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Report of a workshop

Research Policies and Management for Agricultural Growth and Sustainable Use of Natural Resources

The Hague, December 7–9, 1994

DSE

isnar

The mandate of the International Service for National Agricultural Research (ISNAR) is to assist developing countries in bringing about lasting improvements in the performance of their national agricultural research systems and organizations. It does this by promoting appropriate agricultural research policies, sustainable research institutions, and improved research management. ISNAR's services to national research are ultimately intended to benefit producers and consumers in developing countries and to safeguard the natural environment for future generations.

ISNAR offers developing countries three types of service, supported by research and training:

- For a limited number of countries, ISNAR establishes long-term, comprehensive partnerships to support the development of sustainable national agricultural research systems and institutions.
- For a wider range of countries, ISNAR gives support for strengthening specific policy and management components within the research system or constituent entities.
- For all developing countries, as well as the international development community and other interested parties, ISNAR disseminates knowledge and information about national agricultural research.

ISNAR was established in 1979 by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force. It began operating at its headquarters in The Hague, the Netherlands, on September 1, 1980.

ISNAR is a nonprofit autonomous institute, international in character, and apolitical in its management, staffing, and operations. It is financially supported by a number of the members of the CGIAR, an informal group of donors that includes countries, development banks, international organizations, and foundations. Of the 16 centers in the CGIAR system of international centers, ISNAR is the only one that focuses specifically on institutional development within national agricultural research systems.

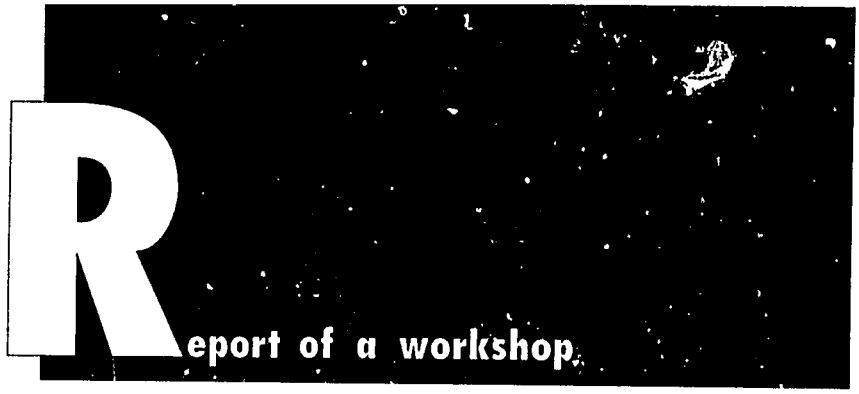
The German Foundation for International Development (DSE) was created by the Federal and Land governments in 1959 on the initiative of all the political parties represented in the Federal Parliament. It was assigned the task of fostering the relations between the Federal Republic of Germany and developing countries on the basis of a mutual exchange of experiences. The DSE fulfills this mandate by organizing conferences, seminars and training programs to support projects which serve economic and social development in countries of Africa, Asia and Latin America.

Since its creation, the DSE, in cooperation with national and international partner organizations, has provided more than 100,000 experts and leading personalities from more than 140 countries with an opportunity to discuss issues of international development or undergo professional training.

In its work, the DSE attaches priority to rural development, food security and the promotion of industrial vocational training. It also supports efforts to improve organization and planning in the developing countries in the fields of public administration, health, education and development planning. Furthermore, the DSE prepares German experts for their assignments in developing countries, and provides a comprehensive information and documentation service.

The DSE is based in Berlin, but it also has specialized centers with branches at various location in the Federal Republic of Germany. Its Food and Agriculture Development Centre (ZEL) has its seat in Feldafing near Münich with a branch in Zschortau near Leipzig.

Through its dialogue and training programs the ZEL supports efforts to mitigate hunger, malnutrition, poverty and environmental degradation in developing countries. Its conferences, expert meetings and seminars promoting international exchange of experiences are addressed to political and administrative decision-makers, scientists and experts acting as promoters of the development of agriculture and rural areas. The advanced training programs of the ZEL are held for multipliers, i.e., managerial and executive personnel who are in charge of programs or projects as well as for teacher at relevant training institutions. The program contents are adapted to the regional training requirements.



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Foreword

Natural resource management — or NRM — has been the subject of human interest and investigation for as long as people have occupied and cultivated land, used its treasures and products, or otherwise harnessed its productive potential.

Farmers are still the prime users of land, water, plant, and animal resources. In recent decades, agricultural and social scientists around the world have been working on a variety of NRM problems and topics. To name just a few: the biophysics of soil-nutrient depletion, conservation of animal and plant genetic diversity, the use of trees and other plants to stop erosion, integrated pest management, enhancement of biological nitrogen fixation, water management in dry areas, and the link between land tenure systems and land degradation.

NRM concerns and motives tend to vary with a country's economic status and with people's appreciation of their environment. In the industrial world where food is plentiful, focus is on environmental protection and pollution control for their own sake. In the developing world, the pursuit of sustainable food security and increased food production are key driving forces behind NRM work.

Natural resource management, and research on it, are not new. What is relatively new in the ongoing global dialogue on agricultural research is the growing consensus that more needs to be done. Action is required to ensure that production and productivity are enhanced in ways that protect the long-term health of the biological and physical environment. Otherwise, it will be impossible to respond indefinitely to the growing global demand for food, feed, fuel, and fiber.

This report records the ideas, discussions, recommendations, and conclusions of an international meeting on research policies and management for agricultural growth and the sustainable use of natural resources. For the national research managers and representatives of donor agencies, international centers, and regional organizations who participated, this was anything but a purely theoretical discussion about a new "fad" in international development. During their three days at ISNAR headquarters in The Hague, they engaged in a lively dialogue on the practical policy and management issues they are now grappling with as they integrate, or help integrate, NRM research with more traditional forms of agricultural research. Indeed, among the papers presented were several dealing with specific experiences and lessons learned — at the national, regional, and international levels.

Funding for agricultural research is currently very tight and will likely continue thus for some years to come. Many national systems find themselves in this financial pinch at a time when their scientific burden is clearly becoming heavier

not lighter, in part because of heightened awareness of environmental issues. In these uncharted waters, it is crucial that research managers, policymakers, and the technical and financial supporters of research have the chance to exchange the experiences and ideas that can help them steer a wise course.

This was the third international meeting on which ISNAR and DSE have collaborated. In staging the workshop, both organizations were pleased to be able to contribute further to the international dialogue on the future of agricultural research, especially as it affects developing countries.

We hope this most recent dialogue will inspire national research leaders and their partners to move ahead confidently with the complex institutional and management adjustments required to integrate more fully NRM concerns into their scientific agendas. We wish them every success in this task.

Christian Bonte-Friedheim
Director General
International Service for
National Agricultural Research

Erhard Krüsken
Director
Food and Agriculture Development
Centre of the German Foundation
for International Development

Acronyms and Abbreviations

AARD — Agency for Agricultural Research and Development (Indonesia)
ASARECA — Association for Strengthening Agricultural Research in Eastern and Central Africa
ASOCON — Asian Soil Conservation Network
CAAS — Chinese Academy of Agricultural Sciences
CARDI — Caribbean Agricultural Research and Development Institute
CATIE — Tropical Agriculture Research and Education Center
CGIAR — Consultative Group on International Agricultural Research
CIAT — International Center for Tropical Agriculture
CIMMYT — International Maize and Wheat Improvement Center
CIP — International Potato Center
CILSS — Comité permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel
CORAF — Conférence des Responsables de la Recherche Agronomique Africains
DSE — German Foundation for International Development
EMBRAPA — Empresa Brasileira de Pesquisa Agropecuária (Brazil)
FSR — farming systems research
GDP — gross domestic product
GIS — geographic information system(s)
GTZ — Deutsche Gesellschaft für Technische Zusammenarbeit (Germany)
IARC — international agricultural research center
ICARDA — International Center for Agricultural Research in the Dry Areas
ICRAF — International Centre for Research in Agroforestry
IFPRI — International Food Policy Research Institute
IICA — Inter-American Institute for Cooperation on Agriculture
IIED — International Institute for Environment and Development (U.K.)
IITA — International Institute of Tropical Agriculture
INRM — integrated natural resource management
INSAH — Institut du Sahel
IPM — integrated pest management
IPR — intellectual property rights
IRA — Institut de la recherche agronomique (Cameroon)
IRETA — Institute for Research, Extension and Training in Agriculture (Western Samoa)
IRRI — International Rice Research Institute
IRZV — Institut de recherche zootechnique et vétérinaire (Cameroon)
ISNAR — International Service for National Agricultural Research
KARI — Kenya Agricultural Research Institute
M&E — monitoring and evaluation
NARS — national agricultural research system(s)
NARO — national agricultural research organization
NGO — nongovernmental organization
NRM — natural resource management
PPPO — participatory program planning by objectives

Introduction

Background

This workshop was the third in a series of international dialogues organized jointly by the German Foundation for International Development (DSE) and the International Service for National Agricultural Research (ISNAR). Titled Research Policies and Management for Agricultural Growth and Sustainable Use of Natural Resources, the workshop was held December 7-9, 1994, at ISNAR headquarters in The Hague.

The two previous meetings, held in 1988 in Feldafing, Germany, and in 1992 in Berlin, examined the policy dimensions of national-level agricultural research in the developing world. A brief discussion of the evolution of policy issues since 1988 — as well as the implications of these policies for national agricultural research systems (NARS) and ISNAR's assistance to NARS — is presented in Appendix 2 of this report.

This most recent workshop in The Hague narrowed the focus of discussion in two ways. First, it looked at a specific research issue over which there is growing consensus among both industrial and developing nations: the need to reconcile national development goals for agricultural science with protection of the natural environment. More precisely, it examined ways for research systems to accommodate the imperative of increasing agricultural output with that of safeguarding and managing the natural resource base — water, soil, forests, plant genetic diversity — upon which production depends. The reconciliation of what some may view as conflicting interests will surely result in an expanded research agenda. This may require a new perspective on research and new ways of organizing it. In some instances, new tasks will need to be assumed and these will have profound implications for NARS.

Second, the workshop devoted considerably more attention to the institutional and management implications of incorporating natural resource management (NRM) concerns into research agendas than to policy questions. In short, the predominant perspective was that of national research leaders rather than of national policymakers, although the latter were represented at the meeting, along with donor agencies and regional research organizations.

Workshop Objectives

The workshop had two main objectives for research leaders, policymakers, and others involved in agricultural research:

- to engage in a dialogue on issues of research policy, organization, and management, arising from the growing awareness of the importance of NRM in agricultural development
- to identify NARS' priorities for the integration of NRM issues into their agricultural research agendas; ways in which NARS can mobilize their resources for this purpose; and the services and support NARS require from

regional and international organizations, including ISNAR, to achieve this integration.

Structure of the Workshop

On each of the three mornings of the workshop, a series of papers was delivered in plenary. The afternoons were reserved for detailed discussion in working groups composed of 10 to 12 participants. A total of 17 papers was presented and discussed. On the final day, the working groups concentrated on drafting recommendations, based on all three days' work, for various stakeholder groups: NARS, donors, regional organizations, and ISNAR. The workshop ended with a plenary panel discussion of the recommendations and key issues emerging over the three days.

Structure of the Report

The structure of this report follows that of the workshop. First, summaries of the welcome and opening remarks are presented. Then the papers presented in the morning sessions and the afternoon working group discussions are summarized for each day. The summaries are based on the written submissions, and are intended to give a sense of the wide range of topics and experiences presented at the workshop. The final section contains the recommendations and conclusions of the workshop, including key points raised in the final plenary discussions. A complete list of the papers presented is provided in Appendix 1. Appendix 2 comprises summaries of a selection of six key papers. Appendix 3 provides a list of workshop participants.

Welcome and Opening Remarks

Food Production versus Resource Protection

Christian Bonte-Friedheim, Director General of ISNAR, welcomed participants to the workshop. He gave special thanks to Erhard Krüsken of DSE, for DSE's continued support of these international meetings. This was the third on which ISNAR and DSE had collaborated.

In many developing countries, food is still scarce, and obtaining it comes before all else, said the ISNAR director general. In the industrial countries, however, where food is abundant, protecting the environment for the present and future generations has become a priority, taking precedence over issues of food production.

Where do these opposing perspectives meet? How can researchers and policymakers reconcile the need for agricultural growth with the need to ensure that the use of natural resources for agricultural production is sustainable? In coming to grips with these often opposing needs, what are the appropriate priorities for the different actors involved: national agricultural research systems (NARS), donors, regional organizations, and international centers such as ISNAR? These, according to Bonte-Friedheim, were the main questions to be answered in the workshop.

The workshop's conclusions and recommendations will be particularly relevant, he said, for the upcoming meeting of NARS representatives, in Rome, to discuss the CGIAR's vision of the future.

New Challenges for Agricultural Research

Erhard Krüsken, Director of DSE's Food and Agriculture Development Centre (ZEL), chaired the opening session of the workshop. He welcomed all participants on behalf of DSE and its Food and Agriculture Development Centre, as well as on behalf of the German government, which funds DSE. He hoped that by cosponsoring the workshop with ISNAR, DSE could help continue the important dialogue, begun in Berlin in 1992, on the future of national agricultural research.

Meanwhile, he said, new challenges and issues have arisen. These were articulated in "Agenda 21" prepared at the United Nations Conference on the Environment and Development (UNCED); in international conventions on biodiversity, desertification, and climatic change; and by the global agricultural research system of the CGIAR. Even the recent Cairo conference on population pointed to issues that will have to be reflected in agricultural and rural development efforts. Finally, preparations for the upcoming conference on women's issues and the social summit in 1995 raise questions relevant to the research efforts of the workshop participants.

To more than double agricultural production in the next 30 years to feed 8.5 billion people is a gigantic task for research and development (R&D). Including NRM makes this task even more complex. And there are other threats such as the decline in agricultural aid since the middle of the 1980s. Developing country governments

have also cut aid to agriculture. "We are asking ourselves," said Krüsken, "is this going to continue?"

