directors of stations, heads of programs, administrative officers, farm managers, etc. -- while planning of the same at national level is mainly the responsibility of policy makers, e.g., directors of research or directors of planning at the ministry level. Scientists, as well as operators, play a great role in providing information for planning and development of physical resources. Training in planning and development of physical resources should be offered to managers as well as policy makers and scientists.

CONCLUSION

Successful agricultural research depends upon the effective planning and development of human, financial, and physical resources. The planning and development of a NARS's physical resources is not done in isolation. It is closely related to such factors as the system's research program needs, its financial resource base, and its human resource endowment. They determine the framework of such planning and development.

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AGRICULTURAL RESEARCH SYSTEM IN EGYPT

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AGRICULTURAL BACKGROUND

The agricultural sector of Egypt accounts for 21% of the Gross Domestic Product (GDP) and involves 34% of the total work force in the country. The cultivated land area, all under irrigation, is estimated at 2,500,000 ha, with a cropping intensity of about 1.9 crops per year; thus giving a total cropped area of 4,900,000 ha. At present, only 3% of Egypt's total area is under cultivation. What compounds the problem of man and land in Egyptian agriculture is a population increase of 380% since the turn of the century, while land under cultivation has increased by only 25%.

During the last 20 years, food production in Egypt has failed to keep pace with consumption, and the country has become increasingly dependent upon food imports. Three main factors have contributed to the present gap between production and consumption of agricultural food commodities. These are:

- a relatively low level of investment in the agricultural sector in general, and research/extension programs in particular;
- slow growth in productivity and total production of major food commodities;
- substantial increases in demand for food due to unchecked population growth and to considerably larger increases in per capita consumption.

Several assessments of Egyptian agriculture have emphasized Egypt's unusually favorable land, water, and climatic resources. These have enabled the country to attain relatively high levels of productivity when compared with world average yields. Yield data from FAO indicate that yields of several crops in Egypt, like wheat, rice, maize, lentils, and soybeans, compare rather favorably with those in more-developed regions of the world such as North America and Europe.

Furthermore, ample and ever-increasing evidence from research trials and large-scale demonstrations carried out during the 1980s suggest that Egypt has enormous potential to further increase agricultural output despite its relatively high levels of productivity.

There is a strong belief that the future of Egyptian agriculture depends on securing a continuing stream of improved agricultural technology. Because of the relatively high levels of productivity already achieved, and the complexity inherent in irrigated intensive agriculture, the technological contraints on Egyptian agriculture are greater and more sophisticated than those operating in most other developing countries. Egypt is perhaps more dependent upon further improved agricultural technology than any other country. Therefore, any strategy to improve agriculture must give high priority to removing whatever constraints limit the relevance, efficiency, and effectiveness of programs concerned with the generation, validation, and wide-scale application of appropriate agricultural technology.

HISTORICAL BACKGROUND

Egypt initiated agricultural research on a modest scale at Gaza as early as 1897, in what was know as the "Royal Agricultural Society". In 1910, the Egyptian government established the Department of Agriculture under the Ministry of Public Works, to perform "agricultural research, seed production, extension in crop production, with emphasis on cotton, soil and fertilizer analyses, and pest control." Only three years later, a separate Ministry of Agriculture (MOA) was established. This underwent various organizational changes over the years. In 1971 a presidential decree established the General Authority for the Agricultural Research Center, thus unifying all research functions within the MOA under one administration.

The Agricultural Research Center (ARC) started as a semiautonomous organization, with the Minister of Agriculture as Chairman of the Board. More recently, the ARC was extensively reorganized as a direct result of a presidential decree in 1983. This decree established the ARC as a scientific and extension institution and gave it broad general authority for agricultural research and extension activities in Egypt. An earlier decree in 1982 gave the ARC responsibility for the production farms known as "state farms", under the General Authority for Agricultural Production, which was amalgamated into the ARC.

Not all agricultural research activities are centered in the ARC. Four other research centers, in various ministries, 13 university colleges of agriculture, and four faculties of veterinary science are also involved in research. Several research activities in the universities have recently been coordinated with the ARC programs through a university grants system adopted by the MOA and funded through USAID grants.

Although the ARC is the largest agricultural research organization in the country and has the primary mandate to undertake agricultural research, considerable research is carried out by the other institutions, with very little coordination. Several proposals have been advanced and are currently under consideration to establish a mechanism for coordination of agricultural research at the national level.

NATIONAL CENTRAL AGRICULTURAL RESEARCH ORGANIZATION

The Agriculture Research Center (ARC). After the reorganization of the ARC in 1983, the center was better qualified to play the major role in realizing the technological leap needed for agricultural development in Egypt. Accordingly, the ARC became entrusted with a twofold mission:

(a) to generate a flow of applied research results for the creation of the agricultural technology needed to ensure the continous development of agricultural production;

(b) to ensure the widespread transfer and extension of such technology among farmers to achieve higher yields and better income, and to determine the economic effects of those new technologies and devise solutions to application of problems.

The ARC is governed by a Board of Directors chaired by the Minister of Agriculture and consists of the Director of the ARC, who is responsible for the day-to-day operations and the supervision of technical, financial, and administrative matters; three deputies for Research, Experiment Stations/Production, and Extension; the directors of the 14 institutes; a representative of the Academy of Scientific Research and Technology (ASRT), and five consultants versed in agriculture and selected by the Minister of Agriculture. The main functions of the ARC Board are to:

- organize, plan, coordinate, promote, and review agricultural research;
- arrange to utilize the results of research;
- identify problems and develop closely coordinated research programs;
- plan and develop extension programs;
- administer agricultural research stations;
- publish or otherwise disseminate research results and agricultural information;
- foster relations with national and foreign scientific institutions.

The Board may establish subject-matter committees to review research projects and report on matters that may be referred to them.

Within ARC there are four major divisions dealing with research, extension, agricultural production and research stations, and finance and administration. There are also seven general departments (library, technical office, technical inspection, planning, legal affairs, financial and administration inspection, and organization and administration).

A three-dimensional management matrix has been adopted since 1985 to facilitate planning, implementation, monitoring, and evaluation of research within the ARC. The three dimensions are:

Research Insitutes. There are 14 institutes and 3 central laboratories. Each institute is governed by a council composed of the heads of the research divisions, the two deputies, and chaired by the institute's director. The institutes deal with soils and water, cotton, field crops, sugar, horticultural crops, plant pathology, plant protection, agricultural mechanization, animal production, animal health, animal reproduction, serum and vaccines, agricultural economics, extension. The laboratories cover pesticides, experimental design and protein and feed analysis.

Coordinated multidisciplinary research programs. During the 1970s not enough research was directed towards solving production constraints. Applied

research did not significantly reflect the major goals of both vertical and horizontal agricultural development. Furthermore, the interrelationships among specialized institutes occupied low priority in research programs. In the last five-year research plan, 1982 - 1987, a multidisciplinary approach was adopted, and twelve national programs were implemented. The new five-year research plan further emphasizes the multidisciplinary concept. It includes 18 integrated improvement programs in: cotton; maize and sorghum; wheat and barley; rice; oil seeds; sugar; legumes; forage crops; fruit trees and ornamentals; vegetable and medicinal crops; soils, water, and fertility management; crop intensification and agricultural systems; adaptive mechanization; milk and meat production; small ruminants; poultry; new land technology development; and integrated pest management.

