A Two-Way Continuum for Agricultural Development

edited by
Michael M. Cernea
John K. Coulter
John F. A. Russell

A World Bank and UNDP Symposium
Research-Extension-Farmer

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The World Bank
Washington, D.C., U.S.A.
Foreword

The World Bank is pleased to sponsor this important volume as a contribution to a better understanding of a significant topic related to agricultural development.

The Bank's interest in this topic stems from its very heavy involvement in investment for agricultural development; indeed, the World Bank is the single largest source of external financing for agricultural development in the Third World. In the past decade some $30 billion has been invested in more than 700 projects throughout the tropics; since each project catalyzes a contribution from the host country, the total investment under the aegis of the Bank has been more than $70 billion over the past ten years.

All projects have one common objective: an increase in the productivity of agricultural producers, especially small-scale producers. Raising productivity, of course, involves technological change at the farm level; technological change depends on the development and diffusion of new and improved technologies and involves behavioral and sociocultural change. Institutionally this is accomplished by the links between research and extension services—the subject matter of this volume.

The editors and authors are to be congratulated on the comprehensive coverage of this important topic and their success in bringing together a wide range of country experiences. It is our hope that this presentation will lead to a pooling of experience which will stimulate further discussion. We hope that policymakers and practitioners, researchers and extension staff, managers and students of development, sociologists and agricultural economists, and many others will benefit from this work and that there will be improvements in the institutional arrangements needed to make research and extension services more effective than at present.

Montague Yudelman
Director, Agriculture and Rural Development Department
The World Bank

September 1984
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List of Contributors
A few words about this volume's intellectual history are needed to clarify its genesis, content, and objectives.

Although agricultural research and agricultural extension obviously have a common ultimate objective, there is often little close collaboration between them. The reasons for this lack are more complex than much of the casual discussion and rhetoric around this topic would indicate. Seldom are the underlying technical, institutional, sociological, and economic implications of building up such linkages confronted squarely, analyzed in detail, and translated into action programs. Thus, the weak linkages between research and extension persist as a critical constraint on these support services and on the promotion of agricultural development in general.¹

To address these issues in more depth, the Agriculture and Rural Development Department of the World Bank organized a review and analysis of actual experiences in Asian countries with linking research and extension, particularly, but not exclusively, under the framework of the training and visit (T&V) system of agricultural extension. The present volume is a result. Through this analysis, it was hoped to identify not only successful approaches, but also the weaknesses and obstacles that impede these linkages in different country environments. The objective was to derive political, institutional, and technical recommendations to guide future efforts.

To capture the key facets of this theme, the overall subject of research-extension linkages was divided into four main issues;

- Policy and institutional issues in the improvement of research and extension linkages
- Identification of farmers' priority production problems
- The generation of improved technology and its on-farm validation
- The joint identification and formulation of extension messages by extension and research staff.

Prominent researchers, policymakers, trainers, and managers of research and extension services from India, Indonesia, the Republic of Korea, Pakistan, the Philippines, Sri Lanka, and Thailand were invited by the World Bank to write position papers on these issues. For each topic, at least one paper was sought from the research side and one from the extension side, so that both perspectives were presented. A tentative outline of issues was circulated in advance to foster topical convergence among authors and a common analytical framework.

The commissioned draft papers were then submitted for discussion at an international workshop convened by the World Bank and the United Nations Development Programme (UNDP) in Denpasar, Indonesia, in March 1984. Other specialists from the same and other countries, some of whom contributed discussion papers, also attended the workshop. Small working groups discussed a series of subtopics, selected to provide complementary perspectives on the issues in the light of the variety of social, economic, and agroecological circumstances in the countries represented. Subsequently, the authors of the main papers revised and completed their contributions. Several new chapters were commissioned by the editors to round out, topically, the overall treatment of the theme.

The structure of this volume follows fairly closely the four subtopics of the main theme. The overall thrust is to substantiate the idea of agricultural research and extension as a process rather than as discrete or mechanically aggregated activities. It is argued that technological know-how can best be incorporated into the agricultural production process if extension is used to build a continuum between research and its ultimate beneficiary, the farmer. The volume advocates that this continuum should be regarded and used as

a two-way communication process, since each component of this three-element continuum can mutually reinforce the others to the best effect.

Each section addresses a set of specific theoretical and practical issues. Thus, the section on "Policy and Institutional Issues" provides an opportunity to discuss the wider macro policy and managerial issues that bear on the interaction of the two services not only nationally, but also on a regional scale and in the field. Also discussed are the relationships between specialized commodity research organizations, often with their own extension services, and the national extension services that purport to benefit all of the farmers in any particular area. This topic also includes some issues of management and manpower, for example, the development of reward systems, staff training, and other institutional factors that are often regarded as barriers to the closer collaboration between research and extension staff.

The section on "The Identification of Farmers' Production Problems" covers the key agrotechnical, sociological, and cultural issues involved in obtaining a sound understanding of farmers' problems, which in practice should be the basis of linkages between the two services. This topic covers both the role of researchers in identifying farmers' problems through farming systems research and the role of extension staff in learning, through daily contact with farmers, about their technical difficulties and in feeding back this information to the researchers. Joint diagnostic surveys combining the two approaches emerged as a vital tool in this field.

The third section, "The Generation of Improved Technology and Its On-Farm Validation," focuses on the methodology of designing research programs, particularly the selection of research themes that are most relevant to the goals of the national agricultural development plans and the perceived needs of farmers. The discussion covers successful experiences with on-farm validation, an often grey area between research and extension, but one that is crucial to the design of messages of proven value for the farmers.

The last topic, "The Formulation of Extension Recommendations" is another area in which research and extension staff must interact very closely. In this section, the authors explore the forms in which this interaction occurs—or does not yet occur effectively. Such cooperation is essential for the selection of useful technologies, for demonstrations of their practical usefulness to farmers, and for their modification when feedback on farmers' reactions is received.

These issues and others are debated in the following pages in the light of field experience in several Asian countries. The contributors hope that this volume and its findings might have further operational and policy relevance for them and other countries of the developing world.

Michael M. Cernea  
John K. Coulter  
John F. A. Russell
Acknowledgments

The authors and editors of this volume are indebted first to the government of Indonesia and its Ministry of Agriculture for hosting the Denpasar workshop, where the chapters of this volume were first presented and discussed. We are especially grateful to His Excellency Ir. Achmad Affandi, minister of agriculture, who opened and closed the workshop. Our thanks also go to the United Nations Development Programme, which cosponsored the workshop together with the World Bank, and especially to William Mashler, senior director of the Division of Global and Interregional Projects, for his personal support and active participation during the conference.

Particular thanks must also be given to Donald Pickering, assistant director of the World Bank’s Agriculture and Rural Development Department, who organized the workshop. He was ably assisted by a steering committee comprising Bank staff and Dr. M. P. Singh from Bangladesh, who worked as consultant on workshop methodology and was made available by the Food and Agriculture Organization (FAO). We thank them and the workshop administrative organizer, Ted J. Davis, who with his staff of Marge Corneliz, Susan Teh, and Rini Samoed from the Bank’s Jakarta office ensured the smooth running of the conference and well-being of the participants. Indonesia’s logistical support in planning and running the conference was provided by the Ministry of Agriculture, especially through the good offices of Soenarso Wirjoprajitno, the director of the National Agricultural Extension Project, Salmon Padmanagara, the head of the National Agricultural Extension and Training Agency, and by Dr. S. W. Sadikin, the director general of the National Agricultural Research Agency, and their staff. They were closely assisted by staff of the World Bank’s office in Indonesia, particularly through the unstinting support of the director, Russell Cheetham, and Michael Walden and Sydney Draper.

Many other staff, too numerous to name, of the World Bank, FAO, international agricultural research centers, and donor agencies have contributed ideas and comments throughout the preparation of the workshop and the manuscripts that emerged from it, for which we are most grateful. Additional stimulation was provided by Daniel Benor, who has tirelessly promoted and motivated improved research and extension linkages in the majority of the countries present at the workshop over the past decade. We are especially grateful for the contribution made by the many country representatives, who shared with us their experiences with linkages between research and extension, the effect of these linkages on improving services to farmers and promoting the adoption of new technology, and the problems encountered.

When the workshop was over, there remained the task of editing, revising, structuring, and integrating the conference papers for wider dissemination. We are most thankful for the tireless efforts of Consuelo Carson, Sonia Moral, and Mae Gahl, who typed drafts of the manuscript and the many revisions to them. Finally, we must pay tribute to the keynote speakers and discussants, whose work provides the basis of this volume. As editors, we only hope they feel we have done justice to their work in our introductions to the volume and each section of it. We join with them in hoping the record of this experience will be helpful to other practitioners who are working with the challenge of improving linkages between research and extension for the ultimate benefit of the world’s farmers and their families.
Definitions

AAETE  Agency for Agricultural Education, Training, and Extension (Indonesia)
AARD  Agency for Agricultural Research and Development (Indonesia)
ADA   Assistant Director of Agriculture (Sri Lanka)
ADDS  Additional deputy directors (Sri Lanka)
AEARP  Agricultural Extension and Adaptive Research Project (Sri Lanka)
AETI  Agricultural and Extension Training Institute (Bangladesh)
AI    Agricultural instructors (Sri Lanka)
AO    Agricultural officer (Sri Lanka)
ASC   Agricultural Service Committee (Sri Lanka)

BADC  Bangladesh Agricultural Development Corporation
BARC  Bangladesh Agricultural Research Council
BARI  Bangladesh Agricultural Research Institute
BIMA  Bimingan Masal or Mass Guidance Program (Indonesia)
BIP   Agricultural Information Center (Indonesia)
BPP   Institute for Agricultural Extension (Indonesia)
BRRI  Bangladesh Rice Research Institute

CARP  Center for Agricultural Research Programming (Indonesia)
CF    Contact farmer
CGIAR Consultative Group on International Agricultural Research
CIMMYT Centro Internacional de Mejoramiento de Maíz y Trigo
CRI   Central Research Institute (India)
CSR   Cropping Systems Research (Bangladesh)
CSWG  Cropping Systems Working Group (Indonesia)

DAE   Department of Agricultural Extension (Bangladesh)
DD    Deputy director of agriculture (Sri Lanka)
DGFCA Directorate General for Food Crops Administration
DOA  Department of Agriculture

FACE  Farmer-centered extension method
FSR   Farm systems research

HASD  Highland Agricultural and Social Development Project (Thailand)
HYV   High-yielding variety

ICAR  Indian Council of Agricultural Research
ICRISAT International Crops Research Institute for the Semi-Arid Tropics
ICTA  Instituto de Ciencia y Tecnología Agrícolas (Guatemala)
IDA   International Development Agency
IITA  International Institute of Tropical Agriculture
IRRI  International Rice Research Institute

KVS   Krushikarma Viyapthi Sevaka (Sri Lanka) (village extension worker)
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>MLT</td>
<td>Multilocation testing</td>
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<tr>
<td>NAEP</td>
<td>National Agricultural Extension Program (Indonesia)</td>
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<tr>
<td>NARP</td>
<td>National Agricultural Research Project (India)</td>
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<tr>
<td>PAO</td>
<td>Provincial agricultural officer (Philippines)</td>
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<tr>
<td>PPL</td>
<td>Penyuhan pertanian lapangan (Indonesia)</td>
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<tr>
<td>PPM</td>
<td>Penyuhan pertanian media (Indonesia)</td>
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<tr>
<td>PTVT</td>
<td>Provincial Technology Verification Team (Philippines)</td>
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<tr>
<td>PWD</td>
<td>Public Welfare Department (Thailand)</td>
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<tr>
<td>REC</td>
<td>Rural Extension Center (Indonesia)</td>
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<tr>
<td>RRC</td>
<td>Regional Research Center (Sri Lanka)</td>
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<tr>
<td>RTC</td>
<td>Regional Training Center (Sri Lanka)</td>
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<tr>
<td>RTWG</td>
<td>Regional Technical Working Group (Sri Lanka)</td>
</tr>
<tr>
<td>SAU</td>
<td>State Agricultural University (India)</td>
</tr>
<tr>
<td>SMS</td>
<td>Subject matter specialist</td>
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<tr>
<td>SMO</td>
<td>Subject matter officer</td>
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<tr>
<td>T&amp;V</td>
<td>Training and visit system</td>
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<tr>
<td>VAT</td>
<td>Variety Adaptability Trial (Sri Lanka)</td>
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<tr>
<td>VEW</td>
<td>Village extension worker</td>
</tr>
<tr>
<td>VLW</td>
<td>Village-level worker</td>
</tr>
<tr>
<td>ZARS</td>
<td>Zonal Agricultural Research Station (India)</td>
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<tr>
<td>ZRAC</td>
<td>Zonal Research Advisory Committee (India)</td>
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Research-Extension-Farmer
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Building the Research-Extension-Farmer Continuum: Some Current Issues

Michael M. Cernea, John K. Coulter, John F. A. Russell

A recurrent theme of most discussions on agricultural research and extension is that the linkages between these two vital parts of the agricultural support services are often weak or nonexistent. Rather than operating as a continuum, these services often act in ways that reinforce their separation rather than their mutual support.

The perception is that researchers often are out of touch with farmers' problems, that research programs tend to be designed in isolation of such problems, and that extension workers are poorly served by, or ignorant of, the output of research systems. There is ample evidence for these weaknesses in many research programs. It is obvious to the critical observer that much research, even when carried through to an apparently successful conclusion, is unlikely to have the expected impact on farmers' agricultural practices.

There is also evidence that extension workers are often out of touch with farmers' problems and do not attempt to understand the research process (Cernea, Coulter, and Russell 1983). They often lack an analytical approach to defining how farmers' problems might be susceptible to solution through the research process.

In this opening chapter we will outline briefly the main issues of concern in this volume and set up a conceptual and operational framework for the discussions that follow. These issues refer to the causes of the weak links between extension and research, to the choices confronting policymakers in deciding on investments for research and extension, to the overriding need for responding to the production problems of the farmers, and to the neglect and importance of the social science perspective in developing the research-extension-farmer continuum.

The Underlying Reasons for the Weak Links

There is insufficient cooperation between extension and research, despite their common ultimate goals, because in most cases these services were established without a built-in complementarity. Additional institutional, political, and sociological factors relating to the composition of these bodies, their location in the administrative and government structure, as well as the values that govern their staffs, have made this relationship even more prone to problems. These causes may differ from country to country and even from program to program within a country. Indeed, there is not much evidence that any one research-extension system leads to weak linkages while another encourages stronger ones, although some systems seem to have better chances of success. Two of the more successful are the training and visit (T&V) system, which is predicated on built-in mechanisms for linking researchers and extension agents, and certain commodity-oriented cash crop systems, particularly those funded by producers. An imperfection of the latter is that the major benefits may be captured by the larger and more vocal producers. Systems in which extension and research are in different institutions are, however, probably more vulnerable to the problems of poor interaction and insufficient communication.

The weak linkages may be symptomatic of a much deeper malaise in the public sector—a sector that often offers poor motivation and poor rewards for initiative, and that does not give adequate priority to essential needs such as consistent funding, money for transportation and travel, and support for library services. It should be obvious that, given the right motivation, research and extension workers would collaborate
under almost any system. This is particularly true where agriculture is prospering; a stagnating agriculture provides little motivation for either research or extension workers to do their best.

Some of the developments in the past decade or two do, however, offer encouraging signs that the two components can work together closely and have a major impact. The large increase in yields of rice and wheat is one obvious example. The introduction of the T&V system of agricultural extension in a number of countries is another. It has provided formally institutionalized structures for research and extension staff to meet and discuss farmers' problems and thereby gain a closer insight into the functioning of research and extension.

Apart from the institutional factors that may hinder or help collaboration, some built-in aspects of the research and extension services may have a divisive effect. For example, research staff are usually somewhat more elitist than extension workers because they have more opportunities to study for advanced degrees, which normally bring rewards in a bureaucratic situation. Research staff usually expect to be posted in or near large cities, which offer concomitant opportunities for additional employment and better facilities for families. Agricultural research scientists have, during the past decade, acquired additional prestige through the network of international agricultural research centers, within or outside the Consultative Group on International Agricultural Research (CGIAR). Many senior scientists have had an opportunity to participate in the management of these centers through board membership, and several hundred have been involved in training programs at the centers, which have widened their contacts and stimulated their interests. The international research centers have developed a network that encompasses researchers in both the developing and developed countries and thus provides many opportunities for exchanges of information and experience. Such contacts may encourage the research scientist to look to his research colleagues rather than his extension colleagues for ideas and support.

By contrast, extension staff have scarcely any opportunity to meet colleagues from other countries through training programs. By the very nature of their job, extension staff are more isolated; only the most senior are stationed in large towns. In research, junior staff are in daily contact with their senior colleagues. Extension staff have only infrequent contact with their senior colleagues—hence the great importance of regular meetings, not only to formulate messages for farmers but also to exchange views with their fellow workers.

Extension workers suffer the greatest degree of intellectual isolation where agriculture is at a subsistence level. Where progressive farming systems are emerging, the farmers themselves can challenge the extensionist to seek out solutions to problems and encourage his contact with the researcher.

Thus, although institutional changes can be developed to encourage or force the extension worker to make closer contacts with his colleagues in research and vice versa, the motivation of the individual is a significant issue.

The Choices of the Policymakers

It is generally recognized that to increase farmer productivity and incomes requires access to new technology, much of which will be developed by research. The role of extension is one of adapting research recommendations to suit the varying needs of farmers and providing a delivery service to speed up farmers' access to and adoption of new technology. Much of the justification for expenditure by governments on research and extension rests on these premises. In a period of financial austerity and competitive demands on scarce investment funds, however, policymakers are forced to make difficult choices between various investment alternatives, either between research and extension or between agriculture and other sectors. On what assumptions should the decisions among such alternatives be made?

The weaknesses in research-extension linkages were, of course, rather academic when investment in both services was small; but in more and more countries this is no longer the case. Indeed, investment in agricultural support services has increased at a spectacular rate in the past decade or so. During fiscal 1978–84, for example, the World Bank invested $1 billion in national research and extension projects, and a
further $600 million in research and extension components of other agriculture projects. Furthermore, this represents a comparatively small percentage of the total investment in research and extension by developing countries.

It is therefore of overriding importance to use these funds effectively so that governments are persuaded to give research and extension the continued stable support and high priority that are essential for their successful operation. What governments expect of the impact on production may be unrealistically high, on occasion, but they cannot be expected to wait indefinitely for results.

Just as the generation of technology is a long-term process, investments in research and extension also take time to yield results. Even then, however, it is difficult to determine whether the benefits come from research or extension or from convergent factors such as fertilizers, credit, and incentive prices. It is thus vital to obtain clear commitment from governments, not only for resource allocations to these two activities, but also for sustained support over a long period. This in turn means convincing policymakers of the potential effectiveness of improving the two services.

Policymakers are not likely to give sustained support for increased investment in research and extension, however, unless clear goals are drawn up for each service within the framework of national policy for the agricultural sector. Furthermore, government resource allocations for research and extension are often criticized because much of the research output is perceived as being irrelevant to farmers' needs and because extension services appear to reach few farmers and have little measurable impact.