The common agricultural policy of the European Union and the recently concluded General Agreement on Tariffs and Trade (GATT) are also major factors. Some predict that with a reduced food supply and rising prices on the world market, many of the food-importing developing countries will not have enough foreign exchange to buy what they need. Krüsken made several observations related to this changing context of global agriculture:

- More than ever, good governance is needed in the developing world. This implies the "democratic and legitimate acknowledgement" of the majority status of rural people. It means putting in place agricultural and food security policies aligned more with rural socioeconomic and sociocultural needs than with the needs of the urban and consumer ranks that are in the minority.

- The economies of Japan, Taiwan, Korea, Malaysia, and other countries got their initial push through heavy investment in the agricultural sector. "This seems to be forgotten even in the quarters of development policymakers."

- There is a direct link between, on the one hand, agricultural and rural development and, on the other, poverty alleviation, protection of the environment, and population dynamics. "I'm afraid this correlation is not known outside the development community."

- National governments in the South, as well as donor countries, must reverse the downward trend in agricultural aid. "Let's challenge our political leaders and governments and make them aware that everybody, South or North, is a loser if the race to double food production is lost."

- Conference papers and recommendations often say little about the social and economic forces that even poor men and women can bring to bear on national development. Each individual is himself or herself a natural resource. Whatever we discuss, and whatever we want to strengthen when we deal with development, people are in the middle of the process. They are not just the target, but also the engine of development. We must not forget to fuel that engine properly.

Finally, Krüsken expressed his gratitude to ISNAR for joining forces with DSE on the workshop. He gave special thanks to Peter Goldsworthy and his ISNAR team for their cooperation in organizing the workshop with Jürgen Richter of DSE. He invited workshop participants to bring the full weight of their expertise in examining the topic of NRM research and wished them success in tackling such a complicated subject.

Day One: The Changing Context of Agricultural Research

Papers

The first day was devoted to a discussion of the changing context of agricultural research at the national and international levels, including emerging policy issues. Following the welcome and opening remarks by DSE and ISNAR representatives, five presentations, based on short papers, were given.

Global trends and policy issues

The opening presentation, by ISNAR's deputy director general, gave an overview of recent global trends and policy issues challenging national agricultural research. He outlined the topics and conclusions of two previous DSE-ISNAR meetings on agricultural research policy. Among the issues were growing demand for food, weakening donor support for agricultural research, heightened concern over environmental degradation, the evolution of regional collaboration, the changing levels of human and financial resources devoted to research, the impact of structural adjustment and privatization on research, and links between NARS and international research. The presentation also outlined how ISNAR has adapted its work program to this changing context and to the evolving needs of NARS. (See first summary in Appendix 2.)

Perspective of a large donor

The next presentation was from the perspective of a large donor agency, the World Bank. It outlined the difficult situation facing developing-country agriculture and strategies that might help it cope with an expanded research agenda at a time when there is a flow of funds away from agricultural research.

The presenter noted that land and water, traditional factors in expanding production, are restricted and that widespread use of chemical inputs is raising serious sustainability concerns. As a result, agriculture increasingly will have to rely on a combination of biological improvement and natural resource management to meet the demand for food and fiber from a world population that will probably reach 8.9 billion by 2030 — a 71 percent increase over the 1990 population. In this shift to knowledge-intensive agriculture, the burden will fall squarely on the shoulders of research, particularly NARS. The presenter reviewed briefly some past trends in, and successes of, agricultural research, particularly those related to the Green Revolution, also looking at current and future factors that complicate the task of increasing production.

The NARS thus face a double challenge. First, they must broaden their research agendas to meet the growing demand for food and the requirements of sustainability. NRM research raises many hurdles having to do with, for example, its complexity, long time horizons, and multidisciplinarity. Second, NARS must become more efficient in their use of research resources, especially scientific expertise and money.

One way to meet the double challenge, the presenter asserted, is by forming partnerships with a variety of institutions, including international, regional, and national organizations, as well as with the private sector. International agricultural

research centers (IARCs), for example, can help NARS with training, information, management, and institution building. The presenter noted advantages of teaming up with different kinds of partners.

A second practical step for NARS is to review their funding strategies. Public authorities who allocate resources often have a short-term perspective geared toward seeing immediate results. This is an obvious problem for long-term NRM work. Here private-sector research entities may have lessons for NARS. In large pharmaceutical companies, for example, decisions on the allocation of funds are often made at the highest management level. At the same time, NARS should try to build a constituency of support by communicating to the public the importance and benefits of research.

The presentation ended with a brief reference to World Bank support for agricultural research in or for developing countries. Between 1981 and 1987, funding for freestanding research projects was about $1.5 billion. The Bank also finances international agricultural research. In 1992, support to the CGIAR centers, for example, was $37.6 million.

Experience of a national technical cooperation agency

The World Bank presentation was followed by one describing the methods and experience of a national technical cooperation agency, GTZ of Germany, in supporting agricultural research and NRM projects in developing countries. Overall GTZ priorities are sustainable rural development, conservation and use of natural resources, education, and population policy. Agricultural development is a major focus of GTZ work with special emphasis on agricultural policy, production and the environment, and agricultural research.

NRM research should focus on sustainable agriculture and on productivity increases to reduce pressure on forest reserves. In working to strengthen NARS, GTZ follows an approach based on participation, capacity building, and organizational development. Consensus among various stakeholders must first be built; then interventions can be implemented in phases in an interactive mode as follows:

- **Policy decisions.** Problems identified; decisions taken regarding mandate, mission, scope, scale, and strategy; collaborative arrangements made for technical cooperation, funding, and research partners.

- **Implementation of changes.** Research plan formulated and priorities set; changes made in organization and structure; management of research cycles organized; management functions, research tasks, and human resources reallocated; staff trained. Changes must be understood by all the groups concerned. Specially assigned staff are usually needed to manage the change.

- **Ensuring client orientation and sustainability of the NARS.** Clients participate in setting the research agenda and at other stages of the research cycle; client-based monitoring and evaluation done to ensure accountability and scientific quality; internal and external linkages established (e.g., networking or joint projects with IARCs). To sustain financing of research, the NARS must also give sufficient attention to marketing its expertise and building support among clients and the public.

Successful rural innovation and development demands that top-down policy formulation be combined with participatory bottom-up planning. GTZ's experience with NARS also leads to the conclusion that research management, including organizational development, is one of the key intervention point for technical assistance. As long as management functions are not being properly carried out, the value of changes at the research operations level is diminished.

Brazil's perspective on NRM

In the fourth presentation of the morning, a research policymaker from Brazil's leading agricultural research body, EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária), gave a country perspective on NRM. National research organizations recognize the importance of sustainability and NRM issues and want to do something about them. Yet the demand for services by NARS is "endogenous" to the development process. That is, it is strongly conditioned by economic, social, political, and cultural factors largely beyond their control. The need for NRM research, like any research, has to be concretely "felt" by government and the general population before political support for a change of scientific direction materializes. If current generations feel that their basic needs are not being met, then arguments for doing sustainability research, which is concerned more with future generations' needs, are not likely to be acted on.

Economic conditions and policies (or lack of them) are major causes of farming practices harmful to the environment, the presenter noted. Because negative effects are not accounted for in production costs, "bad" use of otherwise safe technology becomes a problem.

In Brazil, EMBRAPA recognized the relevance of research on sustainable production and acted on it. After a major strategic planning exercise, it reorganized its research around 36 decentralized centers. Fifteen are ecoregional agricultural research or agroforestry centers. This structure represents the formal institutionalization of Brazilian agricultural research's effort to put development on a sustainable track.

The presenter noted that expanding the research agenda in countries experiencing economic crisis may be counterproductive for the NARS. He argued that NARS must be strengthened first so that, as demand for NRM research grows, they are in a good position to take on the additional burden. Part of that strengthening may be to improve NARS' scientific capacity in frontier areas such as molecular biology, which will become a major source of innovation.

NARS tend to respond to demand for sustainable production research by studying major ecoregions of their countries, particularly ones under population pressure or with a fragile resource base. But NRM and sustainability research is complex and difficult. NARS should weigh what should be done against what is feasible. The presenter argued that it is best to start on research problems where productivity and sustainability goals are complementary — such as with nitrogen fixation, biological control, and integrated pest management (IPM).

The presenter concluded with the observation that developing countries have accepted the sustainability agenda but many of them do not have the required trained people in their research organizations. Moreover, while research has an

important part to play in promoting sustainability, the role of policy adjustment must not be forgotten.

Perspective of an international NGO

In the last presentation of the day, a representative of an international nongovernmental organization (NGO) concerned with the environment and development argued for a new scientific and social paradigm for tackling the highly complex issues of NRM and sustainability. The traditional "positivistic" method, in which the beneficiaries of science and technology are largely left out of the process of innovation, is unsuitable for addressing the newly emerging research agenda, the presenter said. It should be replaced by one that harnesses local knowledge, encourages learning and participation by all affected, and builds "connectivity" and partnerships with other important actors in national development such as NGOs.

The presenter asserted that there is now strong evidence that resource-conserving technologies and practices can bring significant environmental and economic benefits to farmers, communities, and nations. Successes have three common elements. The technologies have been locally adapted. There has been coordinated action by local groups, and the farmers have entered into partnerships with supportive governmental and nongovernmental institutions. Local participation is now key for many development agencies. But only some forms of participation lead to sustainable practices by farmers and improvements in the way research and extension agencies operate.

A number of measures were suggested to help improve interactions between farmers and outside actors, including NGOs, research, and extension. Among these are the formal adoption of participatory methods, fostering NGO-government partnerships, and reform teaching and training establishments so that they focus more on learning processes.

Working Group Discussions

Each of the four working groups discussed one of the following topics: new issues for national agricultural research and the relevance of the 1992 Berlin recommendations; priority setting for NRM research; links between NGOs and research organizations; and funding and regional integration of research.

Berlin recommendations and beyond

The working group's task was to examine the relevance of recommendations from the 1992 Berlin policy workshop and identify new issues for research and their implications for ISNAR, NARS, and donors.

The Berlin workshop had put forward a total of 27 recommendations to five target groups: NARS and national policymakers; regional programs and organizations; the CGIAR and Technical Advisory Committee (TAC) to the CGIAR; ISNAR; and donors. The complete text of the recommendations is contained in a summary of that workshop, titled *Highlights of a Policy Dialogue: Future Challenges for National Agricultural Research* (available from ISNAR). Here we give only a brief overview of the topics covered by those earlier recommendations; most of

this summary is devoted to new issues and recommendations put forward by the working group.

The Berlin recommendations addressed the following:

- **For NARS and national policymakers.** Building analytical capacity to influence policy dialogue at all levels; links between structural adjustment and agricultural research; new sources of research funding; links with universities and other NARS; control over the agenda of research networks and other umbrella groups; incorporating impact assessment into research project design.

- **For regional entities.** NARS guidance of regional programs; emphasis on assistance to NARS in harmonizing policy objectives; facilitator versus gatekeeper roles; provision of technical services and harmonization of regional (transnational) research policies; limiting the size of institutions to avoid diverting resources away from NARS.

- **For the CGIAR and the Technical Advisory Committee (TAC) to the CGIAR.** Placement of agricultural productivity in the long-term system-wide strategy; NARS representation in CGIAR governance; IARCs' role as catalysts in securing donor funds for NARS; IARC-NARS collaboration on informing and influencing technology policymakers.

- **For ISNAR.** Information for policymakers and research leaders on the state of NARS; advice on the implications of structural adjustment; assistance with national-level master planning; methods for regional research planning; management of change; promotion of "multipliers" of ISNAR's impact.

- **For donors.** Mechanisms for funding research partnerships at the global, regional, and national levels; earmarking a portion of agricultural project funds for research.

The working group found most of the recommendations still largely relevant, with no need to reprioritize them. However, it took issue with two recommendations dealing with the role of regional organizations:

- "Take leadership in subregional roles of technical service and harmonizing policies of a transnational (but regional) nature." It was argued that leadership for such roles is not an exclusive function of regional entities but rests with NARS leaders who constitute the various governing councils of those entities.

- "Ensure that the role of facilitator is not one of gatekeeper to the region." While agreeing that regional organizations should avoid the gatekeeper role, the group felt that, to be really effective, regional organizations should perform a substantial function, such as provide a forum for regional issues.

One recommendation also called for international research centers "to serve as a catalyst between NARS and their sources of funding." The working group felt that IARCs, themselves components of the global research system, were not appropriate channels for disbursing funds, especially in view of the possibility that they may at times be in direct competition with NARS for resources.

Members of the group felt that the Berlin recommendations were largely concerned with issues linked to the biological and physical aspects of agricultural

systems. Greater emphasis, they thought, should be put on socioeconomic issues, "often crucial in the evolution of sustainable approaches to agricultural systems and development."

This concern, among other things, led the group to add a number of issues and make recommendations of its own.

- For NARS and policymakers. It is paramount that NARS develop sustainable technologies appropriate to local farming systems (production research and NRM research can be integrated without reducing the former). Greater emphasis needs to be put on socioeconomic parameters in agricultural systems classification.

  Policymakers should be made more aware of the importance of agricultural and NRM research in national development. The portion of agricultural gross domestic product (GDP) allocated to agricultural research including NRM work can serve as an indicator for comparative analysis of countries' commitment to agricultural research.

- For NARS and donors. Expanding the training component of NRM projects can help ensure greater commitment and effort in sustainability research.

- For regional programs and organizations. Intercountry and ecoregional coordination in the planning and implementation of NRM research requires the establishment or reinforcement of legal frameworks and multilateral agreements.

Priority setting for NRM research

The second group was asked to discuss priority setting for NRM research and the ways that donor countries and NARS view the tradeoff between production-oriented research and NRM-sustainability research. The group felt that those views really do not differ, that NARS and donor countries are unified in their concern about the long-term effects of agricultural production methods.

The group therefore rephrased the question, asking "What drives the shift in emphasis from commodity-production research to NRM-sustainability research?" The short answer is simply that this trend is driven by growing concern about preserving the productive resource base, both for the immediate future and over the long term.

It was recognized that significant increases in agricultural production will be needed in developing countries in the coming years and that research for increased production must incorporate concerns over sustainability and protection of the environment. What kind of research, then, will be needed? And how will the allocation of resources have to change, if at all?