Regional Research Stations. The 13 field crop, 7 horticultural, and 11 animal production research stations across the country, as well as production farms, with a total of 11,000 ha, have been organized into regional ARC clusters under a deputy director for experiment stations and production. Each regional station has a director seated at one of the research stations, designated as the regional headquarters. Operations and maintenance budgets for research stations and production units flow through the regional directors. Thus, the various research stations in a region form a composite regional station, even though some are far apart. Staff at research stations remain as members of their respective institute. Staff at ARC headquarters continue to conduct research on the stations, and joint planning and budgeting continue through the permanent committee for research, planning, and follow-up, chaired by the ARC director and including all institute directors and the 3 ARC deputy directors. As a compliment to reseach carried out at the stations, 18 on-farm verification units are permanently located at the provincial governor level to carry out on-farm research in collaboration with the respective intitutes programs.

ELEMENTS OF AN ARC STRATEGY

An overall strategy was formulated by the ARC management and approved by the Board of Directors in January 1985. The elements of that strategy, in summary, are:

- concentrate on integrated multidisciplinary programs;
- establish priorities in research according to clearly identified production constraints at the farm level;
- strengthen linkages between research and extension, and consolidate the interface between the two sub-systems;
- improve coordination of technical assistance projects in research and extension and use available resources in developing and strengthening the basic infrastucture and institution building;
- participate and help develop a national strategy for seed production distribution and marketing;
- provide adequate funding to research stations, institutes, and programs;
- monitor and effectively analyze the socioeconomic implications of newly developed technology at the farm level, and keep a two-way communication and feedback mechanism operative;
- upgrade and expand facilities for publication, documentation, and library services;
- strengthen ties with universities and other research institutions at the national and international levels wherever resources permit.

While such a strategy meets the approval and blessing of all concerned, there is still a lot to do to translate all components of this into coherent action programs.

IMPACT OF AGRICULTURAL RESEARCH ON AGRICULTURAL PRODUCTION

The accomplishments in the agricultural sector as a direct result of applying research results over the past 30 years are impressive. One example will suffice here. Cotton production increased from 700,000t in 1950 to 800,000t during the 1980s, despite a decrease in cotton acreage from 810,000 ha to 405,000 ha. Other examples can be found in cereals, vegetables, and livestock production.

These improvements in average productivity were accompanied by an increase in cropped area of 690,000 ha between 1960 and 1980. Furthermore, the use of nitrogen fertilizer jumped from 500,000t in 1950 to 3,500,000t in 1980, a 450% increase.

The 1980s saw wide-scale demonstrations and extensive production experiments in farmers' fields showing the productive potentials of new varieties developed by the ARC programs, together with packages of technical recommendations. In the maize national production campaign, for example, run over thousands of acres during the 1980 - 1986 period, yields of around three tons/acre across 13 governorates in upper and lower Egypt were seen. This average, over some 375,000 acres in 1986 alone, is almost double the present national average, and some rather progressive small farmers

obtained three times the national average. These results were achieved through the cultivation of three ARC-developed varieties. These results show that appropriate agricultural technology has already been generated or introduced. Now it needs to be widely applied through the intensification of extension programs.

MANPOWER IN AGRICULTURAL RESEARCH

Egypt is one of the few developing countries not suffering from a shortage of trained and adequately qualified staff in agricultural research. In fact, Egypt provides, on-loan, about 20% of its total research staff resources to other Arab and African countries. The 1981 estimates of available manpower gave a total of 3267 scientists and 4403 assistant researchers. With an annual growth rate of 10%, the total number of research staff, including universities, other research centers, and the ARC, is estimated at 10,000 for 1986. Since the 1930s, Egypt has a history of providing scholarships for potential young scientists to obtain PhD degrees in agricultural sciences from the best universities in the USA, UK, Germany, and the USSR, among other developed countries. Furthermore, during the last two decades Egyptian universities have been carrying out an impressive MSc and PhD training program. Today, highly qualified and dedicated scientists are available in all research institutions. However, there is an evident need to examine and improve employment, working conditions, and motivation, if the country expects them to perform up to their full potential.

The actual time allocated to research functions varies from one institution to another and from discipline to discipline across institutions. At the universities a large segment of staff time is devoted to teaching. Only about 40% is allocated for research, and this is largely the supervision of thesis research problems. In the ARC and other research centers, twice as much staff time is available for research and extension support.

In all cases, a minimum of 10-15% of staff time is used for administration and consultancy. By 1986, in ARC at least 30% of staff time is required for extension subject-matter support.

An examination of manpower resource distribution by groups of commodities against the value of production reveals some discrepancy. While horticultural crops account for 23.6% of agricultural production value, some 31.4% of the total manpower in research is working in horticulture. The opposite situation is found in animal production. While only 24.4% of the total scientific staff is involved in animal production research, the share of animal production in total production value is estimated at 35.5%.

In the ARC, research staff account for just under 9% of the total workforce. The majority of employees are clerks, technicians, and laborers. Nonetheless, the number of research staff changes continuously because staff members with Bsc or MSc degrees have the right to continue to the PhD level. At least 30% of their time on the job is allowed for their course work and thesis problems. From 1982 to 1987, 139 scientists were promoted to chief researcher, 213 to senior researcher, and 655 who obtained their PhD degree to researcher. The ARC management put great emphasis on training for both research and non-research staff, as well as extension personnel. From 1982 to 1987, 655 of the ARC's junior research assistants obtained PhD degrees, in addition to 352 who obtained MSc degrees from national and foreign universities. More than 540 staff members were given the chance to visit other institutions in developed countries for short periods. Furthermore, ARC provided the extension service with 20,355 person-days of training on new developments in agricultural technologies. An additional 17,310 person-days of training were given to ARC staff on foreign languages, administration, management, statistics, and computers.

LINKAGES WITH EXTENSION

The transfer of agricultural research results in the form of simple production recommendations suitable for wide adoption by farmers is the cornerstone of any agricultural development. In recent years, a considerable volume of research results has been accumulated. Recommendations derived from these results did not spread into farmers' fields at a satisfactory rate, particularly, during the 1970s. The increases in agricultural production so far realized, even though encouraging, are much less than the potentials indicated by on-farm verification and demonstrations. This is due, in part, to a lack of adequate coordination between research and extension, a lack of adequately trained extension staff, the need for a specific national plan for extension, and the absence of a clear educational philosophy in extension.