Several studies in this volume indicate that to become more effective and thereby receive political and financial support from governments, research has to become more relevant to farmers' needs, and extension has to change from its top-down approach and become more participatory. To achieve these goals, research and extension have to work together and with the farmers; but this can be done only if existing government policies also change in ways that facilitate such a development. Among other changes, steps should be taken to attract and motivate staff and to fund them consistently over time. Appropriate administrative arrangements need to be set up so that the two services can interact effectively with each other and with the farmers (as well as with other key agencies) to address the critical needs of the production process at the farmers' level.

On the research side, the usefulness of a farming systems approach in identifying farmers' needs is increasingly recognized. Thus, research is often restructured not merely to organize it along disciplinary or commodity lines, but to enable it to serve entire farm enterprises on a regional or zonal basis. Many countries have now designated research stations to serve agroecological zones or have set up new stations to meet these objectives. This restructuring is a necessary prerequisite to more effective interaction of research with both extension staff and farmers, because it involves everyone at the local level in finding the most appropriate opportunities for improving productivity on a whole-farm basis. From these regional stations, farming systems research can be initiated and a network of adaptive trials on farmers' fields established. Better recommendations relevant to farmers' needs can then be obtained, as well as feedback to ensure that future research priorities address technical constraints with good prospects for resolution.

To develop strong extension services, policymakers have to recognize the need for professional subject matter specialists, who, relieved of being mere links in the administrative chain, can devote their time to training staff and to learning from research and extension staff and farmers. They should also routinely conduct on-farm trials in their specialty in order to give more professional and flexible advice to farmers.

Policymakers have to be sensitized to the need to develop incentives for research and subject matter specialist staff to work under this new approach. Experience with the T&V system has shown that early misgivings by research workers about the time spent training and interacting with extension staff and visiting farmers have been partly overcome by the satisfaction of seeing the results of their work in the field. When new work programs are instituted, however, it must be remembered that every new task leaves less time for some aspects of previous work. This is just as true for extension as for research, and if much more time is to be spent on field visits by all levels of staff, other activities have to be given up or curtailed. One of

1. In this volume all dollars are U.S. dollars; billion refers to thousand million.
these may well be the excessive reporting at all levels of many extension hierarchies, much of which is no longer needed if senior staff make comparatively frequent and regular visits to the field.

As both services increasingly become field-oriented, mobility is essential, and adequate transport and field allowances must be maintained. Unfortunately, once new posts are sanctioned they are not likely to be cut back, and any budgetary pressure normally tends to reduce the operating costs needed to keep staff mobile. The T&V approach to extension and the increased emphasis on farm trials and farming systems research demand sustained provision for operating costs; without this the system cannot be kept dynamic, and all the investment in additional staffing, training, and motivation can come to nought. This issue is especially important as many of the T&V extension services in Asian countries move into their second phase, and the governments are still having difficulty in providing the necessary operating funds. The issue has to be faced squarely by all countries adopting more intensive extension systems; funding of operational costs must be sustained in the years ahead.

Appropriate administrative arrangements include procedures for research and extension workers to carry out adaptive trial programs jointly, to meet together in monthly workshops, and to plan their seasonal and long-term programs jointly. This implies not only forming a technical committee so that all parties concerned can decide on recommendations, but also establishing a process of preparation for these committee meetings so that adequate information is made available for meaningful decisions. Careful analysis is needed of the results of trials and of the monitoring of adoption rates in the previous season. Administrative arrangements need to be made for the regular monitoring of adoption rates by extension field staff themselves, by special evaluation assessments, and by diagnostic surveys made on joint visits of research and extension staff to farmers during the season. These strong contributions will ensure that feedback is adequately built into the system.

With more emphasis on feedback, the key decisions on seasonal extension programs and adaptive trials need to be made much closer to the field; this often implies a much stronger element of decentralization than previously. Although guidelines may be issued nationally, the main programs will be drawn up and reviewed at the level of the agroecological zone or region, with variations down to the district level. National bodies should only be expected to comment on zonal or regional proposals.

In this context, there is sometimes a debate over the conflict between national goals and local programs based on the immediate needs of farmers. In essence, national policies and programs that try to force targets on farmers are not likely to get very far. For instance, unless farmers see that there is an economic incentive to change their cropping program to include, say, more oilseeds to meet a national shortfall, they will not do so. National programs therefore have to be responsive to farmers' needs, and it is very important for feedback generated at the field level to be communicated to policymakers. The longer-term policy framework can then take account of farmers' constraints and address them effectively.

In summary, although the need to strengthen research and extension is becoming well recognized at the policy level, this recognition still has to be translated into consistent and sustained funding. New operating procedures and skills are needed, which mean changes in staff incentives, training, and career development. These, in turn, require structural institutional rearrangements, which will take time but will be facilitated if all concerned are well oriented to the new approaches and know exactly what work methods and priorities have to be changed. The goal in the short term is to improve extension and to promote adaptive trials more relevant to farmers' needs; in the longer term the goal is to harness feedback to more relevant national programs that can be more successfully implemented. If research and extension programs can demonstrate their accountability and effectiveness, they will help elicit the sustained support from policymakers that is essential to their success.

Response to Farmers' Production Problems

The second major issue that is frequently addressed in this volume is the need for research to respond to the practical problems that farmers are facing. Unless research is seen as responsive to farmers' problems, it
soon loses its credibility among both farmers and extension workers. If it is to become more responsive, researches have to recognize that the social and economic aspects of the problems are as essential as the biological.

Through a long-term process of trial and error, farmers frequently manage to develop successful and often ingenious solutions to their problems with existing resources. However, research is needed to help them when additional resources are being added—for example, new varieties, new crops, or new inputs such as water or fertilizers. Research is particularly needed when farmers settle on new land as in the transmigration program in Indonesia. The research projects also demonstrate very clearly the need for social scientists to work with the farmers in order to understand the limitations—such as labor bottlenecks, methods of cultivation, and land clearing—that farmers perceive as important.

Traditional agricultural research has not ignored farmers’ problems. Research on pests and diseases, methods of weed control, and water and plant nutrient management are obviously all related to on-farm problems, and solutions to many such problems have increased production in both temperate and tropical agriculture. Because of its commodity or disciplinary orientation, however, traditional research has tended to ignore the implications of a factor of great importance to small farmers: the risk factor. Indeed, farmers readily adopt certain new techniques for irrigated or perennial crops, which usually entail few risks—a clear demonstration that small farmers are innovative and open to the products of research that do not generate additional risks. In rainfed areas, particularly those with large within-season and between-season variations in climate, the risk of not having sufficient food is most important. In such areas farmers have tended to ignore research recommendations that are perfectly valid at the experiment station but obviously invalid at the farm level.

The nonacceptance of such recommendations has helped to focus the attention of researchers on the need for a much clearer definition of farmers’ priorities and of the biological, social, and economic limitations to increased productivity, particularly for resource-poor farmers.

In the current agricultural support systems of research and extension, two major activities focus increasing attention on farmers’ problems: these are farming systems research and the feedback mechanism in extension systems, particularly the T&V system. Farming systems research covers a multitude of activities ranging from sociological and economic studies of farm households to the design of completely new farming systems for a variety of agroecological zones in the tropics. Of concern here are the activities associated with the diagnostic phase. A multidisciplinary team, usually consisting, at a minimum, of an agronomist and a social scientist, attempts to define the farmer’s physical and economic resources, the factors that limit his production, and the interventions necessary to reduce or resolve those limitations. It is then possible to classify farmers into groups for which similar kinds of recommendations are likely to be most effective.

The feedback mechanism in the extension service is another means of identifying farmers’ problems, since the extension agent is in close contact with a large number of farmers in his district. Unlike “unreactive” methods of extending advice, such as by radio or newsletter, face-to-face contact of the agent with farmers provides an opportunity for farmers to explain their problems. In a structured system like the T&V, the agent then conveys the problems up the line to both researchers and agricultural administrators. Thus the system is able to react to farmers’ problems, to analyze their reactions to recommendations, and to alter these recommendations or alert researchers to the need for changes in the research program.

Despite differences in emphasis in these two approaches, the results should be the same—a clearer definition of the farmers’ problems and a better series of guidelines to researchers on the priorities of farmers’ needs. The important issue is how to interlink extension activities with farming systems research so that they will be mutually reinforcing. At the moment, extension services usually have much greater resources and are in contact with far more farmers than farming systems research, although the latter is growing quite rapidly. As currently constituted, the diagnostic activities of farming systems research are concentrated on few farmers, and the scientists involved are trained to look at their problems from the research point of view; that is, they are concerned solely with the contribution of research to solving these problems. The extension agent, however, is part of a national system dealing with large numbers of farmers
with a wide variety of problems, only some of which need or are susceptible to solution through research. Furthermore, as pointed out above, the background, training, and motivation of extension agents are usually quite different from and often inferior to that of researchers. The extension agent is thus in a position to provide a “shopping list” of farmers’ problems but is not well equipped to assign priority to these problems from a researcher’s point of view. It is thus vital for extension and research staff to make joint diagnostic surveys by field visits to farmers at an appropriate time in the season to investigate their responsiveness to current recommendations and reasons for their partial adoption or nonadoption.

A related issue is the role of the subject matter specialist. By training and experience he is in a position to provide the better diagnosis. But subject matter specialists are by definition dealing with a speciality, be it a commodity such as wheat or a factor such as pests and diseases. He is at his most effective in farming systems with one or a few commodities. This raises the question of whether subject matter specialists should be trained to do some form of farming systems research on their own, particularly in areas of rainfed farming with a multiplicity of crops and sometimes livestock as well. This question seems particularly important in poorer countries that cannot afford large numbers of specialists. This question is not answered in this volume since most of the discussion is about research in relatively simple farming systems, mainly confined to annual crops. Nevertheless, it is a question that will have to be faced as more and more government resources are channeled into farming systems research and extension services. Both seek to define better the farmers’ priority problems, to test and validate solutions, and to demonstrate their usefulness to farmers. Their complementarity will be of increasing importance, and research and extension staff will need to find ways to work better together in carrying out and analyzing the results of these activities.

The Social Science Perspective

Far too often the introduction of research-generated recommendations into farmers’ practices is narrowly regarded as a strictly technical matter. This is an error. Neither extension nor research staff, in their efforts to produce or spread new technologies, can afford to let themselves be guided, even implicitly if not explicitly, by the image of the farmer as a *homo technicus*. Such an image excludes other quintessential components that account for farmer rationale and behavior. Farmers’ production problems are by no means only technical, but also sociocultural, economic, or managerial. As farming is a way of life and not a mere profession, the sociology and the (micro) political economy of this way of life explain the adoption or nonadoption of novel agrotechnologies.

But if social and economic factors are decisive in adoption, it follows that they should be regarded as such when agrotechnologies are generated by researchers in research stations, and when they are “packaged” and disseminated by extensionists. In other words, both the separate and joint efforts of researchers and extensionists should necessarily be informed and guided by a sociological understanding of the farmers.

It is not easy, however, to reverse a long-standing neglect of the sociological dimensions of farming. And it is not simple—but it is absolutely necessary—to incorporate the knowledge and the skills for this perspective into the training of extensionists and researchers and the staff composition of the research and extension establishments. Only in recent years have a number of international research centers in the CGIAR network taken the innovative step of bringing in sociologists and anthropologists to team up with the plant biologists, soil specialists, and other technical researchers and economists. (Economists are themselves a relatively recent addition, not often in sufficient number either.) The results of this interdisciplinary approach have been consistently positive (see Rhoades 1983). The national research centers in developing countries are, by and large, still far from this innovative development, less because of a lack of resources than because of not yet having recognized this need.

Farmers’ social stratification is another sociological variable crucial to the effective cooperation between research and extension. Since farmers command different levels of resources, the research approach for
producing alternative technologies should take account of the varying needs of different categories of farmers and their varying ability to absorb and apply these technologies. In turn, extension recommendations should recognize variations from farm to farm and farmer to farmer.

Farming systems research is an organized attempt to produce and introduce a more informed social science perspective for the benefit of both agricultural research and extension. This approach differs from the cropping systems research by attempting, among other things, to capture a set of social and cultural variables formerly overlooked and thus to achieve a holistic understanding of the farm, the farm family, and its strategy. These variables include the farm decisionmaking patterns, the noneconomic determinants of farmers' behavior, the developmental cycle of the farm family, the social organization of family labor resources, and the systems of family authority and mobilization. Capturing such variables increases the explanatory power of farming systems research over that of research limited to the cropping system only, and thus provides better guidance simultaneously for agricultural research and extension. It is therefore important to overcome the resistance to farming systems research still present in certain research establishments, and to denounce the attempt to bypass it by simply relabeling their crop-focused research as "farming system studies" while remaining mute on the social and cultural variables mentioned above.

Last, but not least, the argument for a stronger sociological perspective on the linkage systems between research and extension rests solidly on the need to increase farmer participation in the design phase and the performance of research and extension programs. The farmer and his needs are the primary and the ultimate justification of both research and extension. The two-way movement within the research-extension-farmer continuum means, in other words, that research can be and has to be driven by farmers' needs, inasmuch as the farmers' practices can be and have to be enriched by research products.

Farmer participation, despite its potentially powerful contribution to research and extension programs, is generally inadequate. To be successful it has to be an iterative process. It is important at all stages: in identifying research needs before new technology is generated, in experimenting with different hypotheses and field-testing results, in conducting demonstrations, and in evaluating acceptability, as well as in elaborating on social, economic, and institutional constraints. Farmer participation is essential for gathering indigenous knowledge and for incorporating time-proven solutions into recommendations of improved technology that is suited to local farm circumstances. The farmer is able to recognize this within-farm variability, which is hardly perceivable to the extension worker, and this can help the selection and adoption of extension service recommendations. Farmers involved in direct participation, in addition to being good cooperators, need to be representative of the various categories of farmers in any area. Both individual contact and group approaches can be used, depending on local conditions, traditions, and so on. Farmer groups, particularly in Indonesia (see Dody Sukaryo in Cernea, Coulter, and Russell 1983) and Thailand, have been shown to elicit better accountability from research and extension staff. They help keep current problems in the spotlight and keep track of what research and extension staff are doing about them.

The question of using farmers as paraprofessionals in research and in extension services, under adequate arrangements, is worthy of study. Another question is whether it might be better to have local people as village extension workers. Although they have little education, they understand the farming system and are willing to live in rural areas. In contrast, more highly educated staff may identify less readily with farmers, are less willing to live in rural areas and may have to be housed at additional expense, but are easier to train as both technicians and communicators. Flexible and creative arrangements may thus open up new forms of participation and increase the immediate effectiveness of the entire research-extension endeavors.

As the present volume will show, there is strong agreement that promoting the role of the farmers in the research-extension two-way continuum would lead to more robust and more readily accepted technologies. Since involving the farmer requires the efforts of, and returns benefits to, both research and extension workers, this endeavor would provide common ground and encourage additional cooperation between the two services.
References


SECTION I
Policy and Institutional Issues

Editors' Note

Although the need for effective linkages between agricultural research and extension is readily recognized, the papers in this section clearly show that this objective has been achieved less often than anticipated or required. Underlying institutional and technical constraints explain the reasons for current performance. Evidence from India is provided by Venkatesan and Jain (chapters 2 and 3), while Baharsjah and Zaman (chapters 4 and 5) bring out similarities and differences in Indonesia and Bangladesh. In the light of these countries' experiences, the reasons for variable performance can be much better appreciated and lessons for alternative solutions can be derived. These lessons are further reflected in chapter 6 by Baxter and Thalwitz.

The papers in this section raise several important issues—at least four on the policy side and three regarding the management of research and extension. On the policy side the discussion centers on:

- The importance of developing clear research and extension strategies within the framework of national agricultural sector policy
- The need for changes in staff attitudes and the incentives for this
- The accountability and effectiveness of each service as a condition for ensuring sustained commitment by policymakers
- The relative merits of research and extension being in the same institution.

Regarding management, the discussion in this section centers on:

- The need to institutionalize linkages between research and extension and how to achieve this
- The degree of acceptable overlap between the two services and the need for joint action in interdisciplinary teams
- The use of feedback mechanisms for improving future seasonal research and extension programs, as well as for framing realistic national policies.

The need for clear national policies regarding the role of research and extension within the framework of the overall strategy for agricultural development is argued extensively in the papers by Venkatesan and Baxter and Thalwitz. A key problem has been the difficulty of demonstrating to policymakers the effectiveness of extension, and even the need for it in some cases. Because of the long lead time necessary to develop and deliver improved technology to farmers and the recurrent costs of maintaining service organizations, which are demanding on both staff and operational funds, acceptance by policymakers has to be not only secured but also maintained.

The policy area also includes complex issues of personnel policies for services that require quite different skills. Cooperation and linkage between research and extension are ultimately a matter of cooperation between two large groups of people, and thus a number of sociological issues have to be recognized and dealt with. The contributors to this section, particularly Baxter and Thalwitz, discuss in some detail the attitudinal issues that arise in establishing cooperation between these services when the research staff is generally recognized as a more professional cadre with better pay, conditions, and status. The papers discuss not only the need to recognize and reward these varying skills, but also how to identify appropriate measures of accountability and effectiveness. Venkatesan's analysis shows that the initial hostility of some researchers to closer collaboration with extension workers can be broken down by the experience of working together and seeing farmers' problems at first hand and the satisfaction of working to resolve them.
Incentives for this have been given in India by a system of special awards to research scientists for resolving specific farmer problems.

Different opinions are expressed in these papers about the institutional or administrative location of research and extension. On the basis of the Indonesian experience, Baharsjah argues that ideally research and extension should be in the same institution, but admits that the sheer size of Indonesia’s population and area to be covered has kept the institutions separate. Baxter and Thalwitz argue, however, that although both research and extension are ultimately concerned with the same objectives, it is better for the two to be in separate institutions because of the advantages of each having a discrete organizational base from which to promote appropriate resource allocation. Since, in most cases, the two services are separate, coordination is vital.

All the papers in this section discuss the management issue of how best to institutionalize effective linkages. There is a consensus here that especially at first these have to be formalized through appropriate committees and a framework for the joint conduct of monthly workshops and adaptive trials by researchers and extension staff. Before a joint approach to developing appropriate extension programs can be introduced, however, research has to generate area-specific recommendations for various agroecological zones. Where all research stations may have been previously oriented toward a single commodity or discipline, a network of regional or rural stations with interdisciplinary teams is needed, as has been set up in India and more recently in Thailand. This brings up the problems connected with the decentralization of research. In India’s case, as Jain’s paper points out, the zonal level of the research network has responsibility for largely defining adaptive research and extension programs. Analyzing the Bangladesh experience, Zaman argues strongly that research decentralization is needed if programs are to become more location-specific and relevant to farmers’ needs. At the same time, excessive overlap or duplication between research and extension is to be avoided. Both Venkatesan and Baharsjah deplore the earlier situation in India and Indonesia, in which research was carrying out its own extension, and vice versa, with no coordination between the two. What has to be achieved, suggest the authors, is an overlap that is jointly undertaken and that includes diagnostic surveys of farmer problems, adaptive research trials, training and feedback workshops, as well as input into the planning of each other’s seasonal programs. There is general agreement that these procedures need to be formalized.