Research needs cannot be generalized, the group agreed. They must be determined according to the specific conditions of the region in which the research is conducted. This requires a priority-setting process at the regional level, to decide on the best mix of commodity, production-oriented, and NRM research. Priority setting should be a regular or continuous process that defines such a research

program. The expected results of all research must be analyzed according to the likely economic, social, and environmental benefits.

Priority setting requires information on socioeconomic, agricultural, and environmental conditions. It also requires strong leadership. Priority-setting exercises will often lead to more emphasis on NRM research, requiring a shift in disciplinary mix, perhaps enhancing the role of the social sciences.

Institutes may not be able to house all the required scientific capacity within their walls. They may have to establish links with other national and international institutions such as universities and IARCs to assist in priority setting and to cooperate on execution of the integrated research program.

Links with NGOs

The third working group examined the role of NGOs vis-à-vis agricultural research. Discussion centered on answering the question "What are the areas of action of NGOs and the factors that give them a unique role in relation to public- and private-sector research?" The group tackled the question by looking at the features of NGOs, their advantages, disadvantages, and current functions.

Many types of NGOs are active in developing countries, often in agricultural activities. They can be separated into two major groups: domestic and international. NGOs tend to be socially and locally (grass roots) oriented, emphasizing participatory and interactive processes.

NGOs have several advantages in the way they operate, especially compared with public-sector agencies:

- NGOs tend to be more flexible than government organizations. Being less bureaucratic, they often can channel a large portion of their budget to community activities of direct benefit to the rural poor.
- They often have more operational funds, which permits their staff to get out into the field.
- Those involved in agriculture work mostly with small farmers and tend to have good relations with them.
- In recent years NGOs have begun to expand their technical expertise. As public-sector organizations downsize, NGOs have been picking up ex-public employees skilled in agricultural research and extension.
- NGOs are often better able to learn from experience than are public organizations.

NGOs also have some disadvantages:

- As they move from small-scale, local involvement to higher scales of operation, they may lose their basic character.
- In some situations they are in conflict with government agencies or policies, which means that they may not be appropriate partners for public agricultural research organizations.

- They seldom work with private firms.

- Until recently, most NGOs have had little expertise in agriculture and less in research. They are probably more suited to doing adaptive research and testing work.

- A common criticism is that NGOs are not accountable to the public, but to their financial supporters whether domestic or foreign. As such, some NGOs channel funds directly to community-level groups, bypassing national priorities or policy discussions. International NGOs, particularly those with an environmental mandate, may be unresponsive to real local needs as they pursue their own individual agendas.

- As donors and other supporters of agricultural programs shift their funding away from public-sector organizations, some NGOs are seen as competing for funds previously earmarked for NARS.

- Although some well-funded NGOs have made notable contributions to agricultural production, farmer welfare, and natural resource conservation, these benefits may not be sustainable once the organization withdraws its support. And while such impact at the village level may have been spectacular, the contribution on a national scale may not be very significant. Public-sector organizations generally have the advantage of being able to achieve broad national coverage.

NGOs serve useful development functions and have comparative advantages in certain areas. In particular, they contribute to broader agricultural R&D processes by building awareness of small farmers' interests. They communicate these interests to research organizations and lobby both public and private entities to respond more effectively to local needs. Many NGOs also help tap indigenous sources of knowledge, which are recognized as crucial ingredients in improving small-farm productivity and NRM. In many cases, NGOs have been able to motivate farmers and mobilize their resources for agricultural development. In some instances, NGOs are engaged in natural resource monitoring and data gathering (e.g., observation of erosion or counting members of endangered species).

A related question addressed by the group was "How can relations between NGOs and NARS be improved?" The group identified three strategies. First and foremost, interactions should focus on a practical task, such as data gathering or applied research. Extension agents and farmers should also be involved. Every effort should be made to pull down institutional barriers so participants can work on all aspects of problem solving. Joint evaluations were thought to be particularly valuable since such a learning process could unite various organizations around a jointly determined set of problems and a possible agenda of future work. Planning exercises and documentation of NRM problems were also identified as practical joint tasks.

Members of the group cited examples of NGO-NARS collaboration in Bhutan, Guatemala, India, and Jamaica.

Regional integration and funding

The fourth working group discussed regional integration of agricultural research, financing, and the role of the public and private sectors, and how these factors are affected by NRM-sustainability research.

The group questioned the need to distinguish between NRM and commodity research, noting that if research programs are systems-oriented, then NRM concerns are already taken into consideration. They agreed that fortifying commodity research will automatically fortify NRM research. (This issues was discussed again in a Day Two presentation on the integration of NRM into agricultural research agendas.)

The group highlighted several suggestions and issues:

- Working at a fully regional level only is probably too ambitious. Subregional cooperation, that is, among a smaller number of countries with common research interests, may be more advantageous. Research integration to tackle common problems within a region will permit countries to benefit from each other's experiences. However, integration does not and should not imply centralization of research programs.

- In developing countries, the private sector has generally not contributed much to research funding. In fact, private companies usually look for free research-related services. However, they do fund some commodity research that pays back in the short run. Laws should be enacted to require the private sector to increase its financial contribution to agricultural research.

- Lack of money for NARS is not the main constraint; rather, what is missing is efficient organization and mechanisms to allow NARS to tap and mobilize alternative sources of funding.

Day Two: Integrating NRM into the Agricultural Research Agenda

Papers

On the second day, the focus of attention shifted to concrete experiences of integrating NRM concerns into agricultural research agendas. Five of the seven plenary presentations highlighted examples at the national, regional, or international level.

Conventional versus NRM research

In this overview the presenter, an ISNAR staff member, noted that in the 1980s the growing awareness of three key features of natural resource management (the temporal, spatial, and multisectoral dimensions) demanded a refocusing of agricultural research and changes in the way it is organized and managed.

In the temporal dimension, all agricultural technologies affect the resource base over time. To account for this, research emphasis should shift from short-term to long-term productivity.

The spatial dimension recognizes that the effects of technology are often felt off-site, sometimes far from the point of application. This calls for spatially integrated analysis in order to understand the dynamic changes that occur in a resource system.

The third dimension is the multisectoral nature of resource use. That is, the use of resources for both agricultural and nonagricultural ends, by both farmers and nonfarmers. Water, for example, is used not only in irrigation but also for drinking, transport, recreation, and power generation. Thus, there was recognition of the need to approach NRM in an integrated way, taking into account the needs of sectors other than agriculture.

As a kind of wide-ranging scene-setter, the presenter looked at the implications of NRM research for typical institutional development and management. This includes research, governance, funding, human resources, research planning, information acquisition, priority setting, and monitoring and evaluation. (See summary of paper in Appendix 2.)

Links with biotechnology and conventional crops research

The next presentation, also by an ISNAR staff member, showed how biotechnology can provide important inputs to both conventional and NRM research. A key message was that NARS' efforts to build their research capacity should take into account the separate requirements of biotechnology and NRM research, as well as their complementarity.

In developing new planting material, whether widely adapted or suited to a particular agroecological niche, biotechnology can help assemble the necessary combinations of genetic material by concentrating expertise and effort at the molecular, cellular, or plant level. But it does not replace conventional agricultural

research. Rather, there are strong interactions between the two kinds of research. The same relation can be expected to hold between biotechnology and NRM work.

At the same time, both biotechnology and NRM research should be seen as resting on a firm foundation of traditional agricultural research. Shifting to NRM research is more a matter of emphasis and integration; it does not mean a total redirection of the NARS.

The presenter compared and contrasted various aspects of biotechnology and NRM research, for example, by spatial focus and difficulties in priority setting. Biotechnology concentrates on the molecular, plant, or plot level, while NRM's spatial focus is at the production-system or ecoregional level. "In most cases, biotechnology-derived material is far from ready for introduction at the agrosystem level. . . . However, this must be the final objective, or biotechnology will remain a purely laboratory science." Priority setting is rather complicated for both NRM and biotechnology, in part because of the conflicting interests of stakeholders in each case.

The presenter also briefly described two biotechnology initiatives. The first cited is the Agricultural Biotechnology for Sustainable Productivity project of the United States Agency for International Development (USAID). This work aims to use biotechnology to produce germ plasm more tolerant of adverse environments, pests, and pathogens, thus reducing the need for chemical inputs. It exemplifies some of the interactions between NRM research and biotechnology that we can expect to see more often in the future. The challenge for NARS managers everywhere will be to create incentives for complementarity between the two kinds of research.

The second biotechnology project cited is the Intermediary Biotechnology Service hosted by ISNAR. This is an advisory service to national programs on matters of biotechnology research management and policy. With the addition of a socioeconomist to the program, NRM and sustainability concerns are now being added to the decision-making framework used by Intermediary Biotechnology Service (IBS) to develop management tools and advice for developing countries.

The CGIAR's response

The third presentation, by the director general of the International Potato Center (CIP), outlined the CGIAR response to new challenges in agro-environmental research. He observed that CGIAR scientists have always shown concern for the sustainable use of natural resources. International research has been done on IPM, soil and nutrient management, the chemistry of flooded soils, and the impact of land clearing on soil, to name just a few areas.

A major review and reassessment of CGIAR research programs, begun in 1987, has resulted in even stronger emphasis on sustainable agriculture. And the CGIAR's response to UNCED's Agenda 21 lays heavy emphasis on research designed to help poor farmers, despite evidence that returns to production are greater from research done for prime farm land. This is because agriculture in less favorable areas often causes environmental damage.

The presenter outlined an ecoregional approach to research now being developed by the CGIAR to help farmers produce in a variety of production environments, not just the most fertile ones. This approach is based on the formation of research

consortia. In principle, a consortium is composed of several CGIAR centers working together with national research institutes and other competent organizations to solve NRM and agricultural production problems within a geopolitical region whose countries share a common agroecology. A particularly important aspect of the ecoregional approach is its goal of strengthening cooperation with NARS. (See third summary in Appendix 2.)

An African regional organization

The next paper was presented by the director general of the INSAH (Institut du Sahel), an African regional organization that coordinates research for the member countries of its parent organization, CILSS (Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel). He described the work of a regional soil and water research network set up in 1985.

A major constraint on agriculture in the rainfed Sahel is the degradation of intrinsically fragile lands. This is due in part to population pressure and scarcity of agricultural inputs (the latter reflecting economic difficulties). In an attempt to promote water and soil conservation and improve agricultural practices and production, INSAH launched the regional drought resistance research network (R3S-Réseau de Recherche sur la Résistance à la Sécheresse) in cooperation with the CORAF (Conférence des Responsables de la Recherche Agronomique Africains), an association of African agricultural research leaders. Scientists from Burkina Faso, Niger, and Senegal have established research partnerships with Dutch and French counterparts. The network's ultimate goal is the design of sustainable agricultural production systems suitable for the water-scarce ecosystems of the Sahel. This multidisciplinary work is carried out at a number of experimental sites and focuses on several scales — plots of a few square meters, a village land area, watershed, and region.

The network has developed a yield index linking production potential and rainfall conditions and has measured the impact of various agricultural techniques. It has also contributed to the understanding of the physiological and genetic mechanisms of drought tolerance.

The Latin American context for NRM research

In the following presentation, an Argentinean consultant and former director general of the International Center for Tropical Agriculture (CIAT), in Colombia, noted the striking heterogeneity of natural resource endowments, farming systems, and institutional arrangements across Latin America. Based on recent regional and national experiences, he concluded that building sustainability concerns into research programs is feasible. However, certain conditions must be met, among them effective priority setting to ensure that research systems do not take on more than they can handle. At the same time, NARS need to solve the problem of technology transfer to peasant farmers and contribute the best possible information to high-level assessments of alternative land use strategies and policy options. (See fourth summary in Appendix 2.)

Agriculture-related NRM problems in Indonesia

The presenter described problems resulting from overdrawing of groundwater for irrigation, from excessive application of fertilizers and other chemical inputs, and from vast clearing of coastal areas for aquaculture and of tropical forest for

agriculture. Specific problems include excessively low water tables, waterlogging of fields, soil salinization, and loss of biodiversity. Several root causes for such degradation were cited: inappropriate application of technologies by farmers, weak research and extension work, poorly formulated curriculum in the training of researchers and extension agents, and past government policies that oversubsidized agricultural inputs. On the plus side, Indonesia's Agency for Agricultural Research and Development (AARD) has contributed to some important successes, notably the achievement of self-sufficiency in rice production, the widespread use of IPM, and the introduction of integrated farming systems that incorporate indigenous knowledge. The government has also adjusted input subsidy policies. In the future, AARD's programs will devote more attention to environment-friendly agricultural technology. The decentralization of AARD's R&D gives more responsibility to the regions and provinces. It emphasizes location-specific, consultative, and participatory management of research and NRM capacity building.

NRM research in Cameroon

The final paper of the morning gave an additional country perspective on NRM, from Cameroon. NRM research in this ecologically diverse West African country is conducted within four of the 16 programs of the Institute of Agronomic Research (IRA), as well as by a livestock and fisheries research institute, the Institute of Animal and Veterinary Research (IRZV). Of special significance are efforts to reduce slash-and-burn practices through an agroforestry program based on the use of indigenous and exotic tree species. IRA is supported by the International Institute of Tropical Agriculture (IITA) and the International Centre for Research in Agroforestry (ICRAF) in this work. At the same time the government of Cameroon has paid special attention to the creation of forest reserves. The management of tropical soils is also a key focus of NRM research.

The presenter underlined the importance of the multiple uses of land, especially forests — for example, as a home for groups of hunter-gatherers, as reserves of plant and animal biodiversity, and as a major tourism resource. He stressed the need for land-use policymakers to be sensitive to these multiple uses.

Working Group Discussions

The working groups discussed the following topics on the second day of the workshop: experiences and lessons learned in carrying out NRM research; the advantages and disadvantages of the ecoregional approach from the NARS' point of view; links between biotechnology and NRM research; and the advantages and limitations of various models of regional cooperation.

Experiences and lessons for NRM research

Group members examined the positive and negative experiences of NARS, IARCs, regional organizations, and donors in the effort to integrate NRM research into agricultural research agendas. They identified five key management and institutional challenges:

- Fundamental changes are needed in institutional cultures and procedures.
- New linkages must be established with new external partners.