It was mandatory, therefore, to review the role of agricultural extension and its place in the chain of technology generation and transfer. Subsequently, a directorate for extension was created within the ARC organizational structure. Research and extension are considered by the ARC management as two sub-systems of a holistic approach to agricultural technology

generation, validation, and demonstration. An institute for extension research has been established to deal with matters such as adoption problems, impact, socioeconomic factors, and extension methodology. There are about 4000 extension workers at the provincial governorship, district, and village levels, under the direction of the General Department of Agricultural Extension in MOA. There have been improved extension/research linkages during the 1980s, as the following three instances show:

(a) ARC researchers are required to actively participate in problem identification, technology validation, and demonstration. Visits to farmers' fields to give technical support to extension workers are an integral part of their job description. In fact, extension-related activities are part of the criteria for promotion in the ARC. Subject-matter specialists belonging to integrated commodity improvement programs currently work closely with, and give technical support to, general extension at the district level.

(b) Regional experiment stations serve as centers for technology dissemination in their respective zones. They are active in producing all foundation seed and part of the certified seed of major field crops and at least 60% of the total demand for seedlings of horticultural crops.

(c) Short courses are offered by the ARC to extension staff at central and regional levels through the integrated commodity programs.

AGRICULTURAL RESEARCH INFORMATION AND DOCUMENTATION

There is no agricultural library in Egypt that is completely adequate for a major research or educational institution. However, there are modest libraries at the National Research Center (NRC) of the Academy of Scientific Research and Technology (ASRT), ARC, and the colleges of agriculture. Branch libraries are also found in ARC institutes and regional stations. These facilities have been suffering for years from the absence of back issues of periodicals and magazines due to financial difficulties.

The main ARC library contains over 6800 books, some 132 periodicals, more than 500 technical bulletins, 2894 MSc and 1600 PhD dissertations. Some periodicals go back to the beginning of the century. The ARC also produces three main publications on a regular basis:

- Agricultural Research Review, which dates from 1922. It is issued annually in nine parts per volume. It represents the major medium for publication of agricultural research carried out by the ARC staff. Published in English, with an Arabic summary, the Review is exchanged with 200 local and 130 foreign institutions.

- The Agricultural Scientific Extracts aim to introduce recent world agricultural technologies to Arabic-speaking agricultural specialists and technicians. This series was first published in 1956, one volume annually. Each volume contains three parts of 240 pages each.

- The ARC Technical Series aims to disseminate ARC recommendations about specific commodities and/or production problems. The target audiences are progressive farmers, extension officers, and food industry specialists. During the last five years hundreds of bulletins have been issued.

However, much more effort is needed to make up-to-date information in agricutural research and technology readily available to scientists at all institutions. It is recommended that a centralized, computerized data-base and information storage and retrieval system, including a catalog of country-wide library holdings on agriculture, be created to enhance existing facilities. Although expensive to initiate, this investment is regarded as essential. In line with this recommendation, the ARC has recently joined the AGRIS and CARIS networks of FAO and the National Information Network.

BUDGETARY SUPPORT FOR AGRICULTURAL RESEARCH

It is widely accepted that a steady increase in agricultural productivity through technical change is indispensable to national economic growth. Increases in productivity in the past 100 years have come largely from science-based technology and from changes in management and inputs developed through organized research. Worldwide experience shows that returns from investment in research may be two or three times greater than can be obtained from other investment opportunities.

However, all research organizations in Egypt suffer from limited financial support. The ARC research budget over the past five fiscal years 1982/83 to 1986/87 typifies the budgetary difficulties encountered in all research organizations in the country. Extensive staffing overloads the regular budget, with at least 60% going to

salaries and incentives. Despite this, average wages are quite low. In contrast, very few resources are allocated to program operations and maintenance.

Similar situations exist in other research institutions. Allocations for research in the universities are low. All expenses for graduate students' thesis work of ARC staff registered for MSc and PhD degrees in the universities are covered from the ARC budget.

This situation undoubtedly represents a serious constraint to efficient research management. It is therefore recommended that an annual investment of not less than 1% of GNP or 3% of the gross value of agricultural production, whichever is higher, be made over the next 10 years. This should be accompanied by a sharp focus on priority to assure that the available resources are directed towards the most effective economic use. No duplication, overlapping, or leakage should be allowed.

COORDINATION AND PRIORITY SETTING AT THE NATIONAL LEVEL

The university colleges of agriculture, the NRC, and research centers and institutes in certain ministries all carry out agricultural research, seemingly independent of each other and of the ARC, which is the primary agricultural research organization in the country. Apart from a limited attempt made by the MOA and funded by USAID for a university grants system tied to ongoing ARC research programs, there is duplication in programs and interagency competition for funds. There is a general consensus that if agriculture is to meet the challenge of food production in the future, its research must be put on a sound footing and be developing and managed in a coordinated and integrated manner.

Several assessments of agricultural research in Egypt have been made by international and national agencies during the last five years. They all came to the conclusion that there is an apparent need for a functional coordinating mechanism at the national level. It is therefor recommended than an Egyptian Council for Agricultural Research and Extension be established to overcome the major limiting factors to productive, relevant, efficient, and effective agricultural reseach and extension programs.

The proposed council should form a single planning, coordinating, priority-setting and decision-making body under the Minister of Agriculture. It should be given full authority and freedom to plan, coordinate, fund, and execute all agricultural research programs nationwide. Multidisciplinary cooperative research, progressive personnel management policies, and flexibility of procedures should be the main working characteristics of the council.

INTERNATIONAL AND BILATERAL ASSISTANCE IN RESEARCH AND EXTENSION

Foreign technical assistance has played an important role during the last 10 years in the development of the agricultural sector in general, through the provision of funds and expertise in research, extension, production and credit administration. These resources are channeled to the agricultural sector through the Agriculture and Industry Ministries, ASRT, and the Supreme Council of Universities. Among the largest assistance programs are those funded by USAID. These include an agricultural systems program, the Rice Improvement and Training Project, the Egyptian Major Cereals Project, the University Linkage Project, the PL-480 Projects and, more recently, a National Agricultural Research Project.
FAO has sponsored a number of technical cooperation projects in collaboration with several ARC units. FAO/UNDP collaborated in many areas, including improved irrigation systems. Cooperation between the ARC and several CGIAR centers has been going on since the early 1970s, particularly on germplasm exchange, cooperative testing, and training. IDRC has also funded research activities on oilseed and forage crops.

However, it is recommended that external technical and financial support be better coordinated to strengthen and consolidate national institutions towards greater effectiveness and sustainability in the medium and long term. All external resources should be directed and managed within the institutional priorities, since those priorities have been established in accordance with the goals of national agricultural development. Meeting the requirements of integrated national research programs, improving the efficiency of operations and maintenance of research stations and laboratories, improving the capability to transfer and widely disseminate improved agricultural technologies, increasing the ability to train scientific and administrative staff, establishing and operating a modern central library, and supporting selected research of a semi-basic nature must be given clear priority status. Only then can external technical and financial support be considered cost-effective.