This overall discussion on institutional concerns for improving research-extension linkages is based on the premise that if research and extension programs are to improve farm productivity, they must respond to farmers’ needs. If the programs are to be effective, the farmers must be involved at all stages. Various ways of encouraging farmer participation are discussed in later sections of this volume.
Establishment of the Training and Visit (T&V) system of agricultural extension in India marked the beginning of the "professionalization" of agricultural extension. Before T&V, the village extension worker (VEW; called village-level worker, or VLW, in India) was a multipurpose extensionist entrusted with a range of functions, mostly nonagricultural. There was practically no linkage with agricultural research. Since the introduction of professional extension, linkage with research has become a crucial factor in the successful running of the system.

This chapter gives a brief account of the development of the links between research and extension in India and analyzes the factors that influence the strengthening of this linkage. Although the establishment of a professional extension system in India has certainly created an awareness at all levels, both on the research side and on the extension side, of the importance of such a linkage, experience has shown that such interaction is not easily brought about in practice. It calls for considerable attitudinal adjustment on the part of the research establishment; appropriate changes in the structure of the research setup, particularly at zonal levels (each zone representing an agroclimatic zone) and below; and a recognition both by research and extension workers of the proper role of extension in contributing to the generation of relevant technology. It also requires an appreciation by extension of the role of research, its strengths and limitations. Above all, it calls for a firm commitment at higher administrative and political levels, both central and state, to the concept of professional agricultural extension. That introduction of a professional extension system implies many organizational changes within both research and extension if linkage between them is to be achieved should be clearly understood. This paper shows that, despite these difficulties, such a linkage can be forged and indicates the key organizational and institutional issues that require priority attention.

The Research and Extension Setup before T&V

The history of agricultural research in India is much older than that of professional agricultural extension. The Indian Council of Agricultural Research (ICAR), the apex organization at the central administrative level directing and coordinating all agricultural research activities, celebrated its fiftieth anniversary in 1979. ICAR directly supervises some thirty Central Research Institutes (CRIs). In addition, there are twenty-three State Agricultural Universities (SAUs). Even though these are under the supervisory jurisdiction of the states, ICAR does exercise considerable influence over them, partly because it funds a good proportion of the research and education activities of SAUs and partly because SAUs accept the general leadership role of ICAR. The responsibility for research in almost all the states rests with SAUs. The research work done at the CRIs and SAUs was, until recently, mostly under the umbrella of All-India Coordinated Projects, formulated and funded by the ICAR for different crops and specific problems (for example, dryland agriculture). There are about seventy such projects, and they constitute the main source of funds for the research programs of SAUs. SAUs do not have an appreciable research program outside these projects because the universities depend for such research mostly on funds from state governments, and these are not easily forthcoming. Since 1979, the National Agricultural Research Project (NARP), assisted by the World Bank and administered by the ICAR, has also supported the research programs of SAUs.
The structure of the research setup and the manner of finalization and funding of research programs have in the past tended to encourage research of a general nature, with more emphasis on developing new genetic crop varieties (and a "package of practices" for such varieties) than on adaptation of the "standard" recommended practice to suit varying local farming situations. This, of course, does not detract from the substantial contribution that research has made to Indian agriculture so far. Its contribution to the wheat revolution is now well known. In other crops also, the release of new varieties, composites, and hybrids (for example, of sorghum, maize, pearl millet) has been widely adopted. It is also not correct to presume that research has so far not been responsive to farmers' problems. To cite just one instance, pigeonpea (red gram) farmers have been wanting a short-duration variety, and such a variety has been developed and widely accepted by farmers.

But what needs to be noted is that the structure of the setup and the manner of formulation and funding of research programs are suited to the identification of general problems and prescription of standard solutions of general applicability. Specific farming situations, characterized by agroclimatic as well as other factors (such as farmers' resource endowments and the risk they face and its role in their decisionmaking), cannot be given adequate emphasis unless there is considerable freedom for research stations closer to the field to formulate interdisciplinary research programs. It is important to recognize that, in the evolution of the institutional framework for research, it is inevitable that initially a strong central leadership emerge, that the research establishment throughout the country be guided and coordinated centrally, and that initially research respond, as it ought to, to the need to give the farmer high-yielding varieties of crops. It is necessary, however, to develop local initiative and local research capabilities gradually, through suitable structural changes in the research setup that relate to the location of research stations, the manner of formulating research programs, the manner of funding research, and the degree of flexibility built into the research setup. With an effective extension system, there will be increasing demands on local research scientists, who should in most cases be capable of responding meaningfully. Increasingly, there has been a serious attempt to generate technology that is more specific and more easily adaptable to field situations, and this trend has been endorsed by NARP. Zonal Agricultural Research Stations (ZARSs) set up under NARP are expected to focus on research relevant to the agroclimatic zones in which they are located.

Professional agricultural extension was introduced in India in the mid-1970s but was more extensively developed beginning in 1978–79. Before that, the VLW was intended to provide virtually the entire range of services required for comprehensive development of the village community. Thus, the VLW was a multipurpose worker and in practice could not devote much time to agricultural extension. Despite their preoccupation with multiple responsibilities, VLWs did contribute to the spread of high-yielding crop varieties, particularly of wheat and rice and, in some states (Maharashtra and Gujarat), of hybrid sorghum and pearl millet. They handled the logistics of input supply and very often arranged credit. The major challenge at that time was to bring more and more areas under high-yielding varieties. The extension message was simple and straightforward, and this message was backed by inputs and credit. The arrangement did prove successful, much more so in areas with a long history of irrigation (for example, Punjab and southern Tamil Nadu) and with homogeneous agroclimatic profiles, particularly because the early high-yielding varieties were suited for wide adoption.

The interaction between research and extension was minimal and confined mainly to four areas. First, the VLWs were entrusted with the task of conducting multilocation trials of newly evolved varieties of crops before they were recommended. This task was performed rather perfunctorily, and quite often research scientists themselves had to assess the results of these trials. Release of some varieties in some cases were delayed because the results of multilocation trials were not received. Second, twice every year prior to each major crop-season there was a meeting of all senior staff of the Agriculture Department, addressed by the SAU scientists, in which the recommendations for the season were discussed. Thus, in most states there were only two meetings every year between research and extension workers to discuss the recommendations. Discussions centered mostly around newly released crop varieties and the "package of practices" for them. Third, there was some participation of Agriculture Department staff in finalizing the SAUs' annual research programs. Here again, the interaction could not be meaningful because the departmental staff
themselves did not possess much firsthand knowledge of field situations. In general these meetings were well attended but contributed little toward formulating location-specific research programs. The directors of research of SAUs and the crop specialists of ICAR had the greatest say in deciding what research programs should be taken up. Fourth, SAUs conducted short-term training courses for the staff of the Agriculture Department.

In the absence of a professional extension system to provide the necessary feedback from the field to the research scientists, ICAR initiated several extension-related activities. This innovation was a clear indication that research scientists do require an extension system to transmit their research findings to the farmers, and that the extension system that existed did not fulfill the needs of research. In the absence of professional extension, this innovation was clearly necessary and beneficial. Four main extension-oriented programs are undertaken by SAUs: the Lab to Land Program, Krishi Vigyan Kendras (farmers' schools), National Demonstrations, and the Operations Research Project. It is inevitable that the farmer coverage of these programs could not be extensive. Such programs cannot be replicated widely and still be cost-effective. Their continued relevance after the introduction of the T&V system depends upon the extent to which the feedback gained by the scientists from these programs is used to sharpen extension messages disseminated through the extension system.

While research embarked upon extension-oriented activities, the state departments of agriculture started research-oriented activities. In a few states, adaptive research centers were established as a part of departmental activity. There has thus been some overlapping of functions between the research setup and the extension organization, a heritage passed on to both the reformed extension system (under T&V) and a reformed research setup (NARP).

**Developments since the Introduction of Professional Agricultural Extension**

Two important developments have taken place since the mid-1970s, the first being the introduction of professional agricultural extension in the form of the T&V system of extension, and the second being NARP. The built-in linkage between research and extension in T&V—in the shape of Monthly Workshops, Zonal Workshops, and State Research and Extension Committees—is well known. Under NARP there are also committees, the most important from the point of view of research-extension linkage being the Zonal Research Advisory Committee (ZRAC), on which both research and extension personnel are represented.

One important change that NARP has introduced relates to the manner in which research programs are formulated and funded. In NARP there is a clear recognition of the need for interdisciplinary research in every agroclimatic zone, and this recognition is reflected in the location of the ZARSs. The chief scientist of the ZARS is entrusted with the task of coordinating all research activities in the zone and initiates research programs. There is a greater scope for local initiative in the formulation of research proposals that are then approved by the ICAR. NARP provides a framework and a mechanism that facilitate response to local problems at a particular level.

One area in which there has been considerable expansion of the input of the ICAR institutes and SAUs in increasing the effectiveness of extension is the training of Subject Matter Specialists (SMSs) under the T&V system. The training needs under T&V are indeed vast and increasing. The SMSs in T&V have for many years been out of touch with field problems and technological advances. It has been estimated that annually about 500 SMSs should receive intensive training in various disciplines and in extension methodology. In addition to these intensive training courses, SAUs are expected to organize special short courses so as to cover all SMSs at least once annually. These training programs do provide a forum of interaction between research and extension. Furthermore, because the SMSs are drawn from different states, research scientists do get to know the farming systems in different agroclimatic zones in the country and the research needs of these systems.
Importance of Research-Extension Linkages

The primary objective of both research and extension should be to increase farm productivity and to enhance farm incomes, at least cost to the farmer. To achieve this objective in ways consistent with national priorities, the extension system must feed research workers information about the constraints farmers have experienced in adopting research recommendations, and the research system must have the capacity and readiness to respond with problem-specific recommendations. Research should also seek to obtain direct feedback from the field itself, through field visits undertaken by research scientists, preferably accompanied by extension workers. Quite often farmers, on their own, also pose specific problems to both research and extension personnel. With the introduction of T&V, there is an administrative mechanism, not present earlier, for facilitating the regular flow of information from farmers' fields to researchers. Monthly workshops under T&V provide the forum for such continual information transfer from farmers to extensionists to researchers. Some instances drawn from monthly workshops will illustrate what has been said above.

- **SPV-86** is a composite sorghum that has been propagated by T&V in Maharashtra State since 1982. In one monthly workshop, one of the SMSs brought to the notice of the research scientists that glumes remain attached to the grain after threshing, and that this depresses the price fetched by farmers.

- Thanks to extension, sunflower cultivation has increased in Karnataka and Maharashtra States in the last three years and is now grown on about 500,000 hectares, an almost threefold increase. In one monthly workshop in Maharashtra, the question posed to the research scientists was: Does growing of sunflowers on light and medium soils under rainfed conditions affect soil fertility?

- For rice crop, application of N-P-K fertilizer in the proportion of 100-50-50 kilograms per hectare was recommended "generally" by research, but it was found that there was no response to P and K in certain areas. When this problem was brought to the notice of research scientists in monthly workshops, a more specific recommendation based on soil analysis was given.

- For the control of podborer on pigeonpea, 10 kilograms of BHC 10 percent plus 10 kilograms of Carbaryl 10 percent dust per hectare were generally recommended by research. Many cultivators who adopted this recommendation in one agroclimatic zone where pigeonpea was introduced as a new crop complained of flower shedding. Because local scientists who were told of this by extension staff could not come up with an explanation, the problem was posed to the SAU's main research station.

The examples above illustrate how important it is for research and extension to interact continually, so as to facilitate generation of relevant technology.

Farmers also have many questions about growing a combination of crops. For instance, gram, also known as chickpea (*Cicer arietinum*), is a widely grown rabi (winter) crop in the northern plains of India, but the varieties so far released are to be sown early in October. Thus farmers are unable to sow gram after the harvest of paddy rice, since paddy harvesting cannot be completed by then. In view of the good prices fetched by gram and the higher water requirement for wheat (increasing production of pulses is also a national priority), farmers would prefer a paddy-gram system rather than paddy-wheat except for the above constraint. There is therefore a keenly felt need for a gram variety suitable for late sowing in certain parts of Uttar Pradesh and Bihar. Research on intercropping has pertained mostly to crops grown during monsoon, and that too as a defensive measure in drought-prone regions. There is a demand for suitable intercropping recommendations for the rabi season to increase the overall income of farmers, such as intercropping of gram with safflower in a 2:1 ratio. In the Jayakwadi command area in Maharashtra, many farmers think that pearl millet-wheat is better than sorghum-wheat, but there has been no research recommendation on this pattern that is suitable for local conditions. According to the results of National
Demonstrations, sorghum-wheat rotation is better than pearl millet-wheat. But such general findings do not help to persuade extension workers, much less farmers.

Farmers on their own follow many age-old practices. Many of these practices are not known to researchers, and their validity is not tested. Several such instances have been brought to the notice of researchers by extension staff in the monthly workshops. The following are some examples:

- While growing groundnut, farmers deliberately create moisture-stress conditions when the crop reaches the flowering stage and pod generation. There is a belief that this practice, not in the recommended “package” given by research to extension, increases yields.
- In some areas farmers deliberately trample over irrigated wheat crop by engaging labor when the crop is fifteen to twenty days old. There is a belief that this practice increases tillering.

There is now an opportunity for the researchers to learn from, test, and adapt farmers’ own practices; such adaptations are likely to fit into the farmers' situation better than recommendations emanating from research, and to increase adoption rates. There clearly is a need for more attention to this aspect.

Some Factors Influencing Stronger Research-Extension Linkages

The examples cited thus far show the range of problems that surface with an effective extension system in place and that require a strong research-extension linkage, which is now generally acknowledged as crucial to the success of extension. But in actual practice, linkage is not implemented to an extent commensurate with the general agreement about its necessity. There are many factors that influence this linkage. Unless these factors are analyzed, it is not possible to establish firm and enduring interaction. The linkage should not depend on the chance contact, at the personal level, between the research scientist and the extension worker currently deployed at a place. Rather, linkage should be an integral part of the system. Some factors, external to the research-extension setup that influence the organizational behavior of these establishments are mentioned in the following paragraphs. It is necessary to pay attention to these factors if a proper environment is to be created for the needed organizational changes within research and extension.

India’s past agricultural performance, and the factors mainly responsible for it, generally decide the values placed by policymakers and senior administrators on the type of research and the kind of extension service desired. If, in the past, professional extension did contribute substantially to achieve a breakthrough in production, then there is bound to be a strong commitment to the development of professional extension, including the necessary changes in the research and extension setup, and the establishment of the research-extension linkage can be accomplished without much difficulty. In India, almost 90 percent of the increase in food grain production since the mid-1960s has come through wheat and rice, and the bulk of it from irrigated areas where the conversion of farmers to high-yielding varieties could be achieved under the old extension system, which was backed by logistics (quantity and coverage of inputs). In view of the very crucial role played by management of the logistics of input supply in achieving the initial breakthrough in food grain production, it is generally believed that future sustained increase in production can somehow be brought about by managing the logistics better, without professional agricultural extension. Despite strong commitment of the central administration as well as of some states to professional extension, in many quarters the level of understanding of the role of extension is indeed low, and extension is perceived more as a deliverer of inputs than of technology. Therefore, the first step toward establishing strong research-extension linkage is to improve the overall understanding of the process of agricultural development, and of the role of professional agricultural extension in the context of future challenges. In most developing countries, administrators are not obliged to attend periodical refresher courses to update their knowledge of the changes in agricultural conditions and technology. It is really a problem of public administration management. Until this general problem is tackled, which may take a long time, administrators can be exposed to the problems of modernizing agriculture, and the key role of extension in doing so,
through short films, slide presentations, and simple, readable books. It is equally important to associate the national political system at all levels with extension. The manner and degree of such association will, of course, vary among countries.

On the research side, early successes were largely attributable to superior genetic varieties that emerged from the research stations. The continuing emphasis of research on plant breeding is therefore understandable. There is another reason that scientists are more keen on undertaking research on plant breeding than on soils, for example. It is easier to spread a new and promising crop variety among farmers than a message about how to treat the land for scientific dryland farming. The latter requires a professional extension system, whereas the former—particularly when the varieties are responsive to irrigation, as is often the case—can reach the farmers, at least the progressive ones, provided logistics are taken care of. Thus, the important factors external to the research setup, which largely determine the relative priorities accorded by the research establishment to different disciplines, are the contribution of the different disciplines to the performance of agriculture in the past and the facility of “extendability” of the research findings under a given extension setup. It is quite clear, therefore, that an effective extension system is an essential precondition to the stimulation of research in certain fields.

The extent to which research workers are associated with long-term agricultural planning by development planners and administrators is another important factor. It is necessary for the country’s long-term priorities and research gaps to be clearly identified, and research scientists should be fully involved in this exercise. It is necessary for the scientists to be able to perceive clearly the relevance of their research to the country’s long-term agricultural development. In the absence of such an association, emphasis will continue to be on areas that contributed to the past performance of the agricultural sector. Areas that will be crucial in the future are apt to receive less attention. In the system of awards to scientists for outstanding research work, the relevance of research in meeting future challenges should be an important consideration.

Organizational and Institutional Issues

It is clear from the earlier discussion that the following are the prerequisites for the establishment of meaningful research-extension linkage:

- Extension messages should be based on research conducted in the agroclimatic zone for which they are intended. This obviously implies location of research stations in all agroclimatic zones.
- Even recommendations emerging from such research stations and meant for the specific agroclimatic zone will require further adaptation to suit varying local field conditions. This is particularly true of recommendations for improved soil management, watershed management, fertilizer application, and the like.
- Research trials near farmers’ fields should simulate what takes place on the fields. This entails more emphasis on factors other than technological ones, such as farmers’ resource endowments, risk situations, sociological realities, and the combined effect of these on farmers’ adoption of recommended practices. It calls for increased awareness of the importance of the farming systems approach, particularly at the zonal level and below. But even changing the current emphasis on single crops toward more attention to research on growing a combination of crops is not easily achieved and requires a number of organizational changes. Farming systems research is even more difficult to make operational and calls for a high degree of expertise at local research stations.
- Above all, an effective extension system is needed that is capable of diagnosing field problems and transmitting them to the research establishment.

Thus there should be a two-tier research setup in every agroclimatic zone. The ZARS should have primary responsibility for both basic and applied research relevant to the agroclimatic zone. It should be headed by a scientist of the SAU who also heads the ZRAC. The head of the extension organization of the zone (or, if more than one T&V zone is spanned by the agroclimatic zone, all the T&V zonal officers
concerned) should sit on this committee to ensure linkage at the zonal level. Below the zonal level, there should be a number of adaptive research centers, the exact number determined by the cropped area in the zone and the degree of heterogeneity. In these centers the research recommendations emerging from the ZARS should be modified, if necessary, to suit local conditions. Such adaptive research, quite obviously, will not seek to undertake a basic research program such as plant breeding but will undertake to adapt either a research recommendation or local practice. In adaptive research there should be much greater participation of extension workers. Adaptive research should actually be undertaken jointly by research and extension.