- Ways must be found to create a new professionalism in research, marked by new values, attitudes, and behavior.

- Agricultural research needs new concepts, methodologies, and tools.

- Support for research must be built at all levels, including the political and policy level.

Related to these challenges are a number of lessons that have emerged from rece experiences of research and research-supporting organizations:

- Do not create separate structures for NRM research; its integration into existir research systems is essential. Here, the experience of one international cente IITA in Nigeria, is particularly relevant. The existence of separate NRM ar crop divisions resulted in too much competition and conflict. The progran were eventually integrated and organized by themes such as soil manageme and land management.

- It is best to begin institutional change slowly. NRM work should not try to b too comprehensive. Begin the process of integration, but then allow time fc common platforms of understanding to emerge among research participant: An adjustment period is usually needed. In Bhutan, for example, the integratio of research on forestry, crops, and livestock posed problems of competin "scientific cultures;" time and patience were needed for the arrangements t begin running smoothly. Focus on a small, manageable number of topics an research sites.

- It is not enough to simply bring scientists from differing disciplines togethe physically under one roof. They need to be assigned joint tasks, and a se proportion of their time should be dedicated to the integrated activities. A majo integrated NRM project in China's Yellow River watershed was cited a evidence that large-scale multidisciplinary research enterprises are feasible The project involved, among others, the Chinese Academy of Agricultura Sciences (CAAS), universities, and public agencies in three provinces.

- Past disciplinary approaches carry with them significant historical baggage tha is difficult to overcome. In Brazil, for example, a big integration-relatec challenge for EMBRAPA was to divest scientists of their "monodisciplinary thinking." The group identified several ways to promote a new professiona culture: selection of suitable leadership at all research levels; adoption of new criteria (including social and environmental) for measuring impact, which may come from inside the research community or from outside, for example, from farmers or donors; building new external institutional linkages; hiring new staff or seconding staff to or from other institutes; and adoption of participatory procedures for planning, information gathering, and research. To this list can be added training, both academic and on the job. In universities and colleges, studies should be based on improved curricula. On-the-job training programs should develop new scientific and technical skills to promote systems thinking among professionals. They should also improve research administration capacity, teach participatory methods, and enhance performance evaluation. Good trainers are scarce, so training initiatives should also focus on training trainers.

- Reorganizing research is not necessarily the biggest headache encountered in integrating NRM work with other research. Explaining the rationale for organizational and operational changes to other actors, such as extension and the finance ministry, and persuading them to cooperate may be more difficult. National policies supporting the institutional changes required by integration need to be put in place.

The working group also looked at some of the potential spinoff benefits of "getting it right," that is, of successfully integrating research and getting some positive results. First, new sources of funding may become available. Second, the multidisciplinary experience, which is fertile ground for the emergence of shared values and research paradigms, may boost the motivation and satisfaction of scientists. And third, in an environment of scientific success, there is a better chance that the institutional changes that led to the success will persist.

The NARS' perspective on the ecoregional approach

As a preamble, the group drew attention to a number of features of the ecoregional approach, a concept originating in the CGIAR First, as its name implies, this approach focuses on the ecological dimension of agriculture within defined geopolitical or administrative boundaries. It also focuses attention to socioeconomic and cultural factors. It can be contrasted with the narrower, less systems-based approach adopted by most commodity research networks. However, there is still some confusion over the definition of the ecoregional approach to research — especially vis-à-vis global initiatives. (The distinction between ecoregional initiatives and system-wide programs of the CGIAR was clarified during a meeting of CGIAR center directors in Rome in December 1994, shortly after the workshop.)

Second, the concept of the ecoregional approach gives rise to other related concepts and ancillary vocabulary such as an "ecoregion," an ecoregional "initiative", and the ecoregional "mode" of conducting research. These too need to be better understood.

Third, a key issue that arises in attempting to solve agricultural problems using the ecoregional approach to research is how to classify the biological, ecological, and social diversity found within an ecoregion. The classification will depend on the purpose of the research.

Fourth, the group cited a number of examples of ecoregional initiatives. They focus on the following themes or regions: slash-and-burn practices (global), desert margins, tropical forest margins, soil-water-nutrient management, East African highlands, and Andean highlands. Both the CGIAR centers and donors have launched ecoregional initiatives. It is difficult to identify specific NARS-launched projects that could be called ecoregional initiatives. NARS do not often distinguish between traditional agricultural research and NRM research, although many research projects do have NRM components.

The group then focused its discussion on three questions: Have the ecoregional initiatives of the CGIAR been consistent so far with the NARS' agenda? What will be the main benefits and pitfalls? How can the pitfalls be avoided?

Although the concept and practice of ecoregional initiatives are still evolving, the group felt that such initiatives are consistent with NARS' agendas. Agricultural

research organizations have specific research mandates, mainly production-oriented, that are given to them by their government. Ecoregional initiatives, then, are not an alternative to ongoing research, but could complement it. However, they may require NARS to make structural changes which could be both costly and disruptive. The ecoregional approach may be a better match for the agendas of some research-conducting bodies — universities, NGOs, or individual research institutes — than others.

The working group identified the main benefits of ecoregional initiatives:

- Participating countries can share high-level expertise on natural resources.
- The managerial capacity of CGIAR centers can be tapped.
- Scientific and other responsibilities are shared among participating countries and organizations.
- Scientists from different countries share and exchange genetic and other research materials, although patenting and intellectual property rights could pose a threat.
- Consensus can be built among neighboring countries on appropriate uses of natural resources and the environment, and on what constitutes misuse.
- The scientific groundwork for common legislation is laid.
- The information base for priority setting and policy making is enhanced.
- The chances of getting the ear of policymakers improves since there is a group of national agricultural research organizations (NAROs) speaking, not just one.
- Scientists are encouraged to take a systems approach.
- Data from remote sensing can be used by several countries, possibly cutting related costs.
- Regional organizations can help countries to share data.

Potential pitfalls of the ecoregional approach were also pinpointed, such as the high transaction costs of multi-organization efforts, creation of national dependency, spread of plant diseases within a region, distortion of national research priorities and even structures, impossibility of taking into account all local variations, insufficient resources and lack of political decisions to support national participation in ecoregional initiatives, difficulty of ensuring a "win-win" result whereby sustainability goals are reconciled with driving market forces, reduction in the quality of research as a result of multiple and conflicting goals.

The following recommendations were made to overcome the pitfalls: Decentralize decision making. Strengthen national research capacity. Include biodiversity work in ecoregional programs. Put in place effective plant quarantine measures. Leave existing research structures intact and treat ecoregional initiatives as complementary to the work of those structures. Take effective policy measures and apply win-win criteria. Develop or strengthen research management capacity. Promote competition.

Biotechnology and NRM

The group began its discussion of the links between modern biotechnology and NRM research by noting a distinguishing trait of each. Biotechnology, on the one hand, is a set of tools, a means to achieve chosen ends; it is not an end in itself. NRM, on the other hand, is an area of research, usually made up of programs and projects with specific objectives.

There is clearly a consensus that the tools of biotechnology can be used to good purpose in NRM research. Biotechnology is already used in commodity improvement. To the extent that it helps enhance the productivity of resource use, it also contributes to NRM goals.

Biotechnology methods can make conventional research more cost effective. For example, they can substantially reduce the number of generation cycles required in plant breeding and the duration of each cycle. They can improve targeting for combinations of desirable characteristics — "a few well-aimed missiles replace the shotgun approach of conventional plant breeding." And methods for characterizing genetic composition shorten the time needed to improve perennial tree crops and forestry tree species (e.g., control of Bayoud disease in date palms in Morocco).

The group cited several current biotechnology applications in NRM:

- germ plasm conservation and utilization — characterizing genetic resources and identifying sources of variation;
- research on nutrient cycling, soils, and nutrient availability — advances in soil microbiology and biological nitrogen fixation;
- forestry research — acceleration of research by characterizing genetic materials and diversity;
- organic farming — reducing dependence on inorganic fertilizers;
- livestock research — advances in animal production systems and development of diagnostic tools and vaccines for animal health;
- development of IPM systems;
- development of waste management systems.

The group identified some of the features of NRM research that could promote the institutionalization of biotechnology applications. First, NRM research must often cope with biological and other kinds of diversity, which are typical of difficult or marginal environments. It needs to be able to incorporate specific features of adaptation into plants and animals so that they survive and thrive under these conditions. This is an aim that can be more readily achieved with the help of biotechnology.

A second feature of NRM research germane to the institutionalization of biotechnology is its multidisciplinary, systems orientation. NRM research focuses on various links and interactions between components of systems. In the process, there will likely be new opportunities for biotechnology to assist. In the past,

discipline-oriented research institutions have had difficulty incorporating systems-oriented programs into their agendas. NRM research poses a similar challenge. The institutional changes that will undoubtedly be needed to cope with multidisciplinarity will also serve to make biotechnology part of the required new mix of disciplines. And as biotechnology applications become a permanent feature of NRM research, serving an increasing variety of research tasks, the overhead costs of establishing and maintaining biotechnology capability can be shared among various programs. The working group felt there is a need to explore further possible applications of biotechnology in NRM work.

Biotechnology's capacity to make conventional research more cost-effective too will be an increasingly important criterion in research priority setting and resource allocation.

Regional cooperation

What are the advantages and limitations of different models of intraregional cooperation — from the perspective of regional organizations and from that of the NARS? This group's discussion overlapped somewhat with that of the group that examined a specific form of regional cooperation, namely ecoregional initiatives.

This group first set out a taxonomy of regional cooperation models, giving examples of each. It identified six principal models:

- networks, such as the Semi-Arid Food Grain Research and Development (SAFGRAD) network in Africa and the Asian Soil Conservation Network (ASOCON);
- associations of directors, such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA);
- regional programs, such as PROCIANDINO (Programa Cooperativo de Investigación y Transferencia de Tecnología Agropecuaria para la Subregíon Andina) and PROCISUR (Programa Cooperativo de Investigación Agrícola del Cono Sur) in Latin America and CORAF in Africa;
- formal regional organizations, such as the Southern African Centre for Cooperation in Agricultural Research (SACCAR) and INSAH in Africa, the Inter-American Institute for Cooperation on Agriculture (IICA) in Latin America, and the South Pacific Commission;
- regional research institutes, such as the Caribbean Agriculture Research and Development Institute (CARDI), the Tropical Agricultural Research and Education Center (CATIE) in Latin America, and the Institute for Research, Extension and Training in Agriculture (IRETA) in Asia.
- international centers, such as CIP, the International Center for Agricultural Research in the Dry Areas (ICARDA), IITA, and the International Rice Research Institute (IRRI).

The group identified a number of advantages and limitations common to all models. Advantages include the avoidance of duplication in research; improved communication among participating organizations; consensus building; exchange of methodologies, data, ideas, and materials; attaining a critical mass of expertise

on specific subjects; internalizing spillover effects of biophysical research; provision of assistance from large organizations to smaller ones that lack key resources.

Some of the possible limitations or disadvantages include domination of activities by large organizations or countries; high transaction costs (time and money); dispersion of NARS managers' and researchers' efforts on subjects that may be of low national priority; financial instability due to dependence on external funding; duplication of effort because of the presence of parallel coordinating bodies; linguistic barriers.

The group then considered the advantages and limitations specific to each model of regional cooperation. The presence or absence of these varies from entity to entity within a group.

Networks. Advantages: bottom-up approach, clear focus on specific research subjects, and the ability to promote consensus. Limitations: lack of systems perspective (e.g., commodity networks); lack of sustainability when they depend on short-term, external funding.

Associations of directors. Advantages: good representation of NARS in their governance; evolution in many instances into more formal modes of collaboration. Limitations: lack of legal status and therefore of legitimacy in the eyes of politicians; high turnover of individual membership; narrow representation as membership generally consists of directors of traditional commodity research institutes.

Regional programs. Advantages: ease of operation in neighboring countries and ability to facilitate sharing of research tasks. Limitations: dependency on external funding; high management costs compared with those of networks; narrow membership, usually limited to public-sector research institutes and often omitting other important actors such as private companies, NGOs, and nonagricultural public authorities. The disadvantage of high management costs could be mitigated by assigning management to one institute.

Formal regional organizations. Advantages: formal political legitimacy; financial stability due to comparative advantage in obtaining government funds; equal representation of the interests of country members, large and small, in planning and priority setting (e.g., SACCAR). Limitations: tendency to expand their research mandates (termed "mission creep"), thus leading to a dispersion of effort, resources, and competition; limited coordination capacity.

Regional research institutes. Advantages: research conducted on behalf of small NARS or small countries that may lack the necessary scientific capacity; coordination of research tasks that are divided among participating countries; strong representation of national research institutes in decision making and governance in some cases; strong sense of ownership by the participating countries; good source of training for researchers and technicians. Limitations: limited scope for extrapolating research results to other regions with similar geophysical characteristics due to narrow geographical coverage; lack of critical mass of research effort and expertise in certain subject areas; incomplete representation of national stakeholder bodies in governance in some cases (e.g., one key ministry represented, but another not).

IARCs. Advantages: good equipment and information technology, allowing scientists to use the most advanced research methods and keep abreast of the scientific literature; a farming systems perspective, which is useful in NRM research; capacity to develop new methodologies especially for basic and strategic research; good links with donors; lead role in exploring new funding sources; short-term training programs for NARS. Limitations: competition with NARS for funds; commodity focus of some IARCs. The working group recommended that IARCs move quickly to review their mandates so as to ensure a more comprehensive systems perspective in their work.

Finally, the group considered whether there was an "ideal" model of regional cooperation. It concluded there was not, but that each model had its own merits. It noted a tendency for informal cooperation to evolve into more formal mechanisms. Some of the Latin American regional research programs, for example, began as loose networks of individual scientists.

The institutional evolution of regional cooperation follows, more or less, a progression from network to association, to regional program, to formal regional organization, to regional research institute, to IARC. No single model of cooperation should be discouraged, said the working group. Rather, the efforts of the various entities should be harmonized. Increased attention to NRM will likely see the birth of new organizations and death of others; this is a natural process.