STRUCTURE AND ORGANIZATION IN NATIONAL AGRICULTURAL RESEARCH SYSTEMS

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RATIONALE FOR REORGANIZATION

World agriculture entered a new phase in the 1960s. For most of its 10,000 years since the first domestication of plants and animals, agriculture has been of a traditional kind characterized by low yields and limited use of various farm inputs. The 1960s saw a massive building up on population pressures in the developing countries in the wake of major advances in modern medicine. Also, the 1960s saw a far greater emphasis on improved nutrition, with the newly independent countries striving to improve the standard of living of their people. The increased demands on food supply focused major attention on research for the first time to transform the traditional systems of farming in these countries to make them more productive and profitable.

It was during this period that many developing countries started to take important policy decisions to reorganize and strengthen their agricultural research services. Looking back over the past 20 years, we may well find that more investments have been made in agricultural research in many developing countries during this period than in the entire history of scientific support for their agriculture. Furthermore, this is only the beginning, and even greater investments in building the national research systems are expected in the next 20 years. Many developing countries have yet to reorganize their agricultural research services. Africa's emerging national agricultural research systems in the background of their post-colonial evolution are beginning to receive a great deal of attention. Also, the countries of Asia and Latin America have taken only the first steps in laying down the foundations of a more scientific and modern agriculture. They have a long way to go in equipping their research services with improved management skills, tools and procedures. In this first phase many of them have learned to take better advantage of the international agricultural research system and to forge strong links with it. In the second phase, they must learn to be more self-reliant, to solve some of the more difficult problems of their agriculture in areas like soil and water management and productivity in stress environments. They must also learn to develop renewable resources of energy so that their agriculture in the coming decades will not have such heavy dependence on costly energy-intensive inputs like chemical fertilizers and chemical pesticides. The emergence of biotechnology in relation to agriculture has opened up altogether new possibilities in this direction. Many of the developing countries, with their limited resources of non-renewable energy, have greater compulsion to exploit these new possibilities that genetic engineering and other advances in molecular biology offer.

The reorganization of research services which has already taken place in some developing countries has helped to give them a new research infrastructure -- more confident, more responsive and more committed to the needs of agricultural development in the country. The fundamental changes have been in respect to the administrative framework, governance mechanisms, linkages and relationships with the policy-making bodies and development departments.

DEFINING NATIONAL AGRICULTURAL RESEARCH SYSTEMS

In considering the organization and structure of the national agricultural research systems (NARS), it is important that we begin to define them more clearly. In a broad sense the NARS consist of all those organizations and institutions in the country carrying out research in various fields of agricultural sciences. These institutions are often very diverse and are distributed in the various ministries of the government, parastatal bodies, faculties of agriculture and other science

faculties in the universities, and in the private sector having close links with agri-business. For practical purposes, however, the core of the NARS is more restricted. The core consists of the organizations and institutions created and/or funded by the governments to generate improved production technologies to provide support to their development programs of agriculture.

The government (through its ministry of agriculture and sometimes other ministries) is the promoter of the interests of the farmers -- their largest constituency in most developing countries. As guardian of these interests and recognizing the crucial place of agriculture in the process of economic development, the governments have (or should have) a deep interest in making science and technology an instrument of social and economic advance. For this reason, most governments create their own research infrastructure for the development of agriculture, and it is this research service created by the government which forms the heart of the national agricultural research systems.

The research apparatus consisting of experiment stations may function under the ministry of agriculture and/or other ministries. In some cases the governments prefer not to create research institutions of their own but hand over responsibility for agricultural research to faculties of agriculture to which they extend funding and other support. These core groups of institutions often link up with other research institutions in the country, which may not be directly involved in terms of commitment, but all of which have a potential to make some significant contribution. A good NARS is able to mobilize this support from peripheral institutions for its research work. This is often done through a system of contract research for specific and specialized activities, while the most pressing problems of national priority are addressed by the research service organized by the government.

It is rather important that we make this distinction between the national agricultural research system of a country in its wider sense and the research services specifically created by the governments as an instrument of their policy for agricultural development. The distinction was first clearly made by Lord Rothschild, Scientific Advisor to the British government, in the 1970s. In a report on the organization of agricultural research in Britain, Lord Rothschild spoke of a contractor/client relationship. He suggested that the head of the national research system (in this case the head of the Agricultural Research Council) should see himself in the role of a contractor with the minister of agriculture as a spokesman for the farmers as his client. The Agricultural Research Council should be conducting only that kind of research that leads to improved technologies most needed by the farmers. Here, then, we have a developed country laying down a policy that the government-funded research service will have no other purpose than to serve the needs of the farmers. In retrospect, it is clear that Lord Rothschild's report did have a great deal of influence on Britain's policy in reorganizing its national agricultural research system. Many of the institutional changes which have taken place recently in that country have been influenced at least in part by the Rothschild Report. It follows that the linkage between the national agricultural research system and the national programs of agricultural development should be even stronger in the developing countries, where agriculture constitutes the mainstay of the economy.

BASIC COMPONENTS OF NARS

A successful national agricultural research system is built around three main components. First, it must have the needed experiment station infrastructure, and this means:

i) qualified scientists and technicians;
ii) field and laboratory facilities in the form of well-equipped stations;
iii) a stable budgetary support consistent with the needs of the evolving research programs.

Second, it must have the organization and structure to use these resources effectively. The organization and structure provide the foundation for effective mobilization of the available resources to achieve the goals of the system. Organization and structure have been defined by management specialists in theoretical terms, and if I have time, I could cover some of this ground, but my purpose in this lecture is not to treat the subject in terms of management theory. My purpose is to discuss in practical terms what organization and structure mean in the context of NARS and why we consider them to be so very important.

Third, the NARS must have the management skills, tools and techniques to do their job more efficiently.

EFFECTIVENESS AND EFFICIENCY

Organization and structure help to create the potential for a NARS to be effective. Once you have created this potential for effectiveness you can build on it the

additional dimension of efficiency. You can do this by giving it the management techniques and tools which the NARS leaders and other scientists can use in the course of their work. Some national agricultural research systems, including many in the developed countries, are highly effective in achieving their objectives, but they are not particularly efficient in the use of their resources. Conversely, there are NARS which the management scientists would consider as highly efficient -- they do not waste resources - but they are not necessarily very effective.

TYPES OF NARS ORGANIZATIONS

This distinction between effectiveness and efficiency is something which we may find useful for operational purposes. I would define organization and structure in NARS as the institutional framework and entities, and the governance mechanisms and decision-making processes created to make use of the human and physical resources of NARS for the research process. The institutional framework and the governance mechanisms may or may not provide the right environment in which improved management tools can be used. To take one example, a national research system may be doing an excellent job of determining research priorities and programs, but if its governance mechanisms do not give it any control over its scientific manpower -- selection procedures and personnel policies -- it cannot use these management skills very efficiently.

What are the different kinds of institutional models characterizing the organization of NARS around the world, more particularly the developing part of the world? There is a great deal of variation, but is is possible to identify a number of them, recognizing at the same time that they represent only some of the dominant characteristics. We may consider the models at the level of the research system and in terms of the research station network. At the system level, some of the different kinds of organizations which are commonly found today are as follows.