To illustrate what is meant by adaptive research, in Pali District of Rajasthan State in India, about 8,000 hectares of irrigated land was affected by salinity. The agronomist of the local adaptive research farm conducted experiments on placement of seed. He came to the conclusion that salinity from the subsoil rises only to the top of the soil ridges. This made it possible for the farmers to sow the crop on either side of the ridge and not on the top, as was the local practice. The crop thus sown escaped salinity damage. Now all farmers in that area follow the new practice, and even small farmers have taken up multiple cropping. Again, for summer groundnut in Maharashtra, the research recommendation is to irrigate the crop initially every three days. Very few farmers can follow this recommendation in many areas because wells in summer yield insufficient water. Is it possible to obtain a reasonably good crop with fewer applications? What is the crucial timing? Will mulching with sorghum stubbles (from the previous crop on the field) help? These are relevant questions for adaptive research. Trials with different farming systems are an important area of concentration for adaptive research stations.

Whether the research establishment or extension establishment should be in charge of adaptive research is often debated. In India not all states have established adaptive research centers. In Orissa, where such centers have been set up, they are under the control of the Agriculture Department, which runs the T&V system of extension. In Assam, too, where they are called field trial stations, they are run by the Agriculture Department but are closely associated with the SAU (the Joint Director in charge of all the field trial stations has his office in the SAU itself). It is not possible to lay down a hard and fast rule about administrative control of adaptive research. Not all SAUs are strong, and not all state Agriculture Departments are strong. Where the SAU is strong and has a good record of extension work, there is considerable advantage in placing the adaptive research centers under the SAU. First, the scientist who has run an adaptive research center is likely to remain concerned about research being relevant to farmers as he moves up the research hierarchy. This, in due course, will make researchers more extension-oriented. Second, adaptive research centers being linked with SAUs will facilitate upward communication between the centers and the ZARSs. Third, SAUs have more flexibility than government departments in administrative and financial matters. Finally, and most important, ultimately research is responsible for giving not general recommendations, but specific ones that seek to overcome local constraints. This responsibility should not cease at the zonal research stations because that would dilute the accountability of research. There is a third alternative. Adaptive research stations could be placed under the administrative control of the state Agriculture Departments but manned by SAU scientists on deputation. This arrangement combines the advantages of the two earlier alternatives. No matter who actually heads the adaptive research station, it should be clearly understood by both research and extension staffs that adaptive research is a joint exercise.

The effort to generate problem-specific technology does not stop with adaptive research. It is necessary to conduct trials on farmers' fields. The field trials should be carefully planned and monitored. What is more important, their results should be processed and discussed in monthly workshops. Field trials are the most vital link between research and the farmers and bring to light unsuspected constraints in farmers' adoption of technology. To illustrate, the research recommendation for intercropping of pigeonpea with sorghum is to plant two rows of sorghum and one row of pigeonpea. In field trials farmers experienced difficulty in harvesting sorghum and transporting it in bullock carts. The recommendation was then modified to planting of four rows of sorghum with two rows of pigeonpea.
Conducting field trials, in which researchers participate, is the primary responsibility of extension staff, just as adaptive research, conducted in adaptive research stations and in which extension staff participate, was mentioned earlier as the primary responsibility of research staff. It is expected that SMSs visit the field trial plots regularly. One factor that often acts as a serious constraint to farmers' adoption of recommendations is the farmers' resource endowments. Quite often research does not give this factor adequate weight. In the conduct of field trials SMSs should select some resource-poor farmers and examine the extent to which they are able to adopt the recommended practices.

The upward linkage of SARs is with the SAU's main campus station as well as with national research projects. The organization of research at the national level largely determines the extent to which interdisciplinary research is undertaken at the ZARSs. Although there is merit in having some research programs, such as crop-oriented research, guided and coordinated at the national level, the desirability of such an approach in all areas requires closer scrutiny. For instance, problems of salinity and alkalinity are to be addressed in conjunction with the growing (or not growing) of certain crops and a range of agronomic practices. Technology for rainfed farming is not one technology but really an approach comprising a range of technologies that vary markedly with agroclimatic conditions. There are thus many areas of agricultural research where central direction and coordination will not be helpful. In the Indian context, starting an All-India Coordinated Project tends to create compartmentalization of research at the state level too. This specialization may impede interdisciplinary and farming systems research at the ZARSs. It is therefore necessary to identify problems for which basic research, with central guidance and coordination, is necessary. For other problems, emphasis should be on training SAU scientists in research methodology in central institutes to enable them to undertake interdisciplinary research in ZARSs.

Establishment of research-extension linkage requires many adjustments within the extension organization as well. The key functionary in the T&V system is the SMS. He is the link between field extension workers and researchers. Quite often SMSs lack the necessary orientation—particularly when, as in India, the T&V system has been established by pooling staff from existing schemes with a focus on subsidy administration. SMSs are basically extension agents and are not trained in research. They should specialize in extension and remain with extension. Their strength lies in their capability to diagnose problems, to understand farmers' constraints, and to tell researchers what recommendations can be adopted by farmers and what difficulties farmers are likely to encounter. Therefore, the key to successfully forging research-extension linkage is SMS training, not only in the particular subject matter discipline but also in extension methodology.

Monthly workshops bring research and extension together. But these workshops are only slowly being regarded as an effective mechanism for establishing research-extension interaction and as a forum for SMSs to focus research on local problems. Research scientists think that these workshops are for training SMSs and giving them recommendations, and SMSs are disappointed when they find that the recommendations do not contain anything that is not already available in printed literature. In Maharashtra State, initially there were many difficulties in making such workshops fruitful. These problems were mostly the result of a certain lack of understanding of their role on the part of SMSs and a general lack of sympathy toward the research scientist. Certainly the research scientist who handles the monthly workshops has his limitations. Apart from being new to the system, he quite often does not head a research station and lacks the full support of senior SAU scientists. It is therefore necessary to ensure that:

- Monthly workshops are held at ZARS (or some other appropriate research station if necessary)
- The head of the research station coordinates and leads the monthly workshop in conjunction with his senior extension counterpart
- Senior SAU scientists invariably attend these workshops as resource persons
- Both research and extension clearly understand the real purpose of these workshops and their role in stimulating upward communication.

The existing mechanisms to forge research-extension linkage in the T&V system, apart from monthly workshops, are mostly built around committees at various levels. On the research side, too, zonal
committees (ZRACs) are set up under NARP. But their overall contribution to strengthening research-extension linkage is still not appreciable. This problem was a subject of discussion recently at a national seminar in New Delhi (Government of India, National Seminar on Professional Agricultural Extension, New Delhi, February 9–10, 1984) in which both research and extension personnel took part. Similar seminars have also been organized in some states. The very fact that research and extension are impelled to come together to discuss this issue is encouraging, but it also shows that there is dissatisfaction on both sides about the present contribution of these committees. Some suggestions that have emerged from these deliberations are given below.

- In the initial stages of the T&V system, the head of the state extension system as well as the SAU directors of extension and research should attend the meetings of zonal committees.
- There should be a formal agenda for such meetings. The first item should be the discussion of the problems posed by SMSs and the action taken by the SAU to solve them. In Maharashtra State, this practice was started at the state committee, and it did catalyze more effective two-way communication, even at the zonal level (where the feedback received from the extension system and the action taken by the SAU are regularly recorded). Some other states have also devised procedures to stimulate such upward communication.
- The district committees should regularly submit to the zonal committees a report describing action taken at the district level through adaptive research, and action suggested at the zonal level for research at ZARSs, on the problems posed by SMSs.
- SMSs should submit to the district committees a report on the adoption of recommendations by farmers.
- The follow-up action by research on the problems posed by extension should be reviewed both at zonal and state levels.
- Diagnostic teams comprising zonal level research and extension staff should be formed to visit farmers' fields periodically to diagnose farm-level constraints.

It is often mentioned that SAUs are slow in responding to the problems posed by extension, particularly now that the flow of information from farmers' fields to researchers has increased through the T&V system. It is necessary to analyze the reasons for this and the institutional factors responsible. Funding of research and the manner of formulating research programs require closer examination in this context. As mentioned earlier, in India most of the SAU research projects are funded either through All-India Coordinated Projects or, since 1979–80, through NARP. Many problems posed by extension cannot be fit into the funding pattern of these projects. Outside these projects, SAU funds are limited. Providing every ZARS with a separate channel of funding to take care of a wide range of research programs that obviously cannot be fit into the existing straightjacket is an alternative which should be explored. Many SAU scientists support this proposal, but, again, such an arrangement may delay the restructuring of research at the national and state levels to make it less discipline-oriented and more interdisciplinary.

The present manner of formulating research programs has remained more or less unchanged since the period before T&V. The input of extension in their formulation is minimal. As a first step, the communication between the extension and research wings within the SAU needs to be strengthened. The ZRAC should be given considerable freedom to formulate research programs for its zone, including programs for adaptive research stations in the zone.

Without strong national central direction and coordination, a professional extension system cannot take deep roots in the states. In India, there is strong central support to extension, and the nationwide "umbrella" projects channel funds to the states for strengthening the extension system. But there is as yet no formal research-extension linkage at the central level. One of the recommendations at the national seminar in New Delhi was that there should be a high-level, national coordination committee at the central level headed by the Union Minister for Agriculture and comprising representatives of the Ministry of Agriculture, ICAR, and the Ministry of Rural Development. This recommendation deserves serious consideration.
Some Broader Issues

The linkage between research and extension described in this chapter is only the first stage in a continuing process. But, in a broader sense, the concept of this linkage extends beyond researchers' communicating recommendations to extension workers, extension workers' taking back to research the field problems of farmers, and the research scientists' trying to solve those problems. The process of agricultural development cannot be fit into this simple model.

All the same, linkage in this model is a good starting point. As the reformed extension system becomes established and the first generation of problems (such as filling the positions, training the SMSs and the field extension staff, and getting the dynamics of the T&V system operational) are adequately tackled, attention should be given to the second generation of issues. These issues relate to the larger role that extension must play in the context of national priorities for agricultural development, a responsibility resting equally on both research and extension.

To fulfill this larger role, both research and extension should be involved with planning for agricultural development right from the beginning. If, for instance, rainfed farming and increasing oilseed production are national priorities, research and extension should prepare a joint strategy. At the micro level (that is, in each agroclimatic zone) there should be a joint action plan, based on a baseline survey of the existing situation and the direction in which both research and extension should move. This joint action plan can focus, for instance, on bringing more area under oilseeds (by diverting areas away from less economical crops) or on propagating intercropping.

Funnelling down national priorities through the research and extension systems does not mean that uneconomical messages are relayed to farmers. In a positive sense, it implies that research work is intensified in those priority areas, so that any farm-level diseconomies are overcome. In Maharashtra State, it was decided at the policymaking level that oilseed production should be increased. Both research and extension agreed on a strategy that would not contradict the farmers' economic realities. One element of this strategy was to persuade the farmers that unirrigated wheat is less economical than safflower. In selected areas this message was conveyed. This is an example of how it is possible to achieve the twin objectives of meeting national priorities while at the same time increasing farmers' incomes.

In this larger sense, research and extension are jointly responsible for agricultural planning. There are obvious advantages in involving research right from the start of the planning stage. All the subsequent steps (formulation of the research program, formulation of extension messages, identification of farm-level problems, on-farm validation of recommendations, and adaptation of recommendations emanating from research stations to varying field situations) are then jointly undertaken, with either research or extension having the lead role.

Quite obviously, it is not easy to establish such a close linkage, although it should be the next and inevitable stage in the process of agricultural development. Even the establishment of the linkage in the much narrower sense described earlier requires tackling many of the organizational issues described. There are a few other issues as well, and these are crucial to strengthening linkage in the context of the second generation of issues confronting the system.

These issues relate to the pay and status of the scientists in charge of ZARSs (as well as those of SMSs), the creation of a special cadre within the T&V system for SMSs, the requirement that SAU scientists put in a stint as SMSs before their promotion to higher research levels, equipping the ZARSs with vehicles and training aids, and bringing about effective linkage of T&V with soil conservation organization, particularly in rainfed areas. Addressing all these relevant concerns would contribute to the strengthening of research-extension linkage as the T&V system enters a new area. What is important is to realize that forging this linkage for the future is not easy and cannot be achieved through simple devices such as setting up committees unless a problem is reviewed in its totality and all the relevant, systemic factors analyzed.
Constraints on Research-Extension Linkages in India

T. C. Jain

This paper makes an effort to analyze some of the major constraints on the effective establishment of research-extension linkages in India. Some of the crucial issues that deserve attention and debate are:

- The lack of an effective role of the Department of Agriculture (DOA) in identifying the specific production problems of a zone
- The ineffective utilization of the opportunities for getting feedback through programs (such as those for the transfer of technology or the training of subject matter specialists), which are implemented by scientists
- The gap between the technology generated and that being accepted by farmers, which has to be bridged by developing stronger links between scientists and officials of the DOA in large-scale testing and demonstration of the generated technology
- The lack of formal links between research and extension activities, which need to be supplemented by frequent joint visits and informal discussions on farmers' fields.

The Research Network and Policy Issues

Agricultural research in India is served through thirty-five central institutes, five project directorates, three national centers of the Indian Council of Agricultural Research (ICAR), and twenty-three agricultural universities. The ICAR also operates front-line extension programs such as operational research projects, national demonstrations, and the Lab to Land Program.

Emphasis has lately been shifted from centralized research to location-specific research through the implementation of the National Agricultural Research Project (NARP) that started in January 1979 with financial assistance from the World Bank. This project is designed to encourage agricultural universities to conduct location-specific research based on needs in 116 agroclimatic zones that have been identified. It provides financing to strengthen the research resources of the universities to meet the requirements of the sixteen major states. This project also promotes stronger linkages between research conducted by university-based scientists and the extension activities supervised by the DOA. There is definite progress in the direction, but implementation is still slow since it involves basic changes in the attitudes, behavior, and perceptions of both scientists and extension workers.

Historically, the first important step in the development of Indian agriculture was the establishment of agricultural universities in seven states (Punjab, Pantnagar, Orissa, Rajasthan, Andhra Pradesh, Madhya Pradesh, and Karnataka) in 1960–65. The Education Commission (1964–66) then recommended that every state have at least one, and in 1978 a comprehensive review by the Randhawa Committee critically assessed the growth and development of agricultural universities in India.

In the late 1970s, it was realized that the growth and development of agricultural universities concentrated mainly on institutional infrastructure and on the strengthening of education programs on the main campuses. The universities had a broad mandate for education and research, but had few or no facilities for generating relevant technology at their outlying research stations.

With the recognition that agricultural research should be location specific, the establishment of strong multidisciplinary research stations was considered essential to meet the specific research requirements of
different agroclimatic situations. This was the only way to carry out the mandate of state agricultural universities to develop need-based technology.

ICAR took the important step of launching the NARP in 1979, with the main objective of strengthening the regional research capabilities of the universities. The project is intended to implement a number of organizational changes that express the current policy in India for developing agricultural research. The project is funded by ICAR, and the financial assistance received from the International Development Association of the World Bank amounts to about 50 percent of the expenditure.

Four main features regarding the objectives of the NARP are relevant here:

- State agricultural universities are responsible for meeting all the research needs of each state. Location-specific research is to be conducted at the regional research stations and other supporting stations identified in each agroclimatic zone, and these zones should be the functional units for management of research in each state.

- Research should be not only location-specific but also based on needs, with appropriate priorities, and multidisciplinary.

- The various research resources in a zone should be completely integrated under the overall supervision of the associate director of research at the regional research station.

- Stronger linkages will be instituted organizationally between research staff of the university, officials of the Department of Agriculture, and farmers in the area.

Developing Linkage Mechanisms

Since the last of these four features requires institutional development and good organizational mechanisms, it may be worth outlining in detail how these linkages are forged in India as part of the regular activities of the research units.

Seasonal zonal workshops are held twice a year before kharif (the rainy season) and rabi (the winter season). These are attended by the research scientists, senior officials of the Department of Agriculture, and farmers' representatives. The immediate research problems are identified, the whole research program is reviewed, and recommendations for field testing and for the transfer of technology to the farmers are finalized. These workshops have proved to be an effective mechanism for building research-extension linkages.

The research station conducts field tests in two or three selected villages to determine whether the technology that has been developed at the station is viable in the farmers' fields. These tests also provide an opportunity for the scientists to gain a better understanding of the problems of the farmers and to plan their research programs accordingly.

An agronomist and an agricultural economist are usually assigned to the regional research station to collaborate with the DOA officials in the design, supervision, execution, and analysis of the field testing conducted by the university scientists or the DOA.

Under the training and visit (T&V) system, the subject matter specialists (SMSs) are trained by the university research scientists in monthly workshops. The research stations established and strengthened under the NARP are used for these programs. They provide an excellent opportunity for research scientists to come in contact with the specialists who are in close, frequent contact with farmers.

Research reviews have been completed for twenty-two agricultural universities in sixteen Indian states (the review of the university in Jammu and Kashmir has not yet been completed). On the basis of these reviews, the country has been divided into 116 agroclimatic zones. Each zone is a contiguous area of fairly homogeneous agroclimatic conditions. It is served by a multidisciplinary regional research station and some supporting stations, the number of which depends on the size of the zone and the heterogeneity of agricultural practices at the microlevel. Specific research subprojects for 67 zones have already been sanctioned. It is proposed to cover about a hundred zones by the end of 1985.
A continuous effort is being carried out to link the NARP and the T&V extension system of the DOA. To make research results relevant to the needs of farmers, the specific role of agricultural economists in the research system was discussed in detail in a workshop held in May 1983, and the recommendations have been circulated to the universities for necessary action. The economist should help the biological scientists identify constraints on production and the adoption of technology. He must also collaborate with the biological scientists in the economic analysis of the research results. Since this is a new approach, continuous efforts are necessary to orient scientists, as well as the development agencies, toward the concepts articulated by the NARP.

Transfer of Technology

In addition to generating new technologies through agricultural research, ICAR sponsors extension programs to transfer the technology to farmers. These programs also provide excellent opportunities for interaction between research and extension workers. They include national demonstrations, operational research projects, Krishi Vigyan Kendras (Farm Science Centers), and Lab to Land programs.

The National Demonstration Project is being implemented in forty-seven selected districts in the country. About 2,500 field demonstrations are conducted every year by agricultural scientists in farmers' fields to show the production potential of important crops.

Fifty-nine operational research projects are being operated by scientists. They tackle community-based agricultural problems through improved technology and identify the constraints against the rapid diffusion of agricultural technology. The major technologies offered in these projects are for integrated pest management, reclamation of saline soils, mixed-farming crop improvement, fisheries, plantation crops, water management, dryland agriculture, and postharvest needs.