Day Three, Morning: Institutional and Management Issues

Papers

The morning of the third day featured five presentations on the practical institutional and management implications of giving more emphasis to NRM topics. These covered five critical factors in research management: priority setting, human resources development, monitoring and evaluation, scientific information systems, and research funding. All presentations except the one on scientific information were by ISNAR staff. The papers and the names of the presenters can be found in Appendix I.

Setting NRM research priorities

The first presentation of the morning examined the special requirements for setting NRM research priorities at the national level. It was based largely on the experience of the Kenya Agricultural Research Institute (KARI) with research on soil and water management.

Standard priority-setting methods used in commodity programs are of limited use in NRM programs. In particular, they need to be supplemented with improved understanding of farmer perceptions, partly because the rates of adoption of improved methods of soil and water management have been low to date, not just in Kenya but in many countries.

The presenter noted three factors that complicate priority setting in NRM research: the spatial diversity of the natural resource base, the complexity of interactions between system components and levels, and the long time frame associated with the sustainability of agricultural production components.

Effective priority setting for NRM research calls for greater emphasis on the collection and analysis of site-specific information, both physical and socioeconomic, on the potential impact of new technologies. This is a major challenge. The likely effects of an NRM technology or practice at different system levels (e.g., soil, crop, farming system) and on different components of the farming system must be taken into account. The data must then be extrapolated to a variety of other locations to assess potential national impact.

Physical impact models, household models, and resource valuation models can be useful tools in this work. The presenter emphasized, however, that using models can be costly and sometimes they obscure rather than assist the decision-making process. Further, models should not be seen as a replacement for expert opinion, the traditional basis for priority setting.

New skills to do NRM research

The second paper looked at how NARS might respond to the need for new skills to do NRM research. Geography, meteorology, ecology, soil science, hydrology, sociology, and civil engineering are some of the disciplines in which added expertise will likely be needed. NARS can increase the pool of skills available by recruitment or training.

Recruitment may involve creating new staff positions. However, with funding for agricultural research as tight as it is in many NARS, the options available may be limited to replacing staff who resign or retire, seconding staff from other government agencies (for example, to work on an interdisciplinary team project), and increasing the number of contract-paid staff.

The pool of skills available can be improved by training, mostly nondegree training, of existing staff in the new disciplines and skills needed for NRM work. This should cover not only the NRM-related sciences mentioned above, but also research management and interpersonal skills for scientific teamwork. An assessment of training needs and planning can help NARS make optimal use of the resources available for staff development, including donor funds.

ISNAR investigations indicate that national research institutes have a long way to go in institutionalizing multidisciplinary research. The presenter noted that the challenge for NARS is to "increase the number of multiple-scientist experiments without increasing the number of public-service jobs." However, it should be noted that the shift from disciplinary to more interdisciplinary research requires more than just this. The experience of the IARCs has shown that the capacity to implement interdisciplinary research and deal with more complex research issues depends on there being a problem-oriented, systems approach to the planning, conduct and interpretation of research. An interdisciplinary organization will develop naturally provided there is a problem oriented character to the research. A key theme of the paper was that no matter how managers decide to enhance their mix of expertise, human resources development decisions should be aligned with stated research priorities and program plans.

Monitoring and evaluation

The third presentation provided an overview of monitoring and evaluation (M&E) of research, with emphasis on NRM. M&E is essentially part of a management cycle — a kind of "reality check" to help managers improve research performance and satisfy accountability requirements. M&E means scrutinizing activities, processes, inputs, outputs, or impact against known standards or criteria.

In the case of NRM research, there are special requirements. In designing an evaluation, it is crucial to identify the system level at which the impact of a research project or product is being evaluated: plot, farm, community, watershed, country, or ecoregion. The large number of physical sites (or the wide geographical area) associated with certain NRM factors or technologies means that data collection for M&E can be very expensive. Furthermore, the effects of NRM interventions may be felt only many years later when it may be too late to correct the damage. Modeling or simulation techniques can help evaluate the likely impact at an earlier stage.

Two further issues arise in evaluating NRM activities. First, with the long time horizons in NRM, the enormous spatial diversity, and complex interactions between system components, it becomes difficult to attribute changes to specific causes (e.g., either good or bad NRM practices or technologies). Second, evaluation will normally require that improvement, protection, or deterioration of natural resources be valued in some way. This is difficult because the costs and benefits to the natural environment are generally not priced in the market. Impact

on the resource base may mean different things to different stakeholders, and even to different generations of stakeholders.

Scientific information needs

The fourth presentation was on the scientific information needs of NRM research. Several desirable traits were cited for any NRM data base. The data should cover long time periods, reflect the spatial heterogeneity of natural resources, be available at the scale and level of accuracy demanded by the research, be complete, and be easily accessible by those who need them. NRM data bases are dominated by physical information such as on soil, geology, climate, and topography. Biological data bases are less complete.

Much better information is needed on interactions between human beings and the environment. This is crucial to the development of models that can predict the likely response of people to potential solutions (e.g., new policies) to NRM problems and the environmental impact of their response. (See fifth summary in Appendix 2.)

Strategies for funding research

The last presenter of the workshop discussed various strategies for funding research. The speaker looked at better ways to attract donor funding — for example, by emphasizing both the production-enhancement functions and the anticipated NRM impact of research. It also explored the pros and cons of four different approaches to funding interinstitutional collaboration on research (a "lead-agency" approach; creation of special project units; parallel financing; joint financing arrangements). More interinstitutional collaboration will be required for NRM research which is systems based and interdisciplinary, involving multiple stakeholders. NRM research also tends to have long time horizons. Several options for securing long-term funding were suggested. Last, the question of accountability was considered. Among other problems, the nature of NRM research makes it hard to demonstrate or quantify the likely impact. Special economics techniques for valuing environmental improvements may be needed to justify research proposals ex ante. (See summary of paper in Appendix 2.)

Day Three, Afternoon: Workshop Recommendations and Conclusions

The four working groups met on the final day of the workshop to summarize key issues arising from the first two and a half days and to make recommendations. One group was to advise ISNAR on its role in supporting NARS in the area of NRM research. Each of the three other working groups were to list desirable actions to be taken by one specific set of stakeholders — namely NARS, donors, or regional organizations. They also were invited to make recommendations to ISNAR. An effort was made to ensure that the various stakeholder groups were represented in the makeup of the working groups.

The following four sections present recommendations and, in some instances, specific follow-up actions that could be taken. Recommendations viewed as high priority by the working group that made them are so noted in parentheses. In addition, each set of recommendations is arranged in order of the resources required; those that are done easily are listed first; those that require more time and money are lower on the list.

Recommendations to NARS

1. Identify the most important natural resource management issues in a national context (high priority). This should be done in national workshops in which all stakeholders take part. The decision to hold such an event should come from a policy level. Agencies that play an important part in natural resources management should be consulted. The NARS could take responsibility for organizing the event, with the assistance of a national task force. Outside expertise and donor support might also be needed. Environmental agencies, grass-roots NGOs, and CGIAR centers could provide support for such national efforts to define NRM issues. It is possible that some commodity-based agro-industries might be opposed to such a move.

2. Create awareness of NRM issues among all agricultural research staff and other stakeholders (high priority).

3. Reassure research leaders that incorporating NRM work into the research agenda is not a threat to them.

4. Using a participatory approach where appropriate, reexamine whether institutional mandates reflect the importance of natural resource management (high priority).

5. Identify new research methods and collaborators in NRM research.

6. Redefine evaluation criteria for research to take natural resource management work into account, thereby expanding beyond the traditional productivity criteria used in commodity research.

7. Identify new sources of funding.

8. Develop human resources within NARS through training in order to secure the necessary special skills that currently may be lacking.

9. Review the adequacy of current natural resources inventories and, where necessary, plan to correct deficiencies.

Recommendations to Donors

1. Assure that support for NRM-related work is compatible with NARS priorities and complements other initiatives, including those on a regional and international scale (high priority). This type of cross-checking should be done at the national policy level, in consultation with the NARS.

2. Consult with relevant national ministries involved in NRM issues and analyze the existing institutional framework to ensure that projects are placed in the most appropriate research institute or program.

3. Help NARS managers to develop accountability mechanisms that are acceptable to several donors. Accountability requirements differ from donor to donor and this often puts a large burden on NARS.

4. Increase funding for training, ensuring that support is consistent with NARS' training needs at all levels, both in management and in the scientific disciplines (high priority). Training is crucial to the sustainability of NRM research.

Recommendations to Regional Organizations

1. Do not set up separate units responsible for conducting NRM research. Integration of NRM research within existing structures and activities is key.

2. While recognizing the national focus of responsibility for NRM, regional organizations should play a key role in training, building consensus, and facilitating supranational research activities by doing the following:

   - **Policy environment.** Promote concern for, and consensus on, NRM research initiatives; identify and work on environmental issues shared by countries of the region; and promote integrated approaches to NRM. More specifically, undertake policy analyses and promote dialogue, working together with policy analysts in the countries concerned.

   - **Priority setting.** Help set research priorities with the participation of national programs; identify comparative advantages and maximize the spillover of research results and technology between countries; serve as a forum in which the diverse actors involved in NRM research can reach consensus on priorities.

   - **Funding.** Help develop the support base for NRM research by mobilizing funds for national projects and programs, for efforts that complement national initiatives, and for multicountry projects (for example, research on watersheds that cross international boundaries). Steering committees with strong national participation should play an active role in supervising funding-related activities.

- **Human resources.** Strengthen national capacity in NRM by training and recycling scientists and by training trainers; help build links with other organizations and encourage new forms of collaboration that enhance expertise; encourage and support change in universities, especially for the incorporation of NRM and sustainability concerns into university activities.

The working group noted that the recommendations to regional organizations also apply to international agricultural research centers when they are operating in a regional mode.

Recommendations to ISNAR

1. Develop models and procedures for planning, monitoring, and evaluating NRM research at both the national and regional levels. More generally, help to strengthen the capacity of NARS in these management functions.

2. In collaboration with NARS, formulate guidelines for managing the institutional changes needed to incorporate NRM issues into national research agendas, and for assessing the costs and benefits of such changes (high priority).

3. Support NARS in the development of information management systems, including giving advice on hardware and software requirements (high priority).

4. Help NARS to increase awareness of NRM research among policymakers.

5. Identify opportunities and mechanisms for allowing NARS to collaborate with each other on NRM issues and problems. This includes supporting intra- and interregional initiatives and modes of collaboration. Help NARS to become "multipliers" of NRM research expertise.

6. Help to identify the complementary roles of NGOs and NARS in NRM research.

7. Develop methods for including the clients and beneficiaries of research in decision making.

8. Help to portray to donor organizations and international agricultural research centers the NARS' vision of the emerging NRM-sustainability paradigm.

9. Assist with techniques for including socioeconomic parameters in the classification of agricultural production systems.

10. Identify human resource requirements (e.g., specialized scientific skills) for conducting NRM research; help NARS to produce comprehensive human resource development plans; assist with management training and promote good leadership; promote training in the area of NRM research policy using a train-the-trainer approach (high priority).

11. Create an NRM information base and disseminate selected information to NARS; provide information on possible mechanisms and sources of funding for NRM research, including CGIAR assistance.

Panel Discussion

Following the presentation of the recommendations in plenary, Hélio Tollini of EMBRAPA (Brazil) chaired a concluding panel discussion. Members of the panel were M. Akhtar Ali, Ministry of Agriculture, Bangladesh; J. Ayuk-Takem, IRA, Cameroon; M. Kalunda, NARO, Uganda; H. Mutsaers, The Netherlands; C. Ndiritu, KARI, Kenya; G. Nores, Grupo CEO, Argentina; and E. Sitapai, Department of Agriculture and Livestock, Papua New Guinea.

Dr Tollini noted that the 17 papers presented in plenary and discussed in the working groups covered a wide variety of topics related to NRM research. The aim of the concluding panel discussion, he said, was to bring into clearer focus some of the key issues raised. The following is a summary of some of the views expressed by the panel members

Raising awareness

Dr Ndiritu of Kenya began the discussion by noting that the workshop's main achievement had been to raise awareness of the importance of natural resource management. While participants had been reminded that NRM is not really a new concept, the workshop also served to underline the value of taking an integrated approach to research when dealing with NRM issues.

The national programs, he said, sometimes devote large amounts of expertise, planning, and energy to commodity programs. This has perhaps been done at the expense of NRM research. The workshop helped to make participants aware of this gap. The NARS, said Ndiritu, may have to rely a little more on the international centers to give NRM the attention it deserves. This means not only sharing expertise but also stepping up joint planning efforts and working together to secure funding. Ndiritu ended his remarks on a personal note of caution. He said he had observed a split in opinion over the three days, with some participants viewing NRM research almost as a separate discipline, and others not. He observed that at one point, worries were raised over the status of farming systems research (FSR) as a scientific discipline. Ndiritu said he would not want to see NRM research equated to FSR as a discipline. Treating FSR as a separate discipline, he said, is one of the reasons why NARS have had trouble incorporating FSR into commodity research.

Clear problem definition

Mutsaers of the Netherlands summed up what he felt were the critical issues raised in discussion. He noted that though it is difficult, it is necessary to define the content of NRM research. On the one hand, there is research specifically dedicated to protecting the environment; on the other hand, there is agricultural research which aims both to ensure sustainable production and to maintain the integrity of the environment. The concept of NRM research, he said, needs to be formulated not only from such different perspectives, but also at different levels, such as ecoregion, watershed, or farm.

Lessons from farming systems research

The need to avoid the creation of separate NRM research units was raised in the discussions, Mutsaers noted. This is also one of the lessons learned from experiences with FSR.

Another danger is excessive data collection. Again, there is a lesson to be drawn from farming systems research.

A third lesson from FSR, relevant to NRM research, according to Mutsaers, is the need to focus on technological content and not to get too absorbed in peripheral issues. In FSR, there was much discussion of concepts, processes, and training. In NRM research there should be a strong focus on technological options.

Finally, Mutsaers noted the need for better awareness about current levels of knowledge. It is important for researchers working in the NARS to have easy access to past research results.