The Agricultural Research Council (ARC)

The response of the larger Asian countries in terms of reorganization and strengthening of their agricultural research in recent years has been to set up semi-autonomous agricultural research councils. These councils have increasingly taken up responsibilities which earlier belonged to the department of agriculture. The basic concept underlying this transfer of responsibility has been to free the research service from the constraints of the larger government bureaucracy and from operational procedures designed more for built-in checks and counter checks in the use of government funds and playing it safe, rather than taking major initiatives and some risks. The new concept has been to hand over much of the administrative and managerial responsibility to the scientists themselves, recognizing that research requires a different kind of administrative culture. At the same time, the governments have made sure through various devices that the councils are not independent of them in terms of accountability. They must remain fully committed to the government's policies of agricultural development and must provide technical support for these policies. It is autonomy combined with commitment.

An important point which must be recognized is that the ARCs have not all taken the same route in evolving their structure and organization. It is already possible to recognize at least three types of councils in terms of their mandates. I will call them:

a) Administering Councils
b) Coordinating Councils
c) Funding Councils

The administering type is all-embracing -- it organizes, and it is in complete control of all the government-funded research infrastructure. In the larger countries where there are two separate federal and state streams of research, the councils control the federal stream but also have a coordinating role at the national level. The Coordinating Council has its primary responsibility in coordinating research at the national level, but the research institutes maintain their administrative and budgetary independence. They are not administratively linked to the council. The Funding Council, while not administratively linked to the research stations, has complete control over the disbursement of the research funds of the government and is, therefore, in a position to define priorities and give a sense of direction to the work. However, it cannot effectively translate these priorities into matching programs because it has no research stations of its own.

National Research Institutes (NRI)

The Latin American countries were prompted in reorganizing their research services by considerations which were very similar to those of the Asian countries. Their newly set up national research institutes are fundamentally not very different from the agricultural research councils of Asia. Perhaps they enjoy greater autonomy, decentralization and a wider resource base. Unlike Asia, the national research institutes in Latin

America control and manage all of the public-funded research infrastructure in the country. Two kinds of national institutes can be broadly recognized -- semi-autonomous and autonomous. The semi- autonomous national institutes receive strong directions in terms of their management and research policy from a board of governors; the president (director general) of the institute reports to the board. The minister of agriculture, however, appoints the board, and in this way, he makes sure that the interests of his ministry are safeguarded. The fully autonomous institutes have no such board and the president of the institute reports directly to the minister of agriculture. The president clearly has more power in these autonomous institutes. Another distinct feature of the Latin American institutes is that in most cases they are responsible for both research and extension, unlike the Asian councils, which have no administrative links with the extension services.

Most of the newly set up national research institutes in Latin America could be placed in one or the other of these two categories. An exception is provided by the national research system of Brazil, under the umbrella of EMBPRAPA. EMPBRAPA has characteristics of both a national institute and an Asian council. It maintains a large research infrastructure of its own, particularly for commodity-oriented research at the national level, but at the same time it coordinates research in a federal setup where the states have a large research infrastructure of their own. Also, EMBRAPA mobilizes resources very effectively from the private sector, and in this way it is less closely tied with the public research sector than some of the other institutes in Latin America.

Ministry of Agriculture Model

The agricultural research services in developing countries have traditionally formed an integral part of the department of agriculture in the government, and in a majority of countries this position continues. This form of research organization continues to be predominant in the smaller African, Latin American and Asian countries, including the countries of the South Pacific. While the larger research systems have found it increasingly difficult to cope with the larger bureaucracy of the government, and for this reason have reorganized themselves with various degrees of autonomy, the smaller countries continue to find this model quite valid for their situation. They find it unrealistic and in many cases unnecessary, to think of large research councils and institutes in their context. Their problem has been to introduce reforms within the existing framework.

An important variant of the ministry of agriculture model is the organization of research in several ministries. The best example is provided by Sri Lanka, where seven different ministries dealing with one or the other aspect of agricultural production have organized their own research services.

The University Faculty of Agriculture

Some developing countries, recognizing the ready availability and concentration of highly trained manpower in their universities, have found it more realistic to mobilize their colleges of agriculture to provide research support to the country's agriculture. Agricultural education and research are fully integrated in these systems. These university-based research services may be highly variable in their organization and commitment. On the one extreme we have the land-grant colleges of agriculture in the United States of America -- one of the most successful experiments in the development of scientific agriculture anywhere. The land-grant colleges in the United States have evolved a very definitive organization consistent with the mandate and responsibilities given to them by the government. Within a period of 25 years of the establishment of the first land-grant college, the United States Congress enacted legislation in the form of the Hatch Act of 1887, which called for the establishment of an agricultural experiment station in each state, and a decision was taken to locate these experiment stations largely in the land-grant colleges. The Hatch Act thus helped to transform the basic character of these colleges. They were no longer solely academic institutions. They became at the same time major agricultural research centers of the country, with additional investment of large resources in scientific manpower, field and laboratory facilities. Several developing countries in recent years have adopted this model with some modification. India's 23 state agricultural universities, for example, have been set up in the past 25 years on the general pattern of the land-grant institutions.

On the other extreme, there are university systems in which research remains a part-time activity of teachers, and the experiment station facilities tend to be limited. One of the more important examples of a large national system organized around faculties of agriculture is provided by the Philippines. In the Philippines, we have a national Council for agricultural research acting primarily through the colleges of agriculture, which it has helped to build up for increased research capacity in the past 15 years. The administrative control of this university-based system rests with the Science/ Education Ministries, rather than the Ministry of Agriculture.

A COMPARATIVE ANALYSIS

Research systems are built around people, some of whom are highly productive under most conditions, while others have the potential to be productive, given the right environment. What determines this environment is partly a function of the organization and structure of the system. This includes all those governance and decision-making processes and institutional structures through which human, physical, financial and other resources are combined in a synergistic manner for undertaking the research work. For the purpose of a comparative analysis of the different systems and their organizations, therefore, we must consider some of these governance mechanisms and decision-making processes as determined by organizational autonomy, distribution of authority and power, and linkages at different levels. The different systems which we have considered do differ significantly with regard to some of these mechanisms and decision-making processes. Table 1 gives an assessment of the different organizational models for some of these components.

We may not all agree with this rather subjective assessment of the governance mechanisms of the different types of research systems. This, however, is not important. What is important is that the different systems do differ significantly for some of these mechanisms. For example, the semi-autonomous research councils and national institutes tend to have full control over the selection of their scientists and development of their manpower resources through suitable personnel policies. The research services of the ministry of agriculture generally would have no independent personnel policies, as they are tied up for the most part with the rules of the civil service. On the other hand, the research service in the department of agriculture may be in a better position to develop close links with the extension service organized by the same ministry than a research council which has no administrative relationships of any kind with the extension service.

Do the different research systems, based on their organization and structure, also differ in their potential to be effective for the functions which they must perform? It is the performance of these functions which is expected to determine their success or failure. This obviously is the more important question. We may consider here some of these functions and again undertake a comparative analysis. This has been done in Table 2.