To improve the educational component of agricultural extension, ICAR has introduced an innovative vocational training institution called Krishi Vigyan Kendra. There are sixty-two Kendras in operation, supported by universities, ICAR institutes, and voluntary organizations. The centers offer skill training to farmers, farm women, school dropouts, rural youths, and field-level extension functionaries. The courses are organized on the principle of learning by doing and vary in length from one day to a few weeks, depending on the type of course. Short-term skill courses are usually preferred.

The Lab to Land Program has 139 centers throughout the country and supports about 75,000 small and marginal farmers and landless agricultural laborers. The major thrust of the program is to increase the income of small farmers through low-cost technology and to provide the landless with additional opportunities for self-employment such as by rearing milch animals and poultry farming.

Difficulties and Weaknesses

The implementation of the NARP by the state agricultural universities has provided an excellent opportunity to develop not only the facilities for conducting research but also fresh approaches to make the research more relevant to the needs of farmers. Identifying the constraints on production, in consultation with the DOA and the farmers of the region, and formulating a research program based on the problems identified are integral parts of this project. At present, the NARP is implemented in almost all the Indian states, and the T&V system in thirteen states. Other activities to promote research, extension, and the transfer of technology are carried out by ICAR and the DOA, as described above.

Despite all these efforts, however, research and extension linkages are still quite weak in India for three main reasons:

* Scientists at the agricultural universities and officials of the DOA are reluctant to accept changes in concepts and procedures.
Although the programs of the DOA and the universities bring officials and scientists together, they often have no real involvement with or appreciation for each other.

Although the physical infrastructure may be built up at the regional level, decentralization of the administration and management of research and extension is a slow process because of insufficient institutional freedom, competency, and will.

Some states in India have done remarkably well, but the large part of the country has yet to begin the swift implementation of the NARP projects. Some questions that need urgent consideration are: Who should say that the technology is relevant? What criteria should be used? What specific steps should be taken for the effective transfer of technology developed by agricultural universities?

The technology is relevant when it is adopted by the farmers. So it is the farmers who, by adopting a technology jointly monitored by the scientists and the DOA, say whether it is relevant. These are intermediary steps between the generation of the technology by the universities and the extension of it to large numbers of farmers by the DOA. Though these steps have been indirectly dealt with to some extent in NARP, there is still a need to identify specific responsibilities and to develop suitable procedures to bridge the long-felt gap between the development of technology and its acceptance by farmers. Two intermediate steps need to be added with responsibilities for both scientists and extension workers.

The first step is the on-farm testing of technology, which should be the major responsibility of the university scientists in consultation with the DOA, which is the agency ultimately responsible for the transfer of technology to the farmers. Such programs should provide a forum not only for testing but also for training and demonstration. Second, once the technology is tested and perfected, demonstrations on a wide scale should be the responsibility of the DOA, under the technical guidance of university scientists.

The collaborative role of agricultural economists and rural sociologists in planning and implementing technical programs needs to be strengthened so that the technology developed is economically viable and acceptable to farmers. This need has frequently been discussed, but in practice it has still to be met.

The zonal concept should effectively be implemented by identifying within the DOA a counterpart to the associate director of research at the regional level. This counterpart should be at the level of joint director or senior joint director and should be responsible for all liaison between the DOA and the research and transfer of technology programs of the zone. The zonal research workshop should be used as a forum to discuss not only the research programs of the university but also the extension program of the DOA. In other words, a zone should be taken as the functional unit of research and transfer of technology activities related directly or indirectly to agriculture.

The responsibility for some of the training (especially that of the subject matter specialists) under the T&V extension system has been assigned to the agricultural universities, but corresponding facilities have not been provided under the NARP or under extension projects. The monthly training of SMSs is a new mechanism but is not likely to be effective unless essential training is provided to the master trainers (university scientists). Frequent interaction between the master trainers and the other university scientists can be encouraged under the T&V system in the monthly and fortnightly training workshops under the T&V system. This can be achieved more easily by organizing SMS training at the research stations. Visits to field experiments should also form a part of this training program.

In view of the specific responsibilities of the agricultural universities, there is a need to reorient the role of ICAR institutes in India so that the research programs will complement each other. In addition to meeting the needs of the specific area in which they are located, ICAR institutes can play a very important role in providing specialized training to the university scientists and in conducting fundamental research of national importance.

Though limited, certain field activities are often implemented by the ICAR institutes and the universities without the presence of village extension workers or other extension staff, who are actually transferring technology at the grass-roots level. All such activities of the ICAR institutes and the universities should be arranged to complement the efforts of the extension staff in that area rather than compete with them (as has
been observed in some states). Thus the village extension worker should be involved in conducting all field-based activities in his area.

In the various efforts being made in India to link research and extension activities, the direction seems to be correct, but implementation is slow. This is due to the slowness of university scientists and DOA officials to accept the proposed changes.

Even if the infrastructure facilities are developed and scientists are appointed, five years is too short a time for the system to have an impact and become effective. Other important components, such as academic freedom and an appreciation of the specific regional problems, take a longer time to develop.

The various research efforts of the central organization at ICAR and of the universities need to be integrated with the work of various local agencies for the transfer of technology. Identifying the agroclimatic zones in each state provides an excellent opportunity for such coordination. All the programs for research and technology transfer can be fully integrated if the zone is taken as the functional unit. Further strengthening of the NARP and of the extension projects will provide more effective research-extension linkages, which in turn should help accelerate agricultural production in India.
Improving Research-Extension Linkages: The Indonesian Experience

Sjarifuddin Baharsjah

In the ideal situation, the link between research and extension is strong, with scientists and extension agents cooperating at all levels and working together to conduct the on-farm trials. Researchers must know what is occurring at the farm level in order to formulate valid and useful questions for their research. They must be aware of not only the biotic and physical environment in which farmers work, but also the economic, sociological, and cultural context in which rural people produce and market. Only if they are intimately acquainted with the genuine rural situation can they develop appropriate technologies and respond to the technical, social, and economic problems confronting the farmers.

Yet, how can a limited number of scientists be aware of the many problems of agriculture in a vast country such as Indonesia? Obviously, the extension service, which has agents in close contact with farmers throughout the country, must assist in communicating these problems to the scientists and advising them on the most important problems. Once the scientists have selected the most relevant issues, they must learn as much about the problem as possible and then formulate their research projects in such a way that the results will be appropriate for the various agroclimatic zones.

When the results have been tested in the farmers' fields, then the extension agents must be able to disseminate it to the farmers. This requires a system with agents capable of understanding the research process, knowing the limits to the research, and communicating on a professional level with the researchers. Thus, there must be an intimate professional link between extension and research.

The Ideal Model

Although there may be a number of variations, it seems there are two basic models for research and extension systems. In the first, research and extension are in the same institution. In the United States, these two functions are found in the land grant universities, where specialists often have both a research and an extension assignment. They may also teach in the faculty of agriculture. This system assumes that the farmers are well educated, have good communication facilities, are relatively few in number with large holdings, and are supported by a viable commercial sector that provides them with inputs and knowledge.

In the second model, the research and extension institutions are separate because of the nature of the agricultural sector, the number of people, and the traditions of the country. When, as in Indonesia, many small farmers are scattered over a vast area with relatively underdeveloped communications, it is difficult for one massive organization to provide all the necessary services. This separation between the scientists and the extension agents must be bridged by various linkages.

When research and extension are separate, it becomes even more important to transform research results into terms that the extension agents can understand. The linkage between them is a two-way communication from the farmers to the extension agents to the researchers and then from the researchers to the extension agents to the farmers. Communication among the three different groups requires an understanding of the needs and levels of education of all three.

To promote agricultural development, information must reach the farm level in a usable form. Researchers traditionally are not the best equipped to transform their results into a form understandable to the farmers. Therefore, a major role of extension agents is to translate this information into culturally usable recommendations, adapted to the farmers' level of understanding and resources.
The Indonesian Research and Extension Situation

The Ministry of Agriculture is responsible for planning, implementing, monitoring, and evaluating agricultural development programs and policies in Indonesia. The main objectives of these programs are to increase agricultural output, to improve farm income, and to contribute to capital formation. The ministry has a number of subunits: the directorates, the Agency for Agricultural Research and Development (AARD), the Agency for Agricultural Education, Training, and Extension (AAETE), the secretariat, and the Inspectorate General. The ministry has regional offices with coordinating responsibilities, and in the provinces, districts, and subdistricts there are Regional Agricultural Services under the provincial governments, which have close links with the directorates.

In this structure there are four directorates with separate responsibilities: food crops, animal husbandry, fisheries, and estate crops. There are also four possible Regional Agricultural Services. Thus, if a farmer has several activities, including a fishery and livestock, he would have to obtain information by consulting with possibly four extension agents in different offices, each representing a specific subsector. This may often create great difficulties and impede the farmer's search for the necessary technical advice. Furthermore, if the farmer wants to participate in an intensification program, which usually provides credit, he must contact several other officials representing these subsectors of agriculture.

The Agency for Agricultural Research and Development has a number of research institutes based on the subsectors and agroecological zones. In addition, the AARD has two research centers for cross-commodity and cross-sectoral analysis and two centers to provide services to researchers. Although the AARD does not have an institute in every province, it does attempt to represent all of the agroecological zones in the country. In this way the research results can be utilized throughout Indonesia.

Most of the AARD's research institutes and centers are assigned to do on-farm research. Because of a lack of resources, however, these institutes find it difficult to conduct a sufficient number of on-farm research projects. This means that not all scientists and administrators have close contact with the farmers, and their response to the farmers' needs and problems is relatively slow. In addition, the information and technologies generated by the institutes may take a roundabout route to reach the farmers.

The Agency for Agricultural Education, Training and Extension has a number of Agricultural Information Centers (BIPs) and will gradually establish one in each province. At the district level, the AAETE has Institutes for Agricultural Extension (BPPs), which are home bases for the extension field workers.

The role of the BIP is to gather information from the research institutes and distribute it to the BPPs. The BIP transforms this agricultural information into a form that can be understood by the farmers and the general public. The BPP collects information from the farmers on their problems and needs and passes it along to the research institutes. It also provides a common meeting place for the various extension field staff and AAETE staff.

The Regional Agricultural Services transmit information and new technologies to the farmers and manage the demonstration plots at the farm level. Since the services are organized by subsector (food crops, estate crops, fisheries, and animal husbandry), in each subdistrict it is possible to have four Regional Agricultural Services giving assistance to the farmers. These services obtain research results through the BIP, BPP, and the research centers and institutes.

The Separation of Research and Extension

Indonesia has made considerable progress in rural development during the past fifteen years. Research and extension have made important contributions to this advance, despite the separation of the two, which is far from an ideal situation. A number of factors explain this separation, however, and made it unavoidable, at least for a period.
The main reason is that Indonesia lacks the communication facilities found in a country like the United States. Most of the country's villages do have radio and television, but there are few telephones and publications to assist in the dissemination of information. Few of the farmers have their own cars, and some of the islands do not have all-weather roads connecting the farmers' houses to the rural towns.

The range of commodities covered in the research and extension efforts may be substantially greater than in more developed countries that have a viable private sector servicing large farmers. The institutions of the Ministry of Agriculture must cover food crops, animal husbandry, fisheries, estate crops, and industrial crops (and until recently forestry too). They must service both the large commercial firms and the subsistence farmers, as well as the wide range of operations in between these two extremes.

The Indonesian archipelago stretches many hundreds of miles and consists of thousands of islands, with many different cultures and agroecological conditions. The country has multiple, very different farming systems that require differentiated services from scientists and extension agents. This regional variation is another reason that research and extension have traditionally been separated in Indonesia.

In summary, because of the extent of this country, the lack of communications, the commodities involved, and the variations that exist, it appeared necessary to the Ministry of Agriculture to have two sets of institutions. The ministry is aware, however, that it does create a communication gap that needs to be bridged.

Notwithstanding the extenuating circumstances, it is felt that for a long time there has been insufficient concentration on policy and organizational linkages between research and extension. Several factors explain why these linkages were not given more attention. First, the main emphasis was on food crops, whereas the other activities—especially smallholder estate crops, animal husbandry and fisheries—were somewhat neglected. Second, most of the ministry's efforts were based on a short-run approach to problem solving. As a result, research received insufficient emphasis and was focused primarily on rice. To have a real impact on development, however, research and extension must be organized for the long run. A concentrated effort is needed over a long period to solve the research issues and to disseminate information as widely as possible.

A third factor is that the ministry was organized mainly on the basis of the subsectors, and the chief objective of the departments was expanding production. This tended to reduce even more the emphasis on long-term research. Fourth, each subsector department until 1975 had research, extension, education, and development projects within its own organization. Thus, each directorate had research and extension institutions that were separated from their counterparts in the other directorates. Compounding this fragmentation and lack of joint effort, each research unit did not have a sufficient number of experienced scientists nor were the scientists in contact with their counterparts in the other institutions.

Reorganization of the Ministry of Agriculture

In 1974–75 the Ministry of Agriculture was reorganized in response to the need to establish more effective research and extension networks. Two separate agencies were created. The Agency for Agricultural Research and Development was established within the ministry in 1974 as a result of an increased emphasis on the role of science and technology to support the large and vital agricultural sector. The Agency for Agricultural Education, Training, and Extension was created, also within the ministry, to concentrate the government's resources on extension to help the nation's farmers use research results.

Through this reorganization, it was recognized that research and extension require more than a short-run concentration on immediate problems. Institutions were needed that would develop a cadre of well-trained staff, supported by sufficient facilities, and with access to funds for research and extension activities over a long period.

Before the reorganization, researchers and extension experts had been scattered throughout the various directorates and had little contact with each other. For research and extension to be effective, it is necessary
to create a critical mass of experts who can work together, support each other, stimulate research, and share experiences. The reorganization made it possible to begin establishing this critical mass.

Probably even more than research, extension requires a continuous effort in the same locations for a long time. Farmers need many and varied types of assistance, preferably from one source, which was difficult to provide when the field extension agents were separated by subsectors. With the reorganization, the AAETE is able to develop a more stable and integrated approach to extension.

In the beginning, the AARD faced a gigantic organizational task with a very limited base of trained manpower—only 211 active research scientists. Substantial progress has been made to improve this situation during the past nine years. Many who have received advanced degrees in Indonesian universities and abroad returned to AARD and many more are now in various training programs.

Major programs are under way to establish new and expanded research facilities for the researchers at many sites. Training programs for both the short and long term have for a number of years been raising the level of expertise at all of the institutes, stations, and experimental farms. Major efforts have been launched to procure the necessary equipment for these research facilities.

**AARD’s Institutions and the National Mandates**

In May 1983 a presidential decree changed some of the functions of the central research institutes and consolidated some programs into new units. The individual institutes where the research programs are actually implemented will now have more authority to establish their own programs and handle more of the budgeting and supervisory responsibilities in their day-to-day operations. Each research institute has been given a mandate to become a center of excellence in a particular commodity area and will serve as a national reference point for that area. For instance, the Maros Research Institute for Food Crops will now become the national center for research on food crops in dry upland areas. This will not be the only site for this kind of research; other institutes will participate, and various experiment stations and laboratories will help support the total research program. Scientists stationed at Maros will take the lead, however, in establishing research priorities on food crops research in dry upland areas.

Under the first and second development plans, agricultural research gave more attention to wet rice, rubber, and oil palm. Under the third development plan, increasing attention has been given to secondary food crops, upland rice, mixed-cropping patterns, intercropping of coconuts and rubber, forestry, livestock, fisheries, processing of agricultural products, and agroeconomics. In addition, priority has been given to location-specific problems of different soil and climatic conditions, especially for food crops, instead of trying to develop varieties and practices suitable for all of Indonesia.

Since the mandates are based on agroclimatic and agroecological factors, the research networks do not actually have to locate stations in every province. This makes it possible for AARD to concentrate its resources in these zones rather than try to follow administrative boundaries. Thus, all of Indonesia is covered by this network of research institutes in AARD.

**AAETE’s Institutions and Administrative Boundaries**

In contrast to AARD, AAETE’s institutions correspond to governmental administrative boundaries. The Agricultural Information Centers (BIPs) are set up on provincial lines; the Institutes for Agricultural Extension (BPPs) are based on district boundaries, and the rural extension centers are based on subdistrict boundaries. Thus, extension and research are organized differently, and these differences must be taken into account when considering linkages.

1. As of October 1983, there were on the job 78 staff members with a Ph.D., 283 staff with an M.Sc., and 1,235 with Sarjana degrees (equivalent to an M.Sc.). At the same time, 119 staff were in Ph.D. programs, 240 in M.Sc. programs, and 13 in Sarjana programs and were expected to return to AARD in the near future.
Policy and Institutional Issues

Since land is becoming limited in supply, agriculture is experiencing a transition from a resource-based to a scientific-based sector. Growth in agricultural output is increasingly based on improved technologies. Consequently, the capacity to develop and to manage technology in accordance with the country's resource endowment is one of the most important determinants of the growth of agricultural production. This capacity includes the ability to organize and to sustain the institutions that generate and transmit scientific and technical knowledge to the farmers.

At present in Indonesia three sets of agencies are responsible for the technological improvement of agriculture. The AARD is responsible for technological innovation and development; the AAETE is responsible for staff development and the formulation of extension policies and programs; and the Directorates General have extension units responsible for transmitting technologies to the farmers. These three units have overlapping activities in research and extension. The AAETE and the directorates, in response to the problems they encounter, at times carry out research. The AAETE and the directorates both have an extension role, and the AARD at times has contact with the farmers. Therefore, steps must be taken to define more clearly the role of extension and research in each agency and to promote closer cooperation. Instead of each agency trying to do its own research and extension, the units need to be linked together.

The problem facing the AARD is how to maintain the researchers' awareness of the needs at the farm level. If the AARD does not have an extension component, it needs some other way of getting a constant flow of information on the agricultural situation to its researchers. One solution is for the researchers to conduct farm-level research, and this close contact with a few farmers could be supplemented by frequent meetings with the extension agents in the field and at the office. If the representatives of the research institutes are not reaching the farm level, they will not know the central questions for research that will make an impact at the farm level.

Because several separate extension units have the responsibility of extending information to the farmers, care must be taken so that farmers are not confused by conflicting advice from different agents. It is very important to develop an integrated approach to extension so that the farmers will receive consistent information from a single source.

The Indonesian Response: Research and Extension Linkages

The main issues in the linkage between research and extension are how and with what mechanisms to communicate the research results to the respective users and how and with what mechanisms to transmit users' needs and problems to the research institutes. This must be accomplished as effectively and efficiently as possible, in a relatively short time, and at the lowest possible cost in manpower and funds.

In response to the situation described above, Indonesia has tried to improve the research and extension linkages of the three agencies. Some of the steps listed below have already been taken; others are expected to be implemented in the near future:

- Meetings are held at all levels between research and extension personnel; they include consultations among the heads of both agencies and directorates to exchange information for the formulation of the development program, working meetings between the second echelon units of the agencies and the directorates to discuss research results and the development problems which need solutions, and research committee meetings to obtain feedback on the research program from the extension agency and the directorates.
- Regional consultations provide the regional leaders and the universities with information on the program and research results and give research units feedback on the entire regional development program.
• Each research institute sponsors an annual field day to give research results to the leaders of development programs, extension personnel, contact farmers, and other interested persons, and at the same time to obtain feedback from these people on research needs.