Mutual support among NARS

Sitapai of Papua New Guinea made a plea for researchers as a group - whether they come from small or large NARS, or from countries with large or small economies — to give their mutual support to efforts to incorporate NRM research into national agendas. In particular, ISNAR should be ready to represent NARS views. Following the workshop, there will be a need to maintain the momentum, he said, particularly to look at policy issues and land use within the national context. Within a country, different ministries and agencies will have their own agendas and their own ideas about what NRM should and should not be. NARS need to be able to translate their vision of the new NRM paradigm into concrete ideas and programs on the home front. For this they will need further support and backing. Ayuk Takem of Cameroon told the meeting that the importance of NRM research was well understood by NARS. He said he hoped the workshop participants understood that the scope of NRM includes not only crops, livestock and forestry in the agricultural sectors, but that it extends the use of water resources, and to the wider issues of land use planning. He made a call for more forestry research, and drew attention to the importance of forestry resources in some of the countries represented at the workshop, namely in Brazil, Zaire, Cameroon and Indonesia. His vivid account of the diversity of environments and natural resources in Cameroon demonstrated the depth of his own knowledge about them. What is needed, he said, is to sustain the awareness of the importance of NRM research, which in turn will require resources. ISNAR can assist NARS by making donors aware that NRM is regarded as a crucial issue by developing countries.

He gave a strong endorsement of regional cooperation, saying that NARS should work together in a region on issues and problems of common interest. He maintained that if they do so, they will be able to move forward much faster.

Growing demands on natural resources

Bangladesh's permanent secretary for agriculture, Akhtar Ali, complimented the workshop participants on having done, on the whole, a "splendid job." He noted that they had come up with specific and important recommendations mirroring both the workshop's title and the content of the three days of discussions.

He reminded participants that Bangladesh is among the most densely populated countries on Earth. Agricultural production and growth are of great importance there. Thirty years ago self-sufficiency in cereal production was thought to be "an impossibility" for the nation. "Today it is a reality," Akhtar Ali observed. "This reality has come out of the excellent research work done by our scientists," together with extension and the "hard work of the farmers."

At the same time, NRM is a priority for Bangladesh "because earth, air, and water are the basic elements for production and survival." The permanent secretary highlighted the special importance for Bangladesh of one natural resource in particular: water, especially water that crosses international boundaries. At the moment, Bangladesh faces the dire consequences of the withdrawal of water from the upper reaches of the Ganges River.

In Bangladesh, research that led to the country's significant achievements in agricultural production was strongly supported not only by the national government and agricultural scientists, but also by donors. Now, the second generation of scientists, according to Akhtar Ali, must get beyond what has been achieved, to identify and work on new research problems in the management of natural resources. Here the development of human resources is critical, especially training in research management.

In closing, Akhtar Ali drew attention to an earlier speaker's plea that technology generation should not be forgotten as NRM research takes on new importance. He advanced the idea that once appropriate policies are put in place "technology will automatically come."

Partnership between NARS and IARCS

The first point raised by Kalunda of Uganda was the issue of cooperation between NARS and IARCs. He said the two groups need to get together to define NRM and to clarify its overall importance since their views on the subject may differ. Such cooperation would allow the NARS and IARCs to identify activities that aim at sustained productivity and a better quality of life in the future.

Second, he emphasized ISNAR's role in assisting NARS with the incorporation of NRM concerns into their research agendas. ISNAR may not have a large enough staff to work in all countries, he said, "but at least it can prepare some of the selected documents which could be used in the regions."

Third, Kalunda underlined an important human factor noted in the working groups' discussions, namely that the growing emphasis on NRM and NRM research will have both allies and opponents. Environmentalists and some other groups will be happy to see some of the workshop's recommendations carried out. But there will also be opponents, he said, not only among industrialists, but also among commodity-oriented scientists. Some may view NRM as a threat to funding for traditional agricultural research.

Development occurs at the national level

Nores of Argentina acknowledged he had learned a great deal at the workshop — something hard for a consultant such as himself to admit, he added. He highlighted several lessons.

First, the country level, as reflected in the recommendation to hold national workshops, is the correct setting in which to define NRM in relation to sustaining increases in the productivity of resources used in a nation's agriculture. "I think that's the right context for any interpretation."

Second, integration of various perspectives and interests is key to NRM. This demands the use of participatory approaches — in assessing land use strategies

and policies, in setting priorities, and in conducting research. There is great diversity in farming systems within and among countries. Participatory approaches are needed to identify the right blend of technologies appropriate to each system.

Third, researchers should be careful not to "overdo it" when becoming involved in certain NRM activities. For example, tools for problem diagnosis and data gathering, such as geographical information systems, should be used sparingly and on a practical scale. Otherwise, they can quickly sap an institute's scarce resources, said Nores. The same goes for expert assessment. "You have experts in your own countries. Tap them, wherever they are." Scientists should also choose just a few representative sites or watersheds for integrated NRM research projects.

With this approach, research focuses from the outset on a feasible, manageable work agenda. If NRM research attempts to be extremely holistic and overly comprehensive, Nores warned, it may fall into the same trap as some other approaches to research that have been tried in the past.

Additional points from the plenary discussion

At the next workshop of this series there should be more discussion of issues of technology generation, funding sources, and human resources. Technologies are the core of natural resource management, and there are special difficulties in securing funding and developing human resources for NRM research, including training (W.S. Alhassan of Ghana).

NRM involves a wider set of issues than those involved in agricultural research. Those working in agriculture must therefore broaden their outlook. The commodity approach to research has its place, but scientists need to consider their work in the context of a wider system of resource use (Carlos Rivas of CATIE, based in Costa Rica).

Better NRM is in the interest of all countries, including those where the demand for food is increasing most rapidly. National governments can be expected to give more emphasis to NRM and environmental issues. As they do so the national research systems will need assistance from the IARCs if they are to deal effectively with the broader research agenda (J. Kumar of Fiji).

Concluding Remarks

Christian Bonte-Friedheim, the director general of ISNAR, made the concluding remarks. Bonte-Friedheim said that for him the workshop had shown that natural resources must be viewed from three different perspectives. First, as a public good, to be managed and maintained. Second, as resources which directly or indirectly serve agriculture. Third, as resources, such as land and water, which are part of the actual production process. Research has to take account of all three perspectives.

The director general referred to suggestions made during the workshop that the IARCs should use their advantage in NRM research to assist the national research systems. He observed that "If they have an advantage, then it is a relative advantage.... I think we ourselves (the IARCs) have to concede that we still know very, very little about NRM research." However, he felt that the request for ISNAR

to help the national systems tap whatever experience there is in the CGIAR centers was a good one. "That is a message I will certainly take with me to the other international centers," he said.

Bonte-Friedheim noted that many countries feel excluded from the benefits of CGIAR. There are various reasons for this. Perhaps they do not grow the principal crops on which the CGIAR concentrates, such as maize or wheat. Or they do not have any of the kinds of genetic material collected by the CGIAR. Or they are not located in Africa and do not raise African livestock. The feeling of being left out is particularly strong among small countries, many of them island nations.

He saw the growing emphasis on natural resource management as a new opportunity. It is a common theme, an issue affecting all countries, whether large or small, with large or small research systems, and whether they have strong or weak economies. Not only can the CGIAR system do something for the developing world on this issue, it should also have something to offer the industrialized nations.

To the recommendation that ISNAR should continue to represent the interests of NARS among donors and other CGIAR centers, Bonte-Friedheim responded by saying that ISNAR will continue to do so. That has long been part of its mandate. But he asked that NARS give their support to ISNAR by speaking up on the value to them of ISNAR's services. Bonte-Friedheim also expressed ISNAR's readiness to follow up on the recommendation that countries stage workshops to examine NRM issues in a national context. He said that ISNAR would support and help organize one or two such events and that he had already broached the subject with one donor. Each workshop would bring together the various research institutes and other actors involved in or concerned with natural resource management in the selected country. Given ISNAR's lack of experience in this area at the national level, there should also be some kind of follow-up a year later, he suggested, to see what has come out of the event. One condition for ISNAR involvement would be that representatives of a few other countries be invited to the workshops so that they can learn from the experience and organize something similar in their own countries. "So here I would think that you will find us very open to suggestions."

The director general observed that everyone at the workshop seemed to agree that the research agenda is now being enlarged. A new mix of skills will therefore be needed. But the available pool of resources, both human and financial, remains essentially the same. He said that if NARS can't afford to achieve the right mix by hiring new people they will have to retrain current research staff. Bonte-Friedheim said that this was one of the best workshops he had ever attended. He particularly appreciated the group's high level of participation, as well as the openness and frankness that was evident as the workshop tried to come to grips with a complicated question to which no one, including the organizers, has the answer. It is a set of problems that will persist for quite some time to come.

The director general thanked all the participants, wishing them a safe journey home. He said he hoped the discussions of the past few days would help them in their work in 1995. He also expressed his appreciation for the work of the ISNAR team that helped organize the workshop and contributed written materials. Finally, he expressed his thanks to the German Foundation for International Development for its financial support and collaboration. He said he hoped DSE would continue

to work with ISNAR on the urgent task of helping developing countries deal with problems of natural resource management.

Appendix 1: List of Papers Presented

Day 1

Future Challenges for National Agricultural Research: An ISNAR Outlook. Howard Elliott, ISNAR.

Priorities and Mechanisms to Support NARS in the Developing Countries. Michel Petit, World Bank. Presented in absentia by H. Rouille d'Orfeuil, World Bank.

The Experience of an Implementing Agency with Natural Resource Management Research. G. Steinacker, GTZ, Germany.

Policies and Management for Research with a Sustainability Perspective: A Country's View from a Policymaker. H. Tollini, EMBRAPA, Brazil.

Institutional Partnerships and a New Professionalism: Some Essential Conditions for Sustainable Agriculture. Jules N. Pretty, IIED, U.K.

Day 2

Characteristics of NRM Research: Institutional and Management Implications. Willem G. Janssen, ISNAR.

Planning for Innovation: A NARO Approach to Biotechnology and Natural Resource Management. Joel I. Cohen, ISNAR.

The CGIAR's Response to New Challenges in Agro-Environmental Research in Developing Countries. Hubert G. Zandstra, CIP.

Experience at a Regional Level of Implementation: NRM Research. M.S. Sompo-Ceesay, INSAH.

Integration of Natural Resource Management in the Agricultural Research Agendas of Latin America. Gustavo A. Nores, Grupo CEO, Argentina.

Experience at a National Level in Implementing Natural Resources Management Research. F. Kasryno, AARD, Indonesia. Presented in absentia by Soetjipto Partohardjono, AARD.

Experience at a National Level of Implementing Natural Resources Management Research in Cameroon. J.A. Ayuk-Takem, IRA, Cameroon.

Day 3

Institutional Structures and Methods for Setting Natural Resource Management Research Program Priorities. B. Mills, ISNAR; R. Kiome, KARI, Kenya; and J. Lynam, Rockefeller Foundation, Kenya. Presented by B. Mills.

Human Resources for Research in Natural Resource Management in NARS. Edwin Brush, ISNAR.

Monitoring and Evaluation for NRM Research. Doug Horton, ISNAR.

Information Needs for Natural Resource Management Research. G. Edwards-Jones, Scottish Agricultural College, U.K., and B. Dent, University of Edinburgh, U.K. Presented by G. Edwards-Jones.

Financing Environmental Research: Policy Options for NARS. S.R. Tabor and B. Mills, ISNAR. Presented by S.R. Tabor.

Appendix 2: Summaries of Selected Papers

Future Challenges for National Agricultural Research at the National and International Levels

By Howard Elliott, Deputy Director General, ISNAR

Elliott gave an overview of recent global trends and emerging policy issues relevant to national agricultural research. These were key topics of discussion at two previous DSE-ISNAR meetings, in September 1988 in Feldafing, Germany, and in January 1992 in Berlin. These events brought together research leaders, policymakers, and international resource persons. He discussed how these dialogues have helped shape ISNAR's services to NARS.

The 1988 meeting examined four issues affecting agriculture and agricultural research: food surpluses, national economic growth, sustainability of production environments, and support to research. The meeting foresaw the trend toward reduced protectionism in the industrial countries, making global food surpluses temporary. It also noted the problem of increasing food deficits and insecurity in developing nations, linked to increases in population, incomes, and food demand, as well as to technical and financial difficulties in achieving higher agricultural growth.

Also challenging national research systems, in the view of the workshop participants, was the increased concern about sustainability of production environments. Key problems of environmental degradation and their causes (such as poverty, land tenure systems, and population growth) were reviewed.

The 1988 workshop identified policy action to combat some of these problems. It also recognized the need for research, particularly to understand better the reasons and incentives underlying human behavior that degrades the environment. Of direct relevance to ISNAR's work was the recognition that new production practices will demand changes in services to agriculture, including research. New policies and organizational methods would be needed to support such changes.

The workshop also examined several other policy issues:

- Human and financial resource allocations to NARS. New ISNAR information and preliminary analyses of historical trends were presented. The growing importance of developing countries in the global research effort was noted, as well as trends in support per scientist.
- **Sustainability of African research institutions.** Topics included over dependence on donors, rescaling research systems to a sustainable size, the importance of re-establishing subregional cooperation on research, and the need to set out clear national research plans.
- **Private-sector research.** The growing role of the private sector in agricultural research, particularly in Latin America, was discussed, along with its links to public research.

Dr Elliott noted that ISNAR had committed itself to continued generation and analysis of information on the state of NARS. This had resulted in the publication of a major book on agricultural research policy. ISNAR also stepped up its research into interactions between public- and private-sector research and was involved in major national research planning exercises.

The 1992 Berlin policy dialogue was an occasion to review ISNAR R&D work since the 1988 workshop and to refine understanding of the emerging needs of agricultural research. The workshop noted changes in the policy and scientific environment and new institutional adjustments that would be required. It stressed the need for agriculture and agricultural research to be involved in the ongoing policy dialogue and to influence decision making.

A number of negative trends, both emerging and likely to emerge, were identified:

- the possibility of another food crisis
- growing competition for scarce water resources
- lack of support for agricultural research in industrial countries and its negative impact on developing countries
- the crisis of publicly funded research due to dependency on external funding and dwindling resources per scientist
- NARS' credibility problem with their policymakers.

On the positive side, recent studies demonstrated the productivity of research in developing countries and some donors were becoming more flexible in their support for research.