Again, it is possible to suggest that the organizational structure does determine the effectiveness of the research service in performing some of its important functions. The problem, of course, is the element of subjectivity involved in an analysis of this kind. We need a great deal of research into the research systems to establish these relationships, and that is why ISNAR is developing a strong research group. We do know, however, that many of the research services, following their reorganization in the last 20 years, have made a significant contribution to the process of agricultural development in a number of developing countries. The adoption rate of technology developed by the scientists of these research services has been high. Vernon Ruttan, based on 23 studies of agricultural research productivity in developing countries, speaks of an average annual rate of return on investment of 55 percent. Agricultural research has thus been found to be highly rewarding. The problem is one of defining those components of the research system which contribute to its success. If our subjective assessment in Table 2 is not entirely off the mark, it seems reasonable to suggest that organization and structure constitutes one of these components.

ORGANIZATION OF RESEARCH STATION NETWORKS

Organization at this level merits a detailed consideration of its own, which we may consider briefly for the present. The very first issue here is one of the size of the network; how many research stations? This will be determined in the first place by the availability of scientific and other resources in a country. The tendency generally is to have too many stations with a sub-critical mass of scientific and other resources. Many of these stations tend to become isolated in terms of leadership and links with the national system, and their productivity suffers. Consolidation of the research station network should probably receive far greater attention in most countries than it normally does. The emphasis most of the time is on growth.

The second factor determining the number of stations and their location is obviously the size of the country and its agroecological diversity. Ideally, and consistent with the availability of resources, the needs of the different agroecological regions should be met. If a country does have a great deal of such diversity and must have a number of research stations, then two other issues become important. First, there is the question of division of responsibility between the different research stations, and second, there is the question of inter-institutional coordination at the national level.

ISNAR's experience of working with many developing countries with a limited number of qualified scientists and other resources suggests that there is some merit in having basically two different types of stations -- national research stations and regional research stations. These will have quite different mandates with a strong complementary relationship. The national research stations will be developed as the country's main research centers for advanced research for the generation of improved genetic materials and technologies for a particular commodity or group of commodities, or for a particularly important factor of production such as soil and water management. The main concern here is that this kind of advanced research, which often cuts across the needs of different regions, cannot be easily replicated and must, therefore, be organized on a centralized basis. The national research stations will have the required concentration of resources in the form of a multidisciplinary team of scientists and laboratory facilities, and their research results must have the potential for wider application transcending provincial or state barriers. The number of such national research stations would vary, depending on the crop and livestock resources of the country, and only the more important priority programs built around commodities of overwhelming importance to the country (e.g., maize in Kenya, rice in Bangladesh or Indonesia) could be addressed through stations of this kind. Depending on the availability of scientific and other resources, countries set up a number of national stations around the more important commodities or factors of production.

Complementing the national stations would be a group of regional research stations placed strategically in the different agroecological regions and having a major focus on production-oriented research closer to the needs of the farming systems in the particular region. The regional research centers would help to improve the productivity of the recommended farming systems, using the new genetic materials and concepts of production developed at the national research centers. They will be doing more of adaptive research by integrating the different components of production technology in response to the specific regional needs. Table 3 illustrates the principle of the organization of the research station network as a function of country size, its agroecological diversity and its scientific resource base.

The problem of inter-institutional coordination has been addressed by a number of countries through the organization of national research programs involving a large number of research stations. These national programs are built around some of the more important commodities, and they help to knit together in a coordinated network the different research stations with a free flow of genetic materials, information and concepts and a great deal of collaborative work. Typically a coordinated national program consists of a coordinating center and a number of cooperating centers located in the different national and regional institutes and national stations, depending on the distribution of the particular crop commodity in the country. The coordinating center, headed by a project coordinator and assisted by a small group of scientists from different disciplines, is located in one of the national stations. The project coordinator is appointed on the basis of his/her recognized position of scientific leadership in the field, as the coordinator's personality contributes significantly to the success of the program. The coordinator exercises little direct control over the cooperating centers which, for all practical purposes, are an integral part of the institutions in which they are located. He/she must maintain close contacts with the directors of the national and regional institutes to ensure that their scientists implement the research programs assigned to them.

The main components of the priority areas of research are identified in the "national workshop" of the scientists from the different cooperating centers. The workshop is held at least once in a year, when a review of the results obtained at the different centers during the previous season are presented by the coordinator in a consolidated form. Also, the workshop provides the opportunity to plan the program of work for the next year on a national basis. The impression one carries of these workshops is of strong interdisciplinary, inter-institutional interactions in the formulation and execution of research programs. There is also an element of healthy competition between the different centers of a national program.

Finally, we come to the question of scientific structure of an agricultural research station. There are research stations which are primarily discipline based and those which have their main focus on one or more commodities or on production systems, and finally those which combine the commodity focus with a discipline-based departmental structure. It is not difficult to see the relative merits of these different types of research stations. While a small research station or an institute in most developing countries must have its major focus on a specific commodity or production system or factor of production, the larger research stations are perhaps better organized with a combined commodity and disciplinary focus. The problem here is one of evolving a multidisciplinary approach in research programs organized around a commodity or group of commodities. The international agricultural research

centers are successful because they succeed admirably in achieving this objective. They, however, operate in a somewhat different context. The national systems have to find their own solutions to this problem.

Table 4 presents a highly simplified approach to different types of organization in a research station which would respond optimally to its mandate.

Table 1. NARS AND THEIR GOVERNANCE FUNCTIONS

Components of Governance	ARC (Administering)	ARC (Coordinating)	ARC (Funding)	NRI (semi-autonomous)	NRI (Autonomous)	MA	University Faculties of Agriculture
1. Experiment Station Network	+++	+	+	+++	+++	+++	+
2. Independent and Stable Budget	+++	+	++	++	+++	++	+
3. Personnel Policies	++	+	+	++	+++	+	+
4. Procurement Procedures	++	+	++	+++	+++	+	++
5. Maintenance of Research Infrastructure	++	+	+	+++	+++	+	++
6. Decentralization	+	+++	+++	++	+++	+	+++

+++ strong
++ average
+ weak

Table 2. RELATIVE POTENTIAL OF NARS FOR RESEARCH FUNCTIONS

Effectiveness for Research Functions	ARC (Administering)	ARC (Coordinating)	ARC (Funding)	NRI (semi-autonomous)	NRI (Autonomous)	MAF	University Faculties of Agriculture
1. Research Priorities and Resource Allocation	+++	++	++	++	+++	++	+
2. Program Formulation	+++	++	+	++	++	++	+
3. Program Implementation	++	+	+	++	+++	++	+
4. Monitoring	+++	+	++	++	++	++	+
5. Evaluation	+++	++	+++	++	++	+	+
6. Research Coordination	++	+++	+++	++	+++	+	++
7. Links with Extension	+	+	+	+++	+++	+++	+
8. Links with Academic Community	+	++	+++	++	++	+	+++
9. Integration of Research, Teaching and Extension	++	+	+	++	++	++	++
10 Links with Policy Makers	+++	+	+	+	++	++	+
11. Staff Development	++	+	+	++	++	++	++