• Researchers and institute leaders have frequent meetings and informal visits with extension personnel, development program leaders, and contact farmers during the year.

• Improvements have been made in the library and information services of the central institutes as well as the research institutes so that information on results is provided to the development programs.

• The extension subject matter specialists will be stationed at the research institutes in order to improve their communication with the scientists, give the specialists quick access to research results, and help the institute staff in developing their programs.

• The research institutes will conduct on-farm research in cooperation with the extension field workers, who will then better understand the results and more effectively disseminate them to the farmers.

• The directorates have demonstration plots throughout the country and will use the research results in these plots in cooperation with the AARD.

• The Center for Agroeconomic Research of the AARD will carry out research on farmer groups, extension methodology, and the impact of technology on rural institutions; then the Center for Agricultural Extension of the AAETE will utilize the results of this research to develop programs and plan the implementation of extension methods. Researchers will thus gradually come to understand better that they must not limit themselves to economic aspects but must take account of the sociological parameters of agricultural production.
Institutional Framework for Research-Extension Linkages in Bangladesh

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Since the establishment of the Department of Agriculture in Bangladesh in 1906, the mechanism for the transfer of agriculture technology to farmers has been a debatable issue. Attempts have been made, time and again, to find organizationally practicable solutions. Until recently, however, a satisfactory mechanism has not been developed and implemented to cover all aspects of farming and include people from the entire range of professions relevant to farming. At one time, both research and extension were under one umbrella—the Department of Agriculture—but the organizational framework was again bifurcated in 1970 with the goal of accelerating the pace of both research and extension.

For many decades Bangladeshi farmers have been very slowly adopting improved farming techniques, but there has been little improvement in their economy. This state of affairs has created confusion among all those working to improve the socioeconomic status of farmers. The situation is not, however, unique to Bangladesh but is more or less similar to that in adjacent states of South and Southeast Asia. Addressing this seemingly intractable problem, this chapter deals with some of the pertinent issues related to institutions for the transfer of technology to farmers.

Historical Separation of Agricultural Institutions

Following the recommendations of the Famine Commission of India, the Directorate of Agriculture, which was then part of the Department of Land Records in Bengal, started agricultural research in 1880. At the initiative of Lord Curzon (1899–1905), the viceroy of India, an Agricultural Research Station was established at Tejgaon (now the capital area of Bangladesh) in 1908. An integral part of the Department of Agriculture of the Bengal government headquartered at Calcutta, this research station dealt with all crops, livestock, and poultry. Export-oriented crops such as tea and jute were soon separated out, and several crops such as rice, sugarcane, and potatoes had separate research institutes. Several agricultural colleges and schools were also established in various parts of India to train the necessary manpower, but the only agricultural college in Bengal was abolished in the early part of this century and until 1939 there were only two agricultural schools. That year the Bengal Agricultural Institute was established at the site of the Agricultural Research Station at Tejgaon. The institute was affiliated with Dhaka University and offered a postgraduate degree in agriculture. The Jute Research Institute was also established in 1935 at this site.

In 1920–25 demonstration and research farms were established in all the districts of Bengal. Headed by an agricultural officer, these demonstration-cum-research farms made direct attempts to establish a strong linkage between research and extension. During this time improved technologies for rice, jute, and sugarcane; vegetables such as tomatoes, cabbages, cauliflowers, carrots, oilseed crops, and legumes; and improved livestock and poultry were introduced to farmers. Success could be observed in areas with big and assured markets. The 1942–43 famine and the partition of Bengal in 1947, however, underscored the need for much bigger and more integrated efforts to accelerate the improvement of crops and livestock.

Until 1952 all crop improvement research was based on low-input or low-cost technology. In 1952 it was conclusively demonstrated that high-yielding Japanese rice varieties (with a yield potential of 5–6 tons per hectare) could be cultivated in the winter season with proper soil, water, fertilizer, and pest management. The country was not prepared to adopt such high-cost technology, however, because of the lack of fertilizer and irrigation. Between 1956 and 1966 the input situation was greatly improved. The Department of
Agriculture took up the Japanese method of rice cultivation and paved the way for the adoption of high-yielding rice and wheat varieties developed at the International Rice Research Institute (IRRI) and the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT).

Since 1966, because of the integrated efforts of both extension and research workers, improved cultivation techniques for wheat and rice have begun to be more widely adopted.

Agricultural Institutions and Their Functions

As recently as 1978 the fragmentation of resources and of the lines of institutional accountability was still a major problem. The main agricultural institutions in operation in Bangladesh in 1978 were:

1. Department of Agricultural Extension
2. Agricultural Information Service
3. Central Extension Resources Development Institute
4. Agricultural Extension and Training Institute
5. Jute Development Board
6. Horticulture Development Board
7. Cotton Development Board
8. Tobacco Development Board
9. Bangladesh Agricultural Research Institute (including research centers for potatoes and wheat)
10. Agricultural College
11. Bangladesh Rice Research Institute
12. Soil Survey Institute
13. Soil Testing and Fertility Research Institute
14. Bangladesh Jute Research Institute
15. Bangladesh Sugarcane Research Institute
16. Institute of Nuclear Agriculture
17. Tea Research Institute
18. Forest Research Institute
19. Department of Livestock and Fisheries
20. Fishery Research Institute
21. Bangladesh Agricultural University
22. Integrated Rural Development Board
23. Bangladesh Academy for Rural Development, Comilla
24. Regional Academy for Rural Development, Bogra
25. Directorate of Agricultural Marketing
26. Bangladesh Agriculture Development Corporation
27. Bangladesh Water Development Board
28. Seed Certification Agency
29. Nongovernmental (foreign-aided, voluntary) organizations

Among these institutes, numbers 1-13, 18, 25, 26, and 28 were under the administrative control of the Ministry of Agriculture; the rest were under different ministries. Integration was therefore difficult, and the lack of it undermined the effectiveness of the individual organizations and impeded their joint efforts. In 1982 all organizations except the Integrated Rural Development Board (including cooperatives and rural academies), the Tea Research Institute, and the Sugarcane Research Institute were brought under the administration of the Ministry of Agriculture. The Bangladesh Agricultural Research Council (BARC),
which started earlier as an apex body to plan and coordinate all research activities in agriculture, was reorganized and strengthened to make it more effective and given a mandate to coordinate the work of nongovernmental organizations with related institutions, particularly the Department of Agricultural Extension (DAE).

These institutions, with their specific mandates, tried to implement their respective development programs, which were planned, controlled, and monitored at the top by their respective ministries. All these institutions therefore acted more or less unilaterally and only sometimes jointly for the transfer of technologies. Naturally, the effectiveness and the pace of the work fell short of expectations. The limited progress was attributed to the lack of integration, the absence of coherence and coordination, and the uneconomical ways of operation that made ineffective use of the manpower available.

To an outsider, such an explanation may appear questionable because often the same administrators and planners who initially had strong reasons for establishing these agencies later abolished them. Unfortunately, no attempt was made to find and correct the real causes of retarded progress before abolishing these institutions.

Nevertheless, an impartial review depicts the decade following liberation (1973-82) as a significant period of agricultural development in Bangladesh. During this period general awareness of the need generated a combined and sustained effort for the transfer of agriculture technology to farmers with the active collaboration of the extension agencies and research institutes. The linkage thus established with various institutes was definitely not up to the mark, because there was no planned mechanism for an effective linkage. When the training and visit (T&V) extension system was introduced, a new and broadly based effort was launched to improve the linkage mechanisms between various institutions. Unfortunately, although the T&V system was introduced with great enthusiasm, it has so far affected only a few institutes. Many relevant institutions are still perhaps unaware of the philosophy and modus operandi of the T&V system and its affiliated bodies.

The Present Status

The present status of this important issue of research-extension linkages may be explained by describing the programs of the Bangladesh Agricultural Research Institute (BARI) and the Bangladesh Rice Research Institute (BRRI).

**BARI**

The Bangladesh Agricultural Research Institute is headquartered at Joydebpur with regional stations at Dinajpur, Rangpur, Bogra, Pabna, Rajshahi, Jessore, Chittagong, Chittagong Hill Tracts, Sylhet, Barisal, and Jamalpur. BARI is an autonomous institute under the Ministry of Agriculture, with a Board of Governors that controls its major policies and budget. The institute conducts research on cereal crops other than rice, fiber crops other than jute, and a range of crops such as legumes, vegetables, tobacco, spices, and fruit. It also has its own training division.

Each regional station trains extension agents, identifies impact points, tests technologies in farmers' fields, and conducts field demonstrations as well as regular training programs for specific crops such as wheat, mustard, and maize. The regional program also handles fertilization trials with the Bangladesh Rice Research Institute. Specialized training programs for potato-growing are conducted at both headquarters and regional stations. Training on the cropping system and on water management is done in association with BRRI and other agencies involved in national cropping system research. Senior scientists of BARI are recognized by the Bangladesh Agricultural University as professors of postgraduate students for M.S. and Ph.D. degrees.

Since Bangladesh has a deficiency in food crops, BARI has taken up special research and development
programs on wheat, potatoes, oilseeds, and pulses. As a result of this special emphasis, the wheat area has expanded from about 50,000 hectares to about 600,000 hectares and production has increased from 100,000 to about 1.5 million metric tons a year. (About 90 percent of the wheat area is under improved varieties.) Potato production has also increased to a great extent, and improved mustard varieties are rapidly being accepted that can triple a farmer's production. The new summer pulse has also shown its merit and is being adopted in the drought-prone uplands.

The linkages between research and extension have been strengthened since BARI is an active member of the extension-research program of the ministry. Both at the regional stations and at headquarters, the seasonal crop production and research programs are planned with the active participation of the extension agencies and other research stations. Research programs focus on major regional problems, such as cultural operations, soil deficiencies, water management, and pest management. With active support from the extension agencies, demonstration plots are planted and farmers' rallies are regularly held. All of these activities assist farmers to produce more food and cash crops.

There are, however, constraints that impede the adoption of technologies and the rapid expansion of areas where improved technologies are used. Some of these constraints are:

- Seed production by the Bangladesh Agricultural Development Corporation (BADC) has been limited by physical and financial problems.
- More cold storage facilities are needed for seeds, which are harvested in April and must be stored in a hot, humid climate for use in September.
- Rice, potatoes, vegetables, mustard, and spices compete for irrigation.
- More power threshers are needed at the farm level to thresh wheat quickly and efficiently.
- Potato prices at harvest are too low (US$30 per ton); farmers have difficulty bargaining for a fair price because their produce is very perishable and there is a shortage of cold storage space as a direct consequence of increased energy costs. (Natural gas fields are in the east, whereas potatoes and wheat are grown in the west and northwest, and 200 kilometers of pipeline are needed.) The government has not yet come forward to provide a floor price to stabilize the market for potatoes, especially in the harvest season.
- There is a shortage of good potato seeds. About 10 percent of the total required is imported, but this is inadequate.
- Irrigation and fertilizer costs have gone up by 50 to 1,500 percent, but the market price of the produce has not increased accordingly.

The future program of research will be to develop more high-yielding, short-duration wheat varieties suitable for late planting, particularly in southern humid areas; to develop nutritive, short-duration summer vegetables; to produce cabbage and cauliflower seeds, since these vegetables do not produce good seed under the climatic conditions of Bangladesh; to continue the development of better varieties of onion and of mustard with a low toxin content; to develop varieties of khesari (grass peas) with a low toxin content and better varieties of lentils, grains, and peas suitable for the short winter season; and to emphasize the production of better mango varieties for southern districts.

**BRRI**

Headquartered at Joydebpur, the Bangladesh Rice Research Institute has outreach stations at Sylhet, Comilla, Noakhali, Barisal, and Rajshahi. Like BARI, it is an autonomous institute under the Ministry of Agriculture and is run by a Board of Governors. Its mandate is to conduct research on all aspects of the production, protection, and processing of rice.

With the active assistance of extension agents, the BRRI works with farmers on projects and in special problem areas to identify and develop location-specific technologies. Both BARI and the BRRI have integrated BARC-sponsored programs on multiple cropping. Both also actively assist Bangladesh Agricultural University in accelerating its manpower development program by enrolling postgraduate degree
scholars. Researchers and extension agents and farmers confer in workshops and group meetings on various production issues.

The BRRI conducts training programs on rice production and rice-based cropping systems both at headquarters and at its outreach stations. It has a special four-month rice production training program for extension agents from the DAE, BADC, Bangladesh Water Development Board (BWDB), BARI, and nongovernmental organizations. Special training and briefing programs are set up on request, and all training expenses are borne by the BRRI. National production plans for rice crops are adopted jointly.

The BRRI has special bilateral agreements with the DAE and BWDB to help them improve their research-extension linkage through mutual cooperation and assistance. The BRRI supplies the DAE and BARI with rice seed for demonstration and fertilizer trials, and the organizations jointly conduct multilocation tests and demonstrations of new technologies. Representatives from the DAE, BARI, BWDB, and other institutions assist the BRRI and participate in the development of its research programs, annual research reviews, and extension-research workshops.

Some nongovernmental organizations are, to an extent, connected with the BRRI and BARI, but the association is very weak. Although there is an association of all voluntary agencies working in Bangladesh, most of them work individually. No effective linkage has yet been established between the research institutes and the academies for rural development.

Bangladeshi farmers are not economically homogeneous. Because most areas are prone to natural calamities such as drought or flood or have soil that is saline or otherwise deficient, low-cost technologies cannot be ignored. The BRRI therefore also assists farmers, particularly in risk-prone areas, with relevant technologies that do not need high-cost inputs. High-yielding varieties (HYVs) have therefore been adopted in about 75 percent of the area planted to boro (the irrigated rice crop grown from December to May). In contrast, HYVs are not grown in the summer (rainy season) in flood-prone areas.

For aus (the rice crop of March/April to June/July) and for transplanted aman (the rice crop of June/July to November/December), the area planted with HYVs has slowly increased to about 20 percent of the total under each crop. In general, HYVs account for about 20 percent of the area of all rice crops but about 40 percent of total rice production.

The rice research program is based on site-specific as well as broad problems affecting production. Such problems are identified in formal meetings with extension workers and researchers at regional stations in accordance with the T&V system. More general problems such as the development of technologies to deal with flood, drought, and salinity are included in long-term research programs, as are socioeconomic problems related to the postharvest season. Special research programs respond to specific needs, such as for varieties that are resistant to the brown plant hopper.

Training programs on modern methods of rice production, rice cropping systems, pest management, organic matter recycling, and so on are conducted only for subject matter specialists and subject matter officers. Under very special circumstances, leading farmers are given training at the request of extension agents (for example, in “mobile rice schools”).

Future rice research strategies will depend upon how fast yield per hectare can be increased to 5 tons. The BRRI position is that the rice area must be reduced to 8 million or 9 million hectares by vertical improvement (more intensive farming methods and better technologies) in order to leave more land for raising other important crops and livestock. Approximately 70 percent of the total effort of the BRRI will be devoted to applied research to improve the productivity of rice crops within the present farming system. A major goal will be to develop technologies that will stabilize yield to a specified level (determined by the National Planning Commission, in consultation with the ministry, using data from researchers and extension workers obtained in group meetings in the T&V system). The other 30 percent of the effort will be to conduct research on the consequences of using a specific technology for a number of years. For example, a researcher must be able to visualize and simulate farm conditions (including farmers’ actual practices) to develop technologies that will be associated with higher cropping intensities under irrigation. Researchers must remain ahead of the farmers so that solutions can be provided as soon as a problem emerges.
Social and Economic Constraints

Most of the agricultural research institutes in Bangladesh suffer from the lack of well-trained manpower, finance (particularly operational funds), adequate physical facilities (laboratories and residential accommodation), and the mobility necessary to administer the outreach programs.

The existing rules and regulations are not conducive to the rapid development of manpower, which is costly and time-consuming and needs foreign financial assistance. The want of scientific equipment, chemicals, books, and journals also impedes appropriate research efforts. Bangladesh cannot afford the requisite foreign exchange to import them; high customs duties and taxes also discourage the procurement of these vitally needed supplies. In most cases aid-giving agencies can provide funds to procure equipment but not to pay customs duties and taxes. The government has not yet found any solution to these problems.

Autonomous institutes are slightly better off than government bodies. Recently, the Tobacco Development Board, the Horticulture Development Board, and the Directorate of Plant Protection have been amalgamated with the DAE. Hundreds of workers in these organizations await appropriate service adjustments and regularization of their jobs. A massive program is needed to train them for the job of total extension envisaged by the DAE. In addition, extension officers and other field workers coming from the Jute and Horticulture Development Boards will have to be trained immediately to enable them to handle other crops well, and other workers will have to be trained to deal with jute and horticulture. This needs time, a large budget, and physical facilities.

Twelve Agricultural and Extension Training Institutes (AETIs) also need well-trained instructors with adequate teaching aids and a suitable curriculum. The Pay and Service Commission did not grant AETI graduates the same status as graduates of the polytechnic institutes, and they therefore have different pay scales and service facilities.

The government has attempted to decentralize the administration of research and extension activities by establishing a system of upazillas (subdistricts), each with its own chairman elected by the people and its own service hierarchy. Now a farmer can get a solution to his problem locally instead of having to go to district headquarters. Since the upazillas are not based on agroecological zones, however, the research and extension workers have to deal with a mixture of different conditions. In addition, there is confusion as to the relationship between the deputy director of agriculture and the agricultural officers of the upazillas. Furthermore, government regulations call for research staff and extension agents to be transferred after an interval of three years, which does not give them time to learn the agroecological and socioeconomic background of the farming community. Such administrative rules are not conducive to running the T&V system efficiently.

Linkages between Research, Extension, and Farmers

Appropriate linkages between research, extension, and farmers may be shown schematically:

Although this linkage looks simple, it has been difficult to establish satisfactorily because of organizational and other constraints. With the adoption of a T&V system, however, a basic framework for the research-extension-farmer linkage has now been established. Forceful application, guidance, and a continuous effort to remove bottlenecks will be essential to derive the expected benefits from it. Some of the factors that impede success are explained in the following paragraphs.
A high dependence on rainfed agriculture never provides a dependable technology because it is impossible to forecast when a drought or flood will damage crops. A farmer therefore plants both modern and local improved varieties as insurance against bad weather. As a result, a mosaic of inputs and technologies has been adopted, causing frustration among farmers, administrators, and planners.

Perhaps the most frustrated group is the farmers. They have no certainty of marketing their produce to earn a satisfactory economic return. Influenced by international markets, the price system has undergone major changes disruptive to farmer’s traditional cropping strategies. At one time, by selling one unit of jute a farmer could purchase three units of rice, but now he sells about three units of jute to purchase one unit of rice. The story for potatoes, bananas, and vegetables is similar.