Structural adjustment was noted as an important trend affecting agricultural research. ISNAR was charged with looking into the effects of adjustment programs and with helping NARS to deal with them. Its research, including a series of country case studies, led to a major publication on the subject.

Continuing ISNAR work on the state of the NARS was presented at the workshop. The statistics showed continued growth in the numbers of public-sector scientists in developing countries, with some NARS perhaps reaching a "critical mass" sufficient to produce relevant technologies. Since the Berlin meeting, ISNAR has extended this "indicator series" work, focusing on sub-Saharan Africa. NARS are continuing to grow, but there appear to be imbalances between numbers of scientists and resources per scientist in the public sector.

The workshop also examined the implications for research of paying more attention to natural resource management. It noted a number of difficulties this will raise for NARS, including the problem of demonstrating impact. The plenary concluded that agricultural and environmental research should not be set in opposition but integrated.

Another trend discussed was the growth of regional collaboration, particularly in Latin America, but also in Africa. The workshop asked ISNAR to look into suitable approaches to priority setting in a regional framework. It is currently working on this question. Issues surrounding regional collaboration include the need for

regional bodies to become more financially autonomous, to broaden membership beyond traditional public-sector research bodies, and to deal with the institutional complexities imposed by NRM research (such as ensuring representation of multiple stakeholders).

The Berlin workshop also looked at the implications of scientific advances — in biotechnology, IPM, and information technology. Lessons learned were that the difficulties and risks associated with new technology should not be underestimated; that there are economies to be gained in research sharing; and, with any new technology, there are important distributional effects to consider. ISNAR subsequently became the host of the Intermediary Biotechnology Service which provides advice and information on biotechnology management and related issues.

Dr Elliott concluded his paper by drawing attention to major changes in the CGIAR which will affect the ways in which scientific support to NARS is given. He noted the recent erosion of support for international agricultural research, subsequent recovery, and the current restructuring plan being undertaken by the CGIAR. There will be special emphasis on "system-wide" and "ecoregional" activities in which partnerships with NARS will be strongly encouraged. Environmental protection, poverty alleviation, and agricultural production will constitute the primary nexus of concern for international research.

Characteristics of NRM Research: Institutional and Management Implications

By Willem G. Janssen, ISNAR

Incorporating sustainability and NRM perspectives into agricultural research has numerous consequences for the way research is planned, organized, monitored, evaluated, and resourced with people, funds, and information — in short, in the way it is managed. It also has implications for research's governance and for its links with its policymakers, farmers, and other stakeholders and sectors of the economy. In his paper, Janssen undertook a wide-ranging comparison of NRM and conventional agricultural research.

The 1980s saw growing international awareness of the urgent need to halt natural resource degradation such as soil erosion, deforestation, salinization, and loss of biodiversity — much of it associated with agriculture. Recognition of three key factors suggested the need for changes in the conventional production-oriented approach to agriculture and agricultural research.

The first factor was temporal. All agricultural technologies affect the resource base over time and, to account for this, the emphasis needed to shift from short-term to long-term productivity. The second was spatial. The effects of technology are often felt off-farm (e.g., pollution of ground water by pesticides), sometimes far from the point of application. This called for spatially integrated analysis in the attempt to understand resource dynamics in their wider context. The third factor was the multisectoral nature of resource use — that is, use for agricultural and nonagricultural ends by both farmers and nonfarmers. Water, for example, is used not only in irrigation but also for drinking, transport, recreation, and power generation. Thus, there was recognition of the need to approach NRM in an integrated way, taking into account the needs of sectors other than agriculture.

The evolving environment for agricultural science can be illustrated by contrasting conventional agricultural research with NRM research. This may exaggerate the actual characteristics and their differences somewhat, according to Janssen, but it helps bring into sharp relief the direction and difficulty of change.

The motives for funding conventional agricultural research differ from those for NRM work. Concerns with food shortages and economic growth are the driving forces behind conventional research. The push to improve NRM comes from more recent worries about pollution and resource degradation and from growing interest in the ecological and recreational value of land. These more recent motives are stronger in industrial countries where food security is not an important issue.

With conventional research, the target sector is agriculture, the stakeholders are mainly farmers and government, and because research objectives mesh well with the private interests of farmers, resulting technologies or practices may be spontaneously adopted.

With NRM research, the community of stakeholders and targeted sector expands to include all resource users, spread out over agriculture, forestry, fisheries, water management, tourism, industry, transport, and other sectors. Research aims may be more in line with the interests of the community as a whole than with those of farmers. For example, NRM research may suggest ways of eliminating cultivation practices that are profitable for individual farmers but which harm the environment and therefore the public interest. Policy measures — for example, subsidies, regulations, pricing schemes, or education — may be needed to stimulate adoption of NRM technology by farmers or other specific interest groups.

Setting priorities becomes more complex with NRM research because of the large number of stakeholders. Negotiation and political intervention may be needed more often than in priority setting for conventional research because of the likelihood of conflicting interests.

The differing motives for conventional and NRM research, mentioned above, directly influence the targeted problems, objectives, success indicators, complexity, time horizons, and spatial focus of each kind of research. Conventional research, usually within a 5- to 15-year time frame, aims to increase agricultural productivity and farmer income. Research is most often conducted at the plot or farming system level, and the analysis is not normally complicated by a large number of nonagricultural variables.

In contrast, NRM research, typically with a 15- to 50-year time frame, concentrates on resource quality, often with the aim of reducing pollution and degradation to acceptable levels for the benefit of the wider community. The research effort tends to be holistic, based on a systems approach incorporating multiple variables and scientific disciplines. It can extend to the watershed level or even higher in the system hierarchy to the ecoregional level.

The functions and outputs of the two kinds of research also differ. Technology generation, for example, tends to be less important in NRM work than in conventional agricultural research. However, the role of NRM research in policy formulation — for example in providing technical information for the assessment of alternative land use strategies — is very important. This is because many NRM problems may be more readily solved by regulation or incentives than by new

technology. The policy-related tasks of NRM research may be more complex than those of conventional research because many of the factors it needs to analyze for policymakers — such as potential improvements to wildlife habitat or reduction of erosion — are not priced in the market the way fertilizer, credit, labor, or land are.

Two other functions that differ according to the type of research are information management and resource conservation. Since changes in the natural resource base tend to be slow, there is a need for physical, biological, and socioeconomic data sets that cover long time series so that trends can be seen. Good information also takes on special significance in the selection of NRM projects since only a few can be executed at any one time due to their high cost, complexity, and long duration.

In the case of conservation, most conventional research concentrates on collecting and preserving germ plasm of cultivated species and their wild relatives for future breeding. With NRM research, the range of organisms to be conserved widens beyond cultivated plants (and domesticated animals in the case of animal husbandry). And the uses of the conserved materials expand beyond mere plant breeding for crop improvement to include applications in land use strategies (for example, planting certain tree species to stop erosion). The logistics of conservation also become more difficult, in part because many plants do not produce storable seed.

Other major differences between conventional and NRM research relate to their governance, partnerships, funding, staffing, organization of activities, and monitoring and evaluation.

Conventional agricultural research is usually positioned within or administered by the Ministry of Agriculture, and its main partner tends to be extension. For an institution with an NRM approach, one would expect part of the institutional patronage to shift to the Ministry of Environment. Authorities responsible for land use, water, forestry, and wildlife, as well as local and regional governments, would become key partners in research and technology transfer.

In giving greater emphasis to NRM, agricultural research institutions should modify their mission statement and arrange for the appointment of boards directors to reflect the new orientation. It is also preferable if funding sources can be diversified to mirror the composition of partners and clients.

The focal point of organization and analysis in conventional research is usually the commodity subsector, with commodity programs often supplemented with farming systems work. In NRM research, work is increasingly organized into ecoregional programs or production system programs, sometimes based on multi-institution consortia. Whatever the arrangements, there is merit to using as simple and as transparent a structure as possible.

Planning, monitoring, and evaluation of NRM research require the use of additional criteria beyond what might be used for conventional agricultural research. Long-term and off-site effects are examples of factors that need to be included. But because long-term (sometimes intergenerational) impact is difficult and in some cases impossible to measure, modeling tools are needed for predicting likely outcomes of alternative technologies, land-use strategies, or policies. These of

course must be empirically based, so some long-term impact experiments will still be necessary.

Being able to extrapolate site-specific results to other locations is also important, particularly in research planning and priority setting. Here, geographic information systems (GIS) and related modeling tools have an important role to play. Special economic techniques for valuing NRM research costs and benefits (which may be unpriced in the market) are also available. (For more on NRM priority setting, see the section with the day three papers.)

A final consideration in comparing conventional and NRM research is the differing requirements for research facilities and human resources. With increasing emphasis on NRM, the importance of agricultural research stations will fall. Much of the necessary work will be carried out on-site in a more decentralized fashion in the ecoregions being studied. The mix of scientists will also change, with less need for certain kinds of scientists — plant breeders for example — and greater need for resource-use and information specialists. (For more on human resources, see the section with the day three papers.)

The CGIAR's Response to New Challenges in Agro-Environmental Research in Developing Countries

By Hubert G. Zandstra, Director General, CIP

Zandstra's paper outlined the CGIAR's approach to organizing and executing agro-environmental research. He observed that scientists in the CGIAR have always shown concern for the sustainable use of natural resources. Research has been done on soil and nutrient management, the chemistry of flooded soils, and the impact of land clearing on soil, to name a few areas of work. In the early 1980s, research on the resurgence of brown planthopper in rice led to future integrated pest management (IPM) programs now widely adopted in rice-growing regions. Similar work on biological control of cassava mealybug and potato weevil led to successful pest management practices in the late 1980s.

A major review and reassessment of the CGIAR's research programs, begun in 1987, has resulted in even stronger emphasis on sustainable agriculture. And the CGIAR response to UNCED's Agenda 21 puts a heavy emphasis on research designed to help poor farmers, despite evidence that returns to production are greater from research done on prime farm land.

Zandstra described the so-called ecoregional approach to research now being developed and implemented by the CGIAR to help farmers produce in a variety of production environments, not just the most fertile ones. The approach to studying an ecoregion has three major dimensions as set out by the CGIAR's Technical Advisory Committee (TAC) and Center Directors Committee (CDC):

- applied strategic research on the foundations of sustainable production systems
- the improvement of productivity by drawing on global research activities
- strengthening of cooperation with national partners and development of transnational mechanisms of collaboration.

The applied strategic research applies to all components of the ecoregion. However, because of variation within an ecoregion, specific research sites need to be identified. These should feature key problems that the ecoregional approach was designed to address.

Initial research at these local sites seeks to understand physical and biological processes affecting the resource base, as well as the economic and social context of farmer decision making. The research must deal with several system levels — watershed, community, farm household, and field. At each level, interactions between resources and human management are studied to diagnose problems and causes.

On the basis of the diagnostic work, possible solutions are evaluated according to criteria such as capacity to restore or enhance the resource base, potential to increase productivity, and compatibility with existing production systems. The evaluation identifies the R&D agenda for on-site research and aims to model the relationships between agroecosystem processes and environmental and socioeconomic conditions. These models can then be calibrated and validated using data sets from benchmark sites. Once models have been tested, the results can be extrapolated to other environments using GIS.

Apart from the scientific framework for research just outlined, Zandstra also noted some of the operational principles and mechanisms for ecoregional collaboration between CGIAR centers and other institutions.

First, there should be greater complementarity among research efforts with tasks being allocated according to institutional comparative advantage. Reducing duplication of effort will boost the overall efficiency of the CGIAR centers. Second, partnerships of participating institutions — be they IARCs, NARS, other public agencies, academic organizations, or NGOs — should be marked by greater equality. This will help stimulate participation and transparency in decision making. Third, extra resources should be mobilized and efforts made to facilitate collaborative work on jointly defined problems, backed by donor support.

The formation of research consortia is the key organizational mechanism for enabling CGIAR centers to carry out ecoregional work. As a partnership of diverse institutions, a consortium creates a critical mass of research expertise and resources so that an integrated research program of common interest to the partners can be jointly planned and implemented. In the case of the consortia created to date, the administrative leadership was catalyzed and supported by at least one IARC, which provided seed money for program planning and governance. In some cases, a method called "participatory program planning by objectives", or PPPO, has been used to formulate the research agenda and set priorities for components of the agenda.

Under the consortium model, participants are asked to submit research proposals and requests for grants-in-aid that will support the direct costs of the proposed work. Proposals are then reviewed by a steering committee representing the participating countries and institutions. Project review often has to be shared among the strongest institutions and may require support from outside peer reviewers.

CGIAR centers used the consortium approach in some of their research activities well before 1992. Examples are IRRI's consortia for different rice ecologies in Asia and the IRRI-CIMMYT consortium on rice-wheat systems. These consortia had a fairly narrow institutional base, essentially national agricultural research institutes, and usually had a commodity focus.

After a request from the CGIAR to set aside more funds for natural resources research, TAC invited proposals to be submitted through convening centers in June 1993. It agreed to provide partial support for 14 of 17 proposals received.

One of the aims of the ecoregional approach is to improve IARC support for NARS. On this point, there has not been as much progress as desired, according to Zandstra. However, the CGIAR centers expect to see improvements in regional-level planning of CGIAR activities such as training and technical assistance to NARS. The recent research planning initiatives undertaken by NARS and CGIAR centers in East and West Africa exemplify the process that should be more widely applied.

A number of factors may have a bearing on the chances for developing a common research agenda in a given ecoregion:

- differences between partner institutions in their objectives and capacity
- differences between countries in the priority they assign to a particular ecological system
- limited capacity of an IARC to contribute to a project because the commodities it deals with are not adapted to the ecoregion in question
- mismatches between commodity networks and ecoregional boundaries.