+++ strong
++ average
+ weak

Table 3. ORGANIZATION OF A RESEARCH STATION NETWORK

COUNTRY SIZE	RESOURCE BASE	TYPE OF STATION	TYPE OF RESEARCH
Large country	Excellent resource base	National stations Regional stations	Basic and strategic Applied and strategic
Large country	Fair amount of resources	National stations (several) Regional stations	Applied and strategic Adaptive and applied
Medium country	Limited resources	National stations (limited) Regional stations	Applied Adaptive
Small country	Limited resources	National stations (one or two) Regional stations	Applied Adaptive
Small country	Very limited resources	Regional stations with lead functions	Adaptive and applied
Very small country	Limited resources	National station testing sites	Adaptive

Table 4. RESEARCH STATION ORGANIZATION BY MANDATE

GOAL	ORGANIZATION
Pure research	Individual scientist
Highly focused mission	Multidisciplinary program structure
Commodity development (single commodity?)	Multidisciplinary program structure or Research station with disciplinary departmental structure
Commodity development and growth of discipline	Research station with disciplinary departmental structure
Growth of discipline	Disciplinary institute
Farming systems research	Multidisciplinary program with a coordinating unit

ORGANIZATION AND STRUCTURE OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEM IN CHINA

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INTRODUCTION

China has a population of one billion people; 80% are in agriculture. These are the 800 million people living in rural areas, mainly engaged in farm production or with part-time employment in township enterprises, who do not have their staple food supply from the government. According to statistics from the State Statistical Bureau for 1985, the gross agricultural production value amounts to 34.3% of the gross agricultural and industrial production value. Although agriculture in China does not make up a large proportion if we only look at that figure, agriculture also provides a large quantity of raw materials to industry, such as cotton, bast fibre (e.g., hemp, jute), wool, tobacco, rubber, sugarcane, etc. The production value of industrial products based on agricultural raw materials accounts for 70% of the gross production value of light industry.

Agricultural growth clearly plays an important role in the development of the national economy. Agriculture, since the founding of the People's Republic of China, has experienced significant changes. Now, China has basically become capable of feeding and clothing its people, providing most of the required agricultural raw materials to industry and exporting some agricultural products. However, agriculture in China still remains at a less-developed level, with antiquated equipment, low production efficiency, and insufficiently explored and exploited resources. A great challenge is confronting China as the government plans to achieve four times the industrial and agricultural production value, based on 1980, by the end of this century. This will undoubtedly need the support of science and technology. To give this support China has an acute need to transform its present agricultural research system into a more effective and efficient one to produce more research findings for agriculture.

Historically, the development of science and technology in the People's Republic of China, since the founding revolution 39 years ago, can be divided into four stages according to the White Book No. 1 of Science and Technology published by the State Science and Technology Commission.

First stage (1949 - 1966)
- Organization and construction of national research institutions.

Second stage (1966 - 1976)
- Serious setback caused by the Cultural Revolution.

Third stage (1976 - 1980)

- Restoration and consolidation.

Fourth stage (1981 - 1985)
- Blossoming of scientific and technological development.

The government of China has paid a lot of attention to agricultural research and organized an integrated national agricultural research system(NARS). The state, province, prefecture and county governments set up science and technology commissions in charge of the overall coordination and management of all aspects of science and technology. The departments responsible for agriculture at these four government levels have corresponding management mechanisms for the coordination and control of agricultural research.

ORGANIZATION AND STRUCTURE OF THE NARS

The organizational type of the NARS in China can be considered as a Ministry Model. This may be subdivided into two categories: extension and research.

Extension

Extension work is practiced in an independent system separated from research. Extension institutions, sponsored by government, are essentially located in counties. The relevant authorities in coordination and management are at national, provincial, and prefectural levels and they deal with the overall plan, resource allocation, monitoring, evaluation, etc.

Research

Research is organized by the different ministries at different levels. Institutions which carry out research are controlled by the agricultural management departments at different governmental levels.

There are four subsystems with differing responsibilities within research.

1. *Chinese Academy of Science.* This is a comprehensive center for natural science in China, affiliated with the State Council. Its mandate is basic research, part of which relates to agriculture. It has 122 research institutes dispersed all over the country.

2. *Ministerial and commission level.* The Chinese Academy of Agricultural Science (CAAS), under the Ministry of Agriculture, Animal Husbandry and Fishery (MAAF), is a comprehensive research center for agriculture and animal husbandry in China. Its mandate is to solve key scientific and technological problems of significant economic importance. It concentrates on applied research in crop breeding and cultivation, plant genetic resources, soil and fertilizer, plant protection, agricultural meteorology, and veterinary science. Each of its 34 independent institutes has one or two main research functions. Funds are allocated after approval by the planning and financial sections in the Ministry from the national budget of the Treasury. The research program is approved by the Ministry. The CAAS does most of the research on key projects with national priority.

   The Chinese Academy of Forestry, under the Minister of Forestry, is a national center for integrated applied forestry research. It has 11 research institutes and pilot farms, and the management pattern is similar to the CAAS.

   Other research institutions at this level include the Chinese Academy of Agricultural Engineering Research and Planning, under the MAAF, and the Chinese Academy of Water Conservation, under the Ministry of Water Resources and Electric Power. They have a similar pattern of relations with the ministries they belong to.

3. *Provincial and prefectural level.* Each province or autonomous region has its own academy of agricultural science, academy of forestry, etc. They are controlled by the departments responsible for agriculture, forestry, etc. in provincial governments. In keeping with local agricultural conditions, research is focused on solving provincial production problems, but they are also assigned work in key projects being conducted nationally or regionally. Main research activities are directly listed in the yearly or long-term program of the provincial government and funding is allocated accordingly.

   Below this level, the NARS has prefectural research institutions, which are under the prefectural departments. They are smaller than provincial research institutions.

4. *University-affiliated institutions.* These institutions specialize in basic theory and applied research in accordance with educational requirements and technology generation needs. Research funding flows from the State Education Commission through the state financial budget. At present, China has 59 agricultural universities and colleges.

RESEARCH AND FUNDING

There are about 1400 agricultural research units in and above the prefectural level within the two subsystems of MAAF and the Ministry of Forestry, according to the statistics of the National Survey on Science and Technology in 1985. Generally speaking, the institutions at ministerial, local (province and prefecture), and university levels are the mainstay of agricultural research in China.

There is an additional source of research and funding in the NARS. Besides undertaking research from government (ministry and local department) with allocated funding, the research institutions or units described above can take on research from the production sectors, with funding support from them.

They can also do research in a large range of areas in which they are interested, capable, and physically qualified. In this case, funding should be found by the research institutes themselves from foundations, loans, and foreign assistance.

PROVINCIAL RESEARCH INSTITUTE

To clarify the organization of research in the NARS, let us take a research institute at the provincial level as an example. In general, research in a provincial institute is dominated by the provincial department in which it is located. Based on a balancing of long-term and short-term plans, production requirements and reports given by research units, the department produces an annual program and assigns projects.