Although such constraints do not directly affect the relationship between research and extension, they act negatively on the adoption of technology, and the ultimate outcome of the research-extension effort is diminished. The successful adoption of improved technologies and efficient land use in the irrigated areas clearly demonstrate the cumulative effect of the extension-research linkage. One major limitation of both research and extension agencies is that none of them has any jurisdiction over the market. Their work ends with the production of crops and does not extend to assisting the farmer to market his produce properly. The lack of storage, processing, and transport facilities is not at all conducive to higher production.

Since 1972 the cost of urea has increased fifteen times, and the cost of sinking a deep or shallow tubewell has increased 200 percent. Although these costs have affected the adoption of technologies, both research and extension workers have stood by as neutral and disinterested observers instead of reacting promptly to them through research and modified extension recommendations.

Bangladesh has a surplus labor force, but not all the time. During July and August, farmers have to harvest jute (about 1 million hectares), process and market it, harvest summer rice (3 million hectares), and simultaneously prepare 4 million hectares for transplanting aman rice. Within these two months they work about 8 million hectares, which demands an intensive use of labor. The resultant labor shortage forces the transplanting of rice to continue into October although the optimal time for transplanting ends in August. Approximately 40 percent of the transplanted aman rice is therefore transplanted late, and the yield is reduced by 25–50 percent. Here extension workers and researchers can talk about mechanization, but economists will dispute them because Bangladesh has surplus labor power.

Looking to the Future

In spite of various administrative and organization problems, there is a positive sign that coordination and linkages between research and extension are developing well for the benefit of the common farmers. The task to be performed by extension agents and researchers is to improve the productivity of farmers subject to an uncertain rainfed agriculture and a difficult socioeconomic environment. Although there has been a gradual improvement in Bangladesh agriculture, there can be much more provided certain steps are taken. One is to increase the purchasing capacity of the farmer by ensuring better market prices for his farm products. Merely withdrawing subsidies without assuring the farmer of a fair price for his crops will retard the adoption of improved technology. Other steps are needed to improve research and extension activities and the linkages between them, as outlined in the following suggestions:

- Each AETI should have a project area where students can work with farmers. A research scientist should be invited to spend two or three days a season at each AETI to discuss with the instructors the latest technologies developed and simultaneously to learn about field problems, which he can take back to his colleagues for solution. All AETI instructors should be trained as subject matter specialists with better pay and should periodically visit BARI and the BRRI for briefing and reorientation.
- All zonal stations or substations should have project areas (25 square kilometers) where research and extension officials can work together with farmers.
• Production blocks need to be organized first where efforts to improve crop productivity will have a better chance of success; later, such production blocks can be established in more risk-prone areas. Attention should be given to storage, marketing, and credit needs and the links between them.

• All extension agents who previously worked for boards need to be trained quickly. Ten or twelve six-week training camps should be established close to research stations, AETIs, and other suitable areas, with six trained SMSs as instructors. Adequate funds should be arranged for not more than four such training sessions a year for thirty trainees each. Five to six of the best trainees should be selected for training in rice or wheat production at the BRRI and BARI that have programs in multiple cropping.

• Tests should be conducted on leased farmland for three consecutive seasons to offset the payment of compensation to farmers. On all these test plots, farmers will practice both the improved and traditional crop production systems. Since outreach experiments cost two to three times more than on-station trials, more operational funds will be needed.

• Before and after the beginning of a cropping season, local extension and research officers should sit together and draw up their respective programs for extension work. If properly monitored and evaluated, this should increase mutual assistance and improve linkages. Similar two-day briefing and discussion sessions should be held at BARI, the BRRI, the Bangladesh Jute Research Institute, or other institutes three or four times annually in addition to the annual research review and workshop.

• In each research station, senior and experienced extension officials should assist scientists in the development of research programs. Both the research and extension people should be very mobile.

• The T&V system itself should be evaluated regularly, and there are improvements to be made. For example, the concept of impact points needs to be made more realistic, since each subject matter officer (SMO) has to deal with more than one crop, particularly in the winter season. And extension agents should no longer be transferred after three years, but should be allowed more experience with the agroeconomic and socioeconomic environment in which they work. The wisdom and confidence gained will be reflected in their later activities.
National Policies and Institutional Constraints to Linking Research with Extension in Asia

Michael Baxter and Wilfried Thalwitz

The need for effective two-way linkages between agricultural research and extension is beyond dispute. Although agricultural researchers must have contact with farmers in order to be directly acquainted with their production conditions and technological requirements, they rarely have time for extension contact directly with farmers. Similarly, agricultural extension workers have little if anything to offer farmers in the long run without research input: existing farmer (and extension) knowledge and practice is a closed system that is unsustainable without input from research. Notwithstanding this mutual dependence of agricultural extension and research, in many places the linkages between them are weak. Reasons for poor linkages vary between country, just as the actual form of linkage established must be specific to a particular country’s administrative, sociocultural, and agroeconomic conditions. Rather than focus on the reasons for weak research-extension linkages in particular countries, however, this paper analyzes some of the broader issues—particularly those relating to policy and institutional matters—involved in establishing effective linkages between agricultural research and extension.

The World Bank has helped its member countries finance improvements in agricultural extension and research, particularly since the early 1970s. Largely under Bank sponsorship, there has been wide adoption of the training and visit (T&V) extension system, which emphasizes systems management and close, two-way linkages between farmer, extension worker, and researcher. Recent reviews indicate that the T&V system has been implemented in some forty countries in Asia, Africa, Europe, and Central and South America.1 In India alone, thirteen major states have now adopted the system. The total cost of these projects in India is about $354 million, with some $200 million in the form of credits from the International Development Agency (IDA). Two follow-up national extension projects (with an approximate total cost of $146 million and an IDA contribution of about $87 million) have been prepared in India and are about to be implemented. The follow-up projects will continue to strengthen and refine the extension systems already established, as well as support their introduction into the few agriculturally important states still without reformed agricultural extension services.

Apart from the support given research through many extension projects, the World Bank has helped finance a variety of agricultural research projects, usually on a national scale. An example, again from India, is the National Agricultural Research Project (total investment of $54 million, with IDA participation of $27 million), which attempts to strengthen the capability of the regional research stations of agricultural universities to undertake locally specific applied research. Another objective is to help these stations operate effectively between the national programs of the Indian Council of Agricultural Research and local adaptive research farms or farm trials programs (which are operated usually by the state department of agriculture as opposed to the agricultural universities). The World Bank has given and continues to give significant support to international agricultural research institutions through the Consultative Group on International Agricultural Research (CGIAR), and has published an analysis of the issues and the Bank’s posture in promoting agricultural research and its development (World Bank 1981).

Although there are exceptions (such as the Bank’s involvement with CGIAR and its agricultural research sector policy paper), the most obvious impact of the World Bank on agricultural research and extension is at the project level. Individual projects are prepared and implemented to help strengthen the development

1. For details of the T&V system, see Benor, Harrison, and Baxter (1984); and Benor and Baxter (1984). The introduction of the former analyzes the broad context of agricultural extension reform.
of either research or extension (and sometimes both) in all or part of a country. As investment activities, these projects generally focus on specific components such as research, training, and field equipment and vehicles; residential, training, and laboratory facilities; staff training; and incremental staff and operating costs. The policy framework and institutional structure in which these investments are made and subsequently utilized are addressed in both analytic pre-investment sectoral reviews and in the course of preparing individual projects. Governments often propose major organizational modifications such as the adoption of the T&V system and institutional changes designed to increase the location- and farmer-specificity of research.

Many Bank-supported research and extension projects, which have been or are being successfully implemented, have had a substantial impact on both agricultural production and the institutional development of the extension and research systems. Almost invariably, however, whatever achievement individual projects may have, much of their effectiveness ultimately depends on policy and institutional issues with origins and national ramifications beyond individual projects.

Being basically “institutional development” projects, both agricultural extension and research projects inevitably involve a high degree of development of the human resources of the extension and research services. The need for human resource development is generally acknowledged and reflected in project preparation and design. Almost equally as common, if not during project preparation then certainly during implementation, is a recognition of the need for effective linkages between agricultural research and extension activities.

Despite this recognition of the importance of developing human resources and effective linkages, the achievement of these objectives is often less than anticipated (or required). Of course, an important factor in such a shortfall is that such changes ultimately require cultural change in the attitudes of individuals, and under most circumstances this can be achieved only slowly. Another important condition, however, is that institutional development impinges on a variety of factors that normally have origins and implications beyond the scope of the individual project. We will review some of these policy and institutional issues and outline ways in which they might be addressed, with particular reference to establishing effective linkages between agricultural research and extension.

In developing effective research and extension linkages, a basic concern is the national policy framework in which they are established and will operate. The policy should indicate national agricultural development priorities; the organizational structure to implement the policy and the basic institutional linkages between all involved organizations; the physical facilities and guidelines on appropriate levels of capital and recurrent resource allocations; positions on and procedures for staff development; and commitment to economic policies that will encourage individual farmers to operate in a manner supportive of national policy. Unless research and extension staff at all levels have a clear understanding of national priorities and the operational parameters of their work, their contribution (and ultimately that of farmers) to national goals is likely to be vitiated.

One basic issue in national agricultural development policy is the priority that should be given to agricultural research and extension. Often the need to support research, particularly basic and applied research, is not disputed. However, the case for agricultural extension is not always so strongly made. Reasons for this can include a belief that researchers are responsible for disseminating their results or, more commonly, that applicable, useful research results will be disseminated independently of institutional support because of their innate attractiveness to farmers. This position reflects the difficulty of effectively organizing and managing an extension system and also of directly attributing to extension any impact on production, as well as confusion over different approaches to extension. Coupled with limited resource availability, these factors can explain why the role of extension in agricultural development is not made explicit in national policy statements.

National agricultural development policy should indicate the contribution of research and extension to agricultural development and to a country’s particular agricultural development strategy, and should show how the two activities are interrelated in terms of policy implementation and their institutional arrangements. It is not for national policy statements to detail the modes of extension or research, but basic
parameters should be established. For extension, these might include its professional and technical orientation, basic work responsibilities and management principles, criteria by which its effectiveness should be monitored, ways in which extension contributes to national policy formulation and implementation, and the basic institutional arrangements for its linkage with other developmental services (such as agricultural research). Parameters defined for research could be similar: the respective roles of different forms of research (basic, applied, and adaptive), criteria of effectiveness and accountability, responsibilities with regard to national policy, institutional linkages, and so on. However national policy is defined, extension and research staff should take account of it in the planning and implementation of their work.

A basic policy consideration is the institutional base of agricultural research and extension, in particular the fundamental issue of the relative roles of government and the private sector. There are numerous examples of agricultural research and extension being undertaken along commodity-oriented lines by the private sector (and by statutory authorities largely independent of government) and there will usually be a strong incentive for such private sector involvement, particularly in commercial, export-oriented production. Aside from such cases, private sector involvement in either research or extension in many developing countries is extremely limited. The usually long lead time for payoff from research, the considerable institutional base implicit in a comprehensive research program and extension service, and occasionally a tendency to see the extension service as creating employment rather than as contributing to production are among the factors that limit private sector involvement in research and extension.

Perhaps, these are however, the very reasons to encourage private sector intervention: the high cost and managerial complexities of most extension and research systems and the inherently limited quest for efficiency and economy in public sector activities could be overcome by some involvement of the private sector. Given its profit incentive, private sector activity is probably best limited to discrete fields (or perhaps zones) in both research and extension; commercial crop production, building on the commodity focus in many countries, is an obvious area. A small number of separately budgeted research and extension groups in the private sector could foster competition among them (and between them and government services). Government’s role should be to establish basic standards for research and extension operations, to ensure their implementation in the context of the national policy, and to use these services to help fulfill its basic task in agricultural development, that of ensuring that farmers are exposed to attractive production options.

Even where a comprehensive policy for agricultural research and extension exists, its translation from the national level to the field is not easy. Not only are there many institutions and levels of administration, but farmers frequently have priorities different from those of national governments. In contrast to the broad policy concerns at the national level, research and extension activities become increasingly locally oriented as they move into the field, particularly in their response to farmers’ production conditions and needs. Indeed, a national policy with farm-level implications is likely to be only as successful as the degree to which it coincides with the interests of (and incentives received by) farmers. A national policy is unlikely to find acceptance with producers unless there are appropriate economic incentives for them to follow it. For example, without adequate returns to locally suited commercial crops, farmers are unlikely to support in practice a national policy of self-sufficiency in food production. National policymakers must take a longer-term and broader view of priorities than do farmers. However, national policy cannot be oblivious to farming conditions and farmers’ practices and priorities; ways must be developed to take account of them—including the use of farmer-oriented research and extension services.

Just as national policy on agricultural development should be supported by realistic incentives to farmers, so should adequate resources be deployed for its implementation. Not only is the level of resource allocation significant, but the time-perspective of resource allocation and regional priorities should also be taken into account. Investment in research or extension rarely has an immediate, attributable impact, a factor that can lead to frequent changes in research and extension organization and strategies and to uncertain financial support. There is no one research or extension system suited to even a specific set of environmental, economic, or administrative conditions, and a system often requires many years to prove its effectiveness. Since the impact of both research and extension activities depends to a high degree on the
quality of their staff, long-term consistency of support is imperative. Different approaches to extension and research can and should be tried, even at the same time. Such experimentation requires clear guidelines on the basic parameters and priorities of agricultural extension and research, as well as recognition that any system takes time to have an effect. Although there are advantages in trying different approaches, fragmentation of research and extension activities in the long term or pursuit of the “ideal” system is invariably counterproductive. Unfortunately, however, it is not uncommon for allocations to research and extension to be unpredictable because such activities have no demonstrable impact and their staff and recurrent costs are dominant.

Although the level of appropriate resource allocation will vary between countries, it is significant that developing countries typically spend only about one-third as much of their agricultural gross domestic product on agricultural research as do developed countries (World Bank 1981, p. 5). The equivalent data for extension support are not available (and would be difficult to compute, given the range of direct and indirect methods of extension support—for example, the subsidized use of telephones in some countries), but they would probably indicate a similar imbalance between developed and other countries. The important point, however, is not the level of budgetary support in an absolute sense, but rather that each country should establish an appropriate level of support for agricultural extension (which should change over time in response to developments in the agroeconomic, cultural, and technological environments) and ensure that such resources are indeed made available.

A basic issue is the form of linkage between agricultural research and extension services. Although extension and research services are normally separate organizations, their responsibilities are difficult to distinguish clearly. Extension workers, for example, generally profit from being involved in trials on farmers’ fields, especially when current practices are being compared with practices recommended by research. Similarly, an important function of agricultural research in developing farmer-acceptable technology is to take account of farmers’ production conditions and their reactions to recommended technology, a procedure that entails the direct contact with farmers that is most commonly associated with extension activities. Moreover, research and extension are mutually dependent: research depends on extension for regular and systematic feedback of farmers’ production conditions and their responses to recommended technology, and extension depends on research for technology to promote among farmers. Attempts to define and isolate precise, exclusive roles and responsibilities of research and extension are not only time-consuming, but also unlikely to be successful, and they have a potential for breaching this necessary interdependence of the two fields. Provided the central areas of the responsibility of extension and research are clear, there is little to be gained from precise delineation of boundaries.

Although extension and research have interests in common and a high degree of interdependence, combining both functions in one institution is likely to be less satisfactory than having separate institutions responsible for each. Since both extension and research are ultimately concerned with the same objective—improving the income and productivity of farmers and, through them, the agricultural sector—such divisiveness is perhaps surprising. Despite their intrinsic interdependence, however, various forces promote their separation: different professional orientations and means of accountability, different methodologies, the advantages of discrete organizational bases to promote appropriate resources allocation for both. With research and extension the responsibility of separate institutions, the establishment of effective linkages between them is therefore a major concern.

Rarely is an absence of physical resources listed as a significant constraint on effective interaction between extension and research; rather, the critical factors are almost invariably the attitudes and interest of staff and inadequate institutional arrangements. In the short term (the need for close linkage between extension and basic research is less obvious and urgent), a variety of measures may be taken to institutionalize the required two-way linkages between extension and research. Committees are an obvious and popular means. From the local to the national level, there are usually numerous technical, coordination, and planning committees in which both researchers and extension workers participate. Such committees can have a significant role in promoting linkages, but differences in the outlook and priorities of participants often limit this potential.
More significant than committees in developing and sustaining effective linkages are regular joint field activities and workshops in which extension and research staff at the working level are able to discuss and investigate immediate mutual concerns. Contacts established in such environments frequently increase researchers' and extension workers' understanding of the priorities and abilities of the other, and promote informal professional contacts as a basis for the development of more formal effective contact. Other ways to develop the necessary practical coordination of research and extension include: the involvement of both extension and research workers at different levels in joint planning sessions to translate national policies into specific goals and activities and to advise policy formulators on the reality of local conditions; the development of subject matter specialists, who provide in-service technical support for extension, as the main source of regular contact between extension and research; and the development of monitoring and evaluation systems that objectively review the impact of extension activities in the field. With statistically valid sampling and survey procedures, regular monitoring and evaluation can provide data on farmer receptivity to research-derived production recommendations, offer a guide to shortcomings in either the extension system or the recommended technology itself, and help identify gaps in both research and extension support.

The requirements of farmers for support from the extension and research services will vary over time in relation to the agroeconomic conditions, technological developments, and so on. Just as research and extension support must adjust to these changing requirements, so must the nature of research-extension linkages. There are advantages in institutionalizing research-extension linkages—and indeed it is often necessary to do so initially to ensure that the required contact does take place—but there should be flexibility in such arrangements: committees that continue in name once their function has been outlived only complicate the implementation of necessary programs. Extension and research priorities and activities and their effectiveness should be subject to regular reviews and consequent adjustment; the system of linkages between research and extension should also be reviewed and adjusted to ensure that the basic objectives of enhancing two-way information flows and improving the operation of both are achieved.

Personnel policy is intimately linked with the quality of agricultural extension and research activities and of the linkages between them. The personnel policies of extension and research will differ somewhat in view of the objectives, organizational structure, and administrative considerations of each service, but they share the similar objectives of attracting and retaining appropriate staff. Efforts should also be made to ensure that the personnel policy of either service does not hinder the necessary interaction between the two staffs. For example, the remuneration policies of the two services should not be so different as to adversely affect informal and even formal relations between researchers and extension workers. The major considerations in remuneration should be qualifications and skills. The basic requirements of most researchers are perhaps readily standardized in terms of formal education, specialization, and experience. In contrast, the level of formal training required for extension workers is rarely as high as for researchers, and their skills are more difficult to evaluate formally. Because of these factors, plus perhaps a belief that extension work is unskilled (or even unnecessary), the remuneration of extension staff is often considerably less than that of researchers. The answer lies not in trying to determine whether research or extension work is more demanding, but in recognizing that each is equally vital to the farmer and to national agricultural development, and that each entails distinct skills. Not only would most extension workers make poor researchers, but few researchers would be effective extension workers. (For this reason, the temporary posting of researchers in extension services and of extension workers in research, which is often proposed, can have little impact except in a few carefully selected cases, such as the exchange of senior extension subject matter specialists with some adaptive research staff.)