The ecoregional approach is being widely used in the CGIAR system, and the recent drive toward a system-wide program matrix will further encourage ecoregional research. However, many issues still remain to be resolved. Among the ones cited by Zandstra are the following:

- NRM research requires the participation of various types of institutions, many of which the CGIAR centers are unaccustomed to working with. Institutions experienced with NRM issues and the environment need to be more strongly represented in ecoregional initiatives.
- Multi-institution participation implies a variety of perceptions about the problems to be addressed. Formal planning and program development by objectives are needed to deal with this complexity.
- A lot can be achieved with existing knowledge about soil, water, nutrient, and pest management. Those working on NRM must recognize that there are two functions to perform. One is the synthetic activity of assembling an integrated natural resources management (INRM) system for agriculture. The other is research to identify novel tools or components that could make future INRM systems more acceptable and efficient.
- Certain aspects of NRM work require strong capability in production systems research and participatory on-farm research. Yet some time ago (before the

emergence of the ecoregional approach), TAC urged CGIAR centers to reduce emphasis on these. It may want to review this recommendation.

- Ecoregional work should include efforts to maintain overall biodiversity as well as agricultural diversity. Such initiatives should go beyond strictly mandated crops and should include support for germ plasm supply, conservation, and distribution.

- Several centers, ISNAR among them, provide key services to the global agricultural research system. Given the CGIAR's growing emphasis on NRM and the environment, these centers may need to serve new client institutions, or at least help them gain access to expertise that complements the agricultural sciences. These centers will also be confronted with growing demand for assistance with policy and management problems in the context of ecoregional activities. This demand will exceed their capacity to respond unless they realign their program priorities.

Integration of Natural Resource Management in the Agricultural Research Agendas of Latin America

By Gustavo A. Nores, Grupo CEO, Argentina

Nores' paper introduced Latin America and the Caribbean's experience with NRM research by noting the great heterogeneity of the region. The sustainability challenge faced by agricultural research there is conditioned and complicated by the particular physical, social, economic, and scientific landscape. As a whole, the region is rich in land and natural resources, but the distribution of these varies widely among countries. In many cases, land is "socially scarce", that is, the best and most accessible properties are owned by a small number of mechanized farmers. Typically, the peasant population (totaling about 90 million people in the region) cultivates small plots of marginal, environmentally vulnerable land. Their poverty currently leaves them with little alternative but to use agricultural practices that mine the resource base and are often unsustainable.

Some polices have favored abuse of marginal lands and deforestation, mainly by large cattle ranches and timber operations. And the new economic model being adopted widely in the region — marked by less government intervention and greater competition in domestic and external agricultural markets — has made sustainability a difficult target for NARS. Public funding for research has gone down and trade competition emphasizes cost-cutting technologies that favor short-term productivity increases over long-term preservation of natural resources.

As for scientific capacity, this varies widely in the region, with some countries having strong, well-developed NARS and others only small or fledgling research systems or none at all. Whatever their capacity, NARS are often trapped between demands for, on the one hand, economic efficiency and equity in agriculture and, on the other hand, environmental conservation and sustainable production, with the latter often taking a back seat.

Despite the difficulties imposed on NARS by the peculiarities of the Latin American context, there is strong NRM capacity and experience in the region. This is found not only in international research centers like CIAT and CIP and in regional bodies like CATIE and IICA, but also in some national systems such as

Brazil's EMBRAPA and Argentina's INTA. Several regional collaboration mechanisms have been set up in the past four years to identify and research NRM problems. These include PROCITROPICOS, a regional forum for the countries of the Amazon Basin, operating via research networks; a joint project by ICRAF, the International Food Policy Research Institute (IFPRI), CIAT, and EMBRAPA on alternatives to slash-and-burn practices in the Amazon; and a consortium of institutes headed by CIP to work on NRM problems in the Andean highlands.

Some of these collaborative projects reflect the so-called ecoregional approach to research being promoted by the CGIAR network of international centers. For example, CIAT, the international research center based in Colombia, organized interinstitutional consortia to conduct research on three agroecosystems: the acid-soil savannas; the forest margins which have infertile soils and are affected by incoming migrants; and the humid, mid-altitude hillsides which have moderately acid soils with low fertility, a high density of small farms, intensive soil erosion, and substantial migration, both in and out.

Representative watersheds were selected as pilot research sites for each agroecosystem. International, regional and country institutions, including local NGOs and community and farmers' organizations, participated actively in setting the research priorities for each site. A participatory approach to research, involving farmers, was adopted by the local consortia and is being implemented project by project.

The selected agroecosystems offered an opportunity, according to Nores, to contribute to the understanding of socioeconomic trends underlying resource degradation. The ultimate aim was to help relieve market and social pressure on the more vulnerable lands by combining land use strategies, policies, and technologies.

Within CIAT, the incorporation of NRM into the research agenda required additional staff. These included researchers in the fields of ecology, geographic information systems, resource economics, soil science, anthropology, and sociology. This expertise added not only to the research competence of the center, but also to its capacity to develop meaningful partnerships with specialized national and international institutions.

Nores saw a dual challenge — management and leadership — facing the NARS of Latin America and the Caribbean. The management challenge is to set priorities. Both commodity research and NRM research are necessary; they are also highly complementary. But NARS cannot afford to cover all commodities and all agroecologies so the only alternative is to set research priorities carefully. The regional experience suggests the need for several kinds of information in order to set priorities effectively. A country's resource endowments and crop comparative advantages should be assessed, areas subject to resource degradation identified, and domestic and export demand scenarios formulated.

Priority setting is a responsibility that NARS should share with policymakers (representing the social interest) and farmer organizations (representing client interests). The experience of Argentina's INTA and Brazil's EMBRAPA, among others, suggests that such early consultation increases the chances of technology adoption.

The leadership challenge is to "close the existing gap in the R&D cycle" and to participate in informed policy making and assessment of alternative land use strategies. The R&D gap refers to research's link with farmers, specifically the problem of developing and transferring sustainability technologies to resource-poor, small-scale producers. Despite various attempts, using various approaches (some of them very expensive), agricultural R&D has not served these peasant farmers very well. In some countries, efforts are being renewed to solve the problem — for example, through decentralization of research and extension and better representation of producers in decision making. But much more is needed. "Sustainability does require a shift in the R&D paradigm." Farmers, communities, and other stakeholders need to participate directly in setting research priorities, testing technologies, and identifying land use strategies. This not only makes research more relevant, it also helps to generate political support and funds for research.

Across-the-board adoption of this paradigm of local participation may be difficult given the heterogeneity of farming conditions. It is a learning process that should start on a small-scale, that is, in just a few representative watersheds. As more is learned from these participatory research projects, the approach can be extended to other watersheds at lower cost.

The second aspect of the "leadership" challenge has to do with research's links with policy. NARS need to contribute the best information possible to national-level assessments of alternative land use strategies and of policy options for sustainable agriculture. "I view this type of upstream extension for informed policy making," wrote Nores, "as a continuous process that requires active participation and feedback from NARS."

Information Needs for Natural Resource Management Research

By G. Edwards-Jones, Scottish Agricultural College, U.K., and B. Dent, University of Edinburgh, U.K. Presented by G. Edwards-Jones

The paper explored some of the scientific information needs for NRM research. The authors cited several desirable traits for any natural resources data base. First, it should include data over as long a time period as possible. In NRM research, it may be more important to know the direction and rate of change in a particular resource's characteristics (e.g., soil nutrient balance) than to have absolute numbers describing its condition at a particular moment. In other words, seeing trends may be more useful than having a snapshot of a resource's current state. Thus, the longer the run of the time series, the more useful the data set will be to the researcher and policymaker. Second, a natural resources data base should capture the spatial heterogeneity of resources and their use, that is, their geographic distribution. Third, the data should be available at scales and levels of accuracy matching the NRM problems being addressed. Data collection can be expensive; so there is no use gathering detailed, small-scale data if the research in question is looking at large-scale phenomena or trends. Fourth, researchers should have easy access to the information, although there may be high costs to providing it. Finally, the data base should be as complete as possible.

Currently, the most geographically complete data bases are those containing physical data — particularly on soils, geology, climate, and topography. Data bases on natural biological systems are less complete.

One poorly understood subject, according to the authors, is the interaction between human behavior and the environment, particularly the psychological and social aspects of the human decision-making that affects the state of natural resources. More information is needed on this.

Models that try to simulate the interaction between, say, farmers and their environment have tended to assume that farmer behavior is motivated simply by financial gain. In fact, many other factors, like personality and experience, come into play. Models that better represent man-environment interactions are needed to predict the outcome of potential solutions to NRM problems. These could help policymakers understand how people are likely to react to certain policy decisions, and how this behavior in turn might affect the quality of natural resources. The very process of developing such models will help define the kinds of information, particularly social information, needed for effective NRM research.

The authors also made a plea for researchers to identify an appropriate scale and relevant level of detail when working with NRM data. They underlined the importance of defining the lowest level of a system hierarchy for which detailed information is needed in order to have "an operational appreciation of the system defined at the top of the hierarchy." For example, if the research problem focuses on a cropping system, then an understanding of soil and water subsystems may be required. However, if the NRM problem is framed at a higher system level — say, the rural community — then data on the subsystem defining the dynamics of household decision-making may be needed. In this case, the soil and water subsystems "may represent an unwarranted level of detail."

Financing Environmental Research: Policy Options for NARS

By S.R. Tabor and B. Mills, ISNAR. Presented by S.R. Tabor

Prepared by two ISNAR economists, this paper presented some funding options for NRM research. It addressed four key issues: ways to tap donor sources, funding arrangements suited to interinstitutional collaboration, long-term financing options, and accountability.

As donor support for agricultural development projects falls, associated funding for traditional commodity research also falls. At the same time, greater donor emphasis on environmental sustainability opens up new opportunities for research — especially existing programs on natural resources like soil and water, many of which are oriented toward improving agricultural production. NARS might consider "repackaging" resource-oriented research proposals and activities to emphasize their contribution to NRM rather than their impact on agricultural output.

Mobilizing support for commodity research will be more difficult. Yet there is a strong case to be made to donors that commodity research per se has a positive impact on the environment. For example, boosting productivity on existing farm land reduces the pressure to bring environmentally vulnerable land under production. At the same time, it can help reduce rural poverty, giving farmers the extra purchasing power needed to eliminate harmful environmental practices. Thus, commodity research programs may have to be "relabelled" to stress their potential to address environmental concerns, a strength that hitherto has not been fully appreciated.

To secure donor funding, commodity programs may also have to "retool," in the sense of developing new approaches that give greater emphasis to sustainability and NRM. For example, programs may have to be restructured along agroecological lines. In many instances, such changes are already happening. Reorienting commodity research, however, is a big task with substantial institutional costs. Donors should be made aware of this. At the same time, NARS must not lose control over their research agenda in the attempt to adapt to donor trends. Careful setting of research priorities in line with national development objectives is crucial to ensuring that donor-funded projects are appropriate to the country's needs.

It is generally agreed that the systems orientation of NRM research demands greater collaboration among different stakeholders — government ministries and agencies, special interest groups, and scientists from various disciplines. This raises the prospect of multiple sponsors of research and the need for ways to coordinate funding. The paper outlined four strategies, noting that the choice of strategy can have a direct bearing on the success or failure of an NRM research project.

Under the "lead agency" approach, the research budget and overall project responsibility are assigned to a single organization such as a national research institute. Skill gaps are filled by seconding staff from other stakeholder agencies, by contracting out, or by temporary hires. The lead agency pays out funds to the agencies or groups providing the extra expertise. Unfortunately, government bureaucracy sometimes forbids or slows down such arrangements.

The second strategy is to create special-project units — an ad hoc approach often used by a group of outside donors wanting to centralize coordination of a project, including hiring and paying of contract staff. Sometimes this arrangement includes funds for managing the collaboration. The special-project approach has the advantage of being able to tailor funding channels to the needs of the project participants, thus getting around bureaucratic bottlenecks. It works best for one-off projects, such as an environmental impact assessments, where there is no need to keep the collaborative research team together once work is completed.

The third strategy cited by the authors is parallel financing. The project is planned jointly by the sponsoring agencies, but then each funds and implements its part or parts of the project separately. This approach is typically used for long-term projects. It works best when the participating researchers are able to work largely independently, with collaboration needed only from time to time, and when the participating institutions have a similar stake in the outcome.

Joint financing is the fourth strategy for collaborative ventures. Funds for a program or project are pooled, although each sponsor retains financial responsibility for the activity as a whole. The executing agencies to which the funds are assigned provide technical and financial reports to each sponsor, as well as to the body charged with administering the common fund. The strategy is appropriate when the sponsors have a well-defined interest in the outcome, when close research consultation is required, and when the research can't easily be broken up into autonomous activities. Detailed agroecological systems research is a good candidate for this funding strategy.

Another key issue highlighted in the paper was long-term financing — something that NRM research is more likely to need than other more traditional forms of

agricultural research. A decade or more may be needed not only to carry out the research itself (in part because the macro-processes under study may take that long to manifest themselves) but also to build the institutional capacity to see it through. But long-term funding is a rare animal, even in industrial countries. In its absence, it may be necessary to break up research efforts into distinct phases.

Several other ways for NARS to mobilize long-term funding were cited: charging for ancillary services like soil testing, using a portion of research lands for commercial purposes, serving as paid trustees or managers of government conservation areas, having government earmark certain tax revenues (e.g., from pollution taxes) for NRM research; establishing a trust fund or endowment. But the presentation also raised a few red flags concerning these options. One is that governments tend to frown on any funding arrangement that reduces accountability, that goes against existing procedures, or that reduces their room for fiscal maneuver. A second caution is that such revenue-enhancing schemes can distract managers and scientists from their main research duties.

The final issue raised in the paper is financial accountability. In a competitive funding environment, demonstrating the actual or potential impact of research is crucial. Here NRM research may be at a disadvantage. Its outputs may be knowledge rather than technology — for example, improving understanding of basic physical and biological processes as a basis for further (downstream) research work, or building natural resource inventories that will be used later by other researchers. Or the results may be highly site specific.

Still, research managers must make every effort to identify intermediate or final impacts to justify their NRM research projects. Even in cases where the eventual benefits are, by the very nature of the research, somewhat unclear, managers must still ensure that the projects that they submit for funding are designed to be cost-effective and efficient. This means asking tough questions about the project design, relevance, and so on.

In some instances researchers will be asked, as part of their accountability requirements, to quantify the likely benefits of improving the natural resource base. Economic analysis offers a number of techniques for valuing such externalities which are not priced in the market. These are usually based on the use of proxy values, such as consumer willing to pay for specified improvements in the environment.

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