As a basic unit, a provincial research institute should make socially oriented investigations several months before the following year begins, to select research projects which are suitable for the agricultural development of the province or region, for development of the unit itself and in keeping with the resources of the research unit. This is the first phase. The second is to compile a proposal report, including research objectives, contents, developments domestically and worldwide, approach, progress schedule, duration, environmental conditions, funding estimate, etc. The third is to give the report to the internal academic commission for evaluation and approval. After it is approved, it will be submitted to the provincial administrative department, e.g., Department of Agriculture. This department has power over project decision-making, determines whether it should be listed in the provincial research program or, if it is of wider social and economic significance, sends it for consideration at a higher level. The decision taken depends on the evaluation of the expert group and the balance between the factors mentioned at the end of the previous paragraph.

When the proposal is accepted, or listed in the government program for research, funds are allocated through the provincial department of the treasury according to the budget made.

RESEARCH AND EXTENSION SYSTEM

The NARS in China manages research monitoring, evaluation, and appraisal at separate levels - national, ministerial, provincial, and unit - depending on the level of the program in which the research is included. The unit conducting research should give reports to these management authorities in a certain period of time. Because of the imperfect appraisal system being used in the NARS, research appraisal takes the form of organizing a workshop composed of a number of experts and professionals

Extension work on research findings is carried out by the independent extension system. There are several levels of extension station, from state to county or even town. The government has unified arrangements for the extension, application, and production of new research findings.

This description gives an idea of the kind of research system the People's Republic of China has and how it works. There are constraints in the system, and what follows summarizes talks with several administrative officials at the national level. They pointed out crucial problems existing in the NARS:

- Research institutions are set up according to administrative divisions rather than natural agro-ecological divisions. So, institutional overlapping and duplication of effort are very serious problems.

- Research institutions do not have relations with producers. Each institution performs its activities and reports them to the authority at the next level up. Being over-controlled by administrative authority, there is no competition between research units and market functions do not work.

- Programs do not accurately reflect the needs of agricultural development. Over-concentration on management of plans gives rise to imbalanced development in some aspects of agriculture.

- There is a lack of sufficient funds to execute research.

Because of these constraints, scientific research is far from meeting the needs of the current systematic reform of the rural economy. Consequently, the government of China will launch a large-scale reform in science and technology in the near future. At present it is being tried in a small area. I will discuss two points arising from this in the next section. One is the goal of agricultural research and priorities; the other is the planned reform of the science and technology system.

RESEARCH POLICY

In the past, China suffered from poor nutrition, low living standards, and a long-standing problem of surplus rural labor, caused by monoculture and imbalanced growth in agriculture. Now China intends to diversify the rural economy through all-around development in agriculture, forestry, animal husbandry, byproducts, and fisheries, and will manage agriculture, industry, and trade comprehensively.

To achieve the general, strategic goal of national economic development, agricultural research should be

closely tied to improving productivity per unit area, quality, gross production, and production value, through:

- research on comprehensive rural development harnessing all resources, developing the base for commodity production in some key areas;
- research on a production structure which can maintain a healthy ecological environment;
- research on intensive technical systems with high output, good quality, and low cost, using mainly biotechnology;
- research on overall control of drought, waterlogging, frost damage, and harmful organisms;
- research on technologies for storage, transportation, on-site processing, and multi-utilization of farm products and byproducts;
- macroscopic research;
- research on basic theory and application of new technology.

PLANNED REFORM

In the science and technology system China wants to put a major effort into the launching of a nationwide reform and has already issued some policies and regulations on relevant matters. The main principle of this reform is that economic development relies on science and technology, and science and technology orients economic development.

The reform will focus on adjusting the distribution of institutions and the funding allocation system. As I mentioned above, research institutions are organized according to administrative divisions. Overlapping and duplication of effort cause great waste in human, physical and financial resources. In the reform, institutions at the national level will concentrate on applied and applied basic research and at the provincial level on applied and adaptive research. The prefectural level will be rearranged according to agricultural, economic, and ecological divisions, and will carry out adaptive research. China is on the way to building centers of agricultural science based on agricultural divisions and is seeking a new approach to combine research, education, and extension as an entity.

The government of China will reform the funding allocation system to avoid management of scientific research relying purely on administrative considerations, to avoid government centralization in decision-making and resource allocation, and to promote close links between the research and production sectors. For research units, there will be several ways to obtain funds, depending on the characteristics of the research, as well as unified planning and management of key national projects.

Basic research and some applied research will be funded by the National Foundation of Natural Science, which is sponsored by government through grants by application. The Foundation gives support to projects based on their priority in national development planning. Adaptive research, and some applied research which is profitable in the short term, will use a technical contract system and will obtain funds by accepting commitments, transferring results, contracting national projects, and servicing.

In the meantime, the reform will also involve macroscopic changes in management, streamlining, and decentralization. The system of giving directors responsibility for their institutes has initially been implemented in the NARS. Research units are allowed to decide on plans, resource allocation, hiring, firing, etc. The NARS has begun to adopt the fixed-term system for research institution directors, a new appointment system for professional and technical posts, and the relevant policies to mobilize the rational flow of technical personnel.

Obviously, the government of China has become aware of the importance of laws in the management of scientific research. A sound NARS would need the protection of law. The Patent Law has just been approved, and the Technical Contract Law of the People's Republic of China will be put into practice this November. But this work is just beginning.

Of course, there are many problems under discussion, such as the scope and degree of planning, market functions for research, salary regulations, etc.

INTERNATIONAL COOPERATION

Opening to the outside world is a cardinal and long-term policy of the Chinese government for the development of science and technology. Nowadays in agricultural research, China has established relationships with over 10 international agricultural research organizations, including IRRI, CIMMYT, CIP, and ICARDA, and is cooperating with the agriculture departments of several countries. In recent years, the introduction of advanced technologies in biology, agronomy, horticulture, animal husbandry, the exchange of crop, fruit tree, vegetable, and animal varieties, and collaborative research in many aspects of agriculture, have given a great push to the

scientific development as well as the agricultural growth of the People's Republic of China.

Although the range of areas in which China is willing to collaborate with other countries and organizations is very wide, training managerial personnel in agricultural research is one of the crucial problems that needs to be solved. This is because management science has been stressed only in recent years. Agricultural research management is, therefore, still a very weak point. Investigation has shown that traditional management relying on experience dominates, that most managers are not well trained, and that they still use old administrative methods and backward equipment. The government of China is aware of these obstacles and is prepared to introduce advanced managerial technology from foreign countries and to train a large number of qualified managerial personnel through various channels.

Since each country has its own history, development pattern, social foundation, and natural environment, no country can simply copy other countries in social and scientific development. China is keen to develop cooperative relations with both developed and developing countries to learn their advantages in technology and management. China also strongly feels that it is very important to find an acceptable path in agricultural development and research management that conforms to its own characteristics and allows it to set up an effective and efficient agricultural research system.

It is hoped that China will receive assistance from the International Service for National Agricultural Research, as ISNAR's goal of assisting developing countries to improve the effectiveness and efficiency of their agricultural research systems through enhanced capacity in research policy, organization, and management, coincides with China's concept of development.

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