In addition to recognizing and rewarding the distinctive skills and qualifications of extension workers and researchers, it is important to identify appropriate measures of effectiveness and accountability for each service. An extension worker's effectiveness is most likely to be indicated by the extent to which he is familiar with technological recommendations suited to a farmer's particular resource conditions, the extent to which he has adapted the basic recommended technology when necessary, the extent to which he has taught and encouraged farmers to adopt improved technology, and the extent to which he has given
relevant feedback to researchers about farmers' production and their reaction to recommended technology. Extension workers should be held accountable on each of these points. For most agricultural research workers, the appropriate indication of effectiveness should be the relevance of research work to farmers.

In developed as well as developing countries, the laboratory bias of agricultural research often constrains the development of research relevant to farmers and their actual resource conditions. This bias has been or is being breached in many places, although agricultural development will continue to rely heavily on basic, primarily laboratory-centered, research. But in many countries professional evaluation or reward systems for agricultural researchers rarely go beyond this stage to reflect the relevance of research to the ultimate user, the farmer. A frequent complaint of researchers is that research findings are not adopted by farmers because of the "extension gap," that is, the failure of extension workers to convince farmers to adopt the technology. But how many researchers are encouraged to analyze with farmers, or even with extension staff, the reasons for nonadoption? Until professional evaluations take account of the extent to which research results are adopted by farmers, research that is seemingly irrelevant and poorly understood by farmers, extension workers, and researchers will continue to be a major constraint on the effectiveness of both extension and research work and on the linkages between the two fields.

The training and visit system is one of numerous approaches to agricultural extension. It perhaps should be seen as a set of principles for extension rather than as a system itself since it does need to be adapted to local and changing conditions. Its widespread recent adoption, however, is not as important as the fact that it has directed the attention of agricultural sector managers and governments in general to basic managerial and institutional issues of significance for extension. In adopting the T&V system, many countries have made fundamental changes in the organization and administration of their extension services. Changes in staff responsibilities and administrative structures are often far-reaching in both their implementation and consequences, affecting basic relations between the farmers, extension and research, and between farmers and government at large. In many cases, it is recognized that only such radical change could ensure the attainment of the basic objectives of a professional extension system. Extension services in many countries had acquired a number of functions not compatible with even their stated objectives. Evaluation of extension's objectives and achievements, particularly in the context of current and expected production conditions, has often led to radical change in the organization and operation of the system.

Both extension and research need to take account of farmers' priorities. In a review of extension services a prime consideration is usually the extent to which the system effectively services its clients, the farmers; and review of agricultural research should have the same orientation (with allowance for basic and applied research activities with medium- and long-term objectives). Not only do researchers and extension workers need to know farmers' priorities if research and extension activities are to be relevant and have some chance of success, but both services need to have a role in making farmers' priorities known to national policymakers.

Mechanisms for ensuring awareness of farmers' conditions and priorities are usually based on the participation of farmers in selected technical and coordination committees for both research and extension. This involvement can be useful, although in practice such farmers are not particularly representative of common or important farming situations. In addition to committees, the effectiveness and representativeness of which should be closely monitored, a most effective way for ensuring farmer participation is for research and extension workers to visit farmers in their fields regularly for comprehensive diagnostic discussions. Frequent, joint field discussions with receptive extension and research staff are likely to result in far more effective farmer participation in extension and research activities, and ultimately in national policy, than the participation of farmers on committees. Farming systems research is another effective means of ensuring such awareness.

An important institutional issue for research and extension linkages is the role of universities, particularly agricultural universities. They have an undisputed primary function of providing the basic manpower for extension and research, and also contribute to the periodic updating of staff either by being directly involved in training or by advising specialized training institutions. Not only are universities the source of research manpower and its upgrading, but they are frequently the site of fundamental, basic research; in
some countries, they are also involved in applied and even adaptive research. Given this basic role in the
development of both extension and research staff, universities have a crucial contribution to make to
fostering effective linkages between the two fields. The constraints to effective extension-research linkages
are rarely only a matter of different resource allocation or the absence of forums in which extension and
research staff can meet; often equally significant is a failure of both extension and research staff to
acknowledge their shared ultimate objective, farmers’ production and income, and the need for coordi-
nated work. Universities can actively promote effective linkages between their own research and extension
activities, probably by using techniques of joint participation in technical and planning committees and field
activities, as is done in the services themselves. These efforts are necessary, but an equally significant
contribution can be made by ensuring that the intrinsic interdependence of extension and research is
acknowledged at all levels of university education and training activities.

Just as there are a variety of research and extension systems and activities appropriate to one country,
even at the same time, so too can there be a variety of research and extension linkages, which should be
reviewed and adjusted as experience and circumstances dictate. The establishment and adjustment of these
linkages require clear policy guidelines on the role of extension and research in national agricultural
development policy and in its translation into field-level activities. The need for an appropriate institutional
framework to successfully implement national policy should be recognized and sufficient flexibility given to
adjust the institutional arrangements, including linkages between institutions, to better serve national
objectives. Such adjustment is rarely effective in the long run if it is based on the accretion of function and
responsibility, as has been shown by the frequent need for far-reaching reforms in the establishment of
professional technical extension services. Without the adoption of such a holistic approach, which includes
appropriate incentives both to extension and research workers and to farmers, the potential benefits of
investment in research and extension, and of attempts to establish and maintain the necessary systems of
linkage between them, are curtailed. Where national policy on extension and research is unclear or there is
an inadequate institutional basis on which to implement national policy, extension and research workers
alike cannot be expected to perform their central functions in agricultural development.

References

Most research and extension programs, if examined carefully, will be found not wholly relevant to farmers’ needs. The reason is that research has too often been confined to the station, and extension has either been excessively “top down” in its approach to passing on recommendations or has lacked the operational resources or organized structure to reach more than a few farmers. There is now a growing consensus that the constraints facing the farmer and the factors that motivate his decisionmaking need to be better understood.

Although more people now agree that both research and extension workers should jointly participate in diagnosing farmers problems, they disagree on the best ways of carrying this out, on what specifically should be identified, and on how to secure more active farmer participation in the whole process. The papers in this section explore alternative ways of identifying farmers’ production problems. In particular, they discuss the relevance of farming systems research, as well as the role to be played by rapid diagnostic surveys. Gomez (chapter 8) describes a sequential methodology that has been successfully used to identify and quantify farmers’ production problems in the Philippines. It includes agronomic trials to measure biophysical constraints, a farm study to identify the sociocultural, economic, and institutional difficulties or resources, and a follow-up survey to determine the extent to which farmers are adopting the recommended practices that the surveys and trials have shown to be beneficial. Effendi (chapter 7) describes the methodology used in Indonesia; it starts with a resource inventory and then moves on to discuss the development of land use maps and the selection of target areas, along with the steps leading to the selection of improved cropping patterns. This methodology emphasizes assessing farmers’ present cropping patterns to establish a baseline, and understanding farmers’ choice of cropping pattern if input and market constraints were removed.

A central problem in identifying farmers’ problems is that farmers are stratified and farmers with different levels of resources respond differently even in the same agroecological zone. Collinson (chapter 9) argues that grouping the farmers on the basis of their farming systems will help define target populations for which the same research effort and the same extension development program will be appropriate. He also points out that agricultural researchers need to understand the structure of the farm household, its organization, labor resources, division of tasks, and resource allocation regarding the production of different crops on various land parcels. To be more effective, extension staff in turn need to have a perception of the sociology of the farm family and its rationale and strategy for implementing the existing farming system. In Section III these points are reinforced by Wirasinghe, Weerasinghe, and Fernando, who provide interesting examples of how the research-extension-farmer continuum operates in Sri Lanka and particularly how information from farmer feedback is handled to increase the ability to respond to production problems at the farm level.

In summary, the papers of this section forcefully argue that farmers’ production problems must be viewed in the context of the whole farming system and the needs and priorities of the farm family. Problems must be identified jointly by farmers, extension staff, and researchers, whose mandate to generate technology does not end at the research station but requires follow-through with the farmers. Problems requiring further research should be ranked according to their potential to increase incomes for the largest number of farmers and the ability of researchers to deal with them. More innovative approaches are needed.
to promote greater farmer participation and thus ensure that future extension and research programs are more relevant to farmers' needs.

Although farming systems research can be used to identify areas to which research programs should be directed in the medium term, the approach needs to be adapted for more rapid diagnostic surveys conducted jointly by research and extension staff to ensure that initial extension recommendations are relevant, as well as to monitor and revise them as necessary from season to season. A farming systems approach to farmers' problems dovetails with, and reinforces, the T&V extension system by emphasizing the vital importance of farmer feedback. The methodologies discussed here for achieving these objectives deserve the full attention of managers of extension systems and their counterparts in research.
The production problems that farmers face are always interrelated. Attempts to solve a specific technical problem may create new problems if the whole complex of farmers’ constraints is not understood.

By training and temperament, scientists like to simplify. A common scientific technique is to isolate for study one aspect of a larger system while holding other factors constant. This technique is a powerful analytical tool that has extended the boundaries of scientific knowledge. Agricultural research in developed countries is usually organized along these lines and concentrates on a particular crop or animal. This specialization permits in-depth study of the components of a farming system. When carried to an extreme, however, this approach becomes counterproductive and the research irrelevant. It is therefore fortunate when agricultural extension workers and farmers are able to incorporate certain useful aspects of the research in the existing farm setting.

Even in developed countries, however, scientists are beginning to devote more time and effort to systems research that addresses the complex and immediate problems of farmers. This approach is similar to the one used in the early days of agricultural research and is appropriate in many situations in developing countries today. Unfortunately, this interdisciplinary, integrated, and holistic approach to farm research sounds complicated and is not easily carried out. The approach does not fit the conventional, narrow scientific method that is still commonly taught in colleges and universities. Expanding the horizons of traditional research costs a lot of money and takes considerable time and institutional and individual commitment. It is difficult to mobilize and maintain the interest of scientists because of the need to establish one’s identity, either personal or scientific, in this kind of research.

But, for those who empathize with farmers and their problems, this kind of research is highly rewarding—not in a monetary sense nor necessarily in the quantity or even quality of scientific papers published, but in the realization that one is identifying problems that affect farmers’ daily lives and is directly meeting the needs of rural people. There is also the reward of working with colleagues from other disciplines such as economics, rural sociology, anthropology, and agricultural extension. Moreover, there is the fascination of understanding how families cope with problems and situations that we as scientists tend to shy away from.

In addition to relevant, problem-focused research, agricultural scientists should provide the technology and ideas for future agricultural development activities. Of course, these scientists need to do the research before they can provide the answers requested. The stimulus for agricultural development should come more from researchers than from planners because researchers working in the systems approach know best the whole farming environment and its exigencies. In this way agricultural scientists will be able to serve their country better, bring credit to themselves, and gain greater support for their research institutions.

Background of Agricultural Research in Indonesia

Most Indonesian farmers own a small piece of land. This is true even of farmers in Java and Bali, Indonesia’s most populous islands. The average smallholding is 0.5 hectares per farm family. Lowland areas are dominated by rice farming, wherever water is available. Rice is usually grown twice a year in fully irrigated land, but only one crop is grown on lands with only five to seven months of irrigation. Such lands are kept fallow when irrigation water is insufficient for a second rice crop.
The greatest potential for an immediate increase in food crop production exists in these lowland areas, which usually have enough infrastructure in place to support efforts in intensified agricultural production. Even under the best circumstances, where considerable irrigation and drainage efforts have been made, there is still scope to increase the existing cropping intensity, and thus to increase food and rice production as well as farmers’ incomes.

The strategies used to accomplish this goal have included the introduction of early-maturing and improved crop varieties, direct seeding of rice, reduction in turnaround time between successive crops, and improved crop management techniques. To facilitate field research and to direct research to more location-specific issues, these land areas were usually partitioned, according to water availability, into the following categories for study:

- **Irrigated lowlands**
  - Full irrigation—for ten months or more
  - Partial (or no) irrigation—for seven to nine months, for five to seven months, or not at all
- **Rainfed uplands**
  - Drought-prone areas
  - Humid areas

Starting in 1972, on-site research was carried out in six sites in western Java, Lampung (southern Sumatra), and Madura (eastern Java).

**Irrigated Lowland Areas**

Inspection indicated that usually only two rice crops were grown in the areas fully irrigated and those irrigated for seven to nine months. Usually one crop of rice was successfully grown in the areas with less than full irrigation (if a second crop was planted, water shortages drastically reduced yields).

Cropping systems research successfully showed how these systems could be further intensified through the use of earlier-maturing crop varieties, the use of directly seeded rice (*gogo rancak*) in partly irrigated and rainfed areas, and a reduction in turnaround time. Component research developed more appropriate rates and methods of fertilizer application, insect control measures, and techniques of weed management.

The pattern of lowland rice-lowland rice-legume was successfully and profitably grown in the full seven-to-nine-month irrigation categories. A combination of directly seeded lowland rice (*gogo rancak*) and lowland rice—in the pattern *gogo rancak*-lowland rice-cowpea—permitted the production of three crops a year in the other categories (five months’ or no irrigation) where previously only one crop had been grown.

**Rainfed Upland Areas**

The second major target area for cropping as well as farming systems research was the rainfed uplands being used for transmigration program development in Sumatra, Kalimantan, and Sulawesi. In general, these areas receive rainfall that is sufficient and adequately well distributed for year-round crop production, but management constraints have prevented stable and sustainable food crop production. There also have been soil management, pest and disease, and socioeconomic problems that transmigrant farmers have not easily been able to overcome by themselves.

Initial research showed that the existing cropping patterns could be simplified and made more productive by growing crops in rows, using moderate rates of fertilizer application, and returning crop residues to the soil directly or as manure. The technology developed in central Lampung has been found to be applicable, with some modifications, to the humid areas of western upland Indonesia, where the rainfall is greater than 2,000 millimeters a year and where there is no distinct dry season. The basic pattern recommended is corn plus upland rice interplanted with cassava.
Research-Extension Linkage

The linkage of research and extension has been instrumental in furthering the developments mentioned above. In Indonesia this linkage is effected by:

- Transferring research results through publications, research reports, leaflets, and brochures
- Inviting the agricultural extension workers and subject matter specialists (SMSs) to attend monthly seminars, usually held by the research institutes
- Inviting the researchers to attend meetings, usually convened three to four times a year, of the agricultural extension staff to discuss the "impact points" in seasonal extension programs for the area or province selected
- Conducting a cropping/farming systems workshop (especially to support the transmigration program) handled by a farming systems working group and attended by staff from agricultural extension, from the Directorate-General for Transmigration, and from universities
- Hosting annual field days, usually done by the research institute, to show extension staff and key farmers what has been done, what is being done, and what is going to be done in the near future in location-specific agricultural research
- Training by researchers, at the request of agricultural extension, of the trainers of the SMSs (in several disciplines, commodities as well as cropping/farming systems).

Present State of Farming Systems Research

Cropping systems research in Indonesia started in 1972. The cropping systems research program has developed a methodology and a core of personnel capable of designing and carrying out on-farm research. Linkages with other commodity research groups and government agencies have been forged through the program. Gradually since 1980, a holistic farming systems research capability has evolved, especially in support of the transmigration program. To conduct research efficiently and effectively, however, it is still appropriate to identify and conduct research on specific issues that involve only two or three commodity groups or components.

In the upland rainfed areas, for example, food crop agriculture is necessary but usually is limited to only a part of the land owned by a farmer. The upland farmer finds it difficult to use more than 0.75 hectare of land for food crop production if only family labor is available. More extensive cultivation is highly risky because the soil is sensitive to erosion. In this situation, growing specific perennial and estate crops is quite feasible. Animal husbandry is equally feasible—not only for producing protein and increasing income, but also for providing animal power and manure to increase soil productivity.

Although the emphasis is on crops, integrated agricultural research in Indonesia considers all farm-related activities—from field preparation (including family labor, animal resources, and so on) to marketing of farm output. In the integrated research strategy, initial research concentrates on food crop production for the farmers' subsistence. Concurrent with this objective, constraints to increasing production or land use are identified.

For example, it was found that in upland areas of Indonesia family labor using hand tools can cultivate only about 0.6 hectares of land in a year. There is a shortage of machine power to make use of the remaining land resources. Animal power may be the solution. If so, the upland farmer will need animal-drawn farm machinery and forage for feed. Consequently, the farmer may be able to cultivate more land with this additional power and make use of even more area by putting some land into forage crops. Animal manure and excess forage for green manure can be used to improve the soil fertility. Additional land may be profitably used for the production of perennial crops for spices, food, fiber, and fuel. Furthermore, it is possible to develop structures for upland water control and soil conservation that can be used to impound water for family use, fish, and animals.
Cropping systems research, it must be stressed, is an integrated research—not only because it deals with several crops (rice-cereals-legumes/vegetables), but also because it encompasses disciplines such as insect management, plant spacing, and the amount and method of fertilizer application within the particular cropping system. Farming systems research amplifies research into cropping patterns by considering not only food crops but also other commodities (such as perennial or estate crops, livestock, and fishery) as components of the farming system.

In Indonesia, integrated cropping systems research has evolved into farming systems research—which is broader, in that it views the farm as an integral socioeconomic entity encompassing more than purely agronomic variables—but this approach has been systematic and hence manageable.

The terminology “food-crops-based farming system research” accurately describes the kind of agricultural research that has been conducted in Indonesia. The research is carried out by a coordinated, interdisciplinary group of scientists integrated among different government agencies and activities (such as extension, local government, irrigation, and national production programs). It is focused on specific target areas and is limited in scope to make more efficient use of research staff and funds. The methodology and staff that have developed in Indonesia are sufficiently strong to continue this research orientation. But renewed efforts, through long-term research projects, are needed to stabilize the gains that have been made. Although production of food crops sufficient for subsistence has been and will continue to be the primary focus in the development of farming systems research for small Indonesian farm operations, greater effort will have to be made to study and improve all production aspects of these operations.

**Problem Identification**

In Indonesia, farmers' production problems are identified by cropping systems/farming systems research teams who conduct a quick agroeconomic profile study for this purpose. The team usually comprises an agronomist, a soil scientist, a plant protection specialist, a specialist in animal husbandry (if needed), and two specialists in socio- or agroeconomics. The team usually is coordinated by the researcher specializing in socio- or agroeconomics. Whatever his specialty, the team coordinator should have some capability in linking the biophysical and socioeconomic aspects to be analyzed in the survey report.

The objective of an agroeconomic profile study is to gain an understanding of:

- The ongoing cropping and farming systems practiced by farmers and the reasons for these systems
- The biophysical and socioeconomic constraints to production—soil, climate (amount and distribution of rainfall), water availability, crops and varietal use, yield performance, inputs and output, labor profile (both potential productivity and current allocation of labor), markets for input and produce, infrastructure, and the like
- The researchable issues and priorities that can be suggested to the farming systems working group.

This study or survey is usually done over a period of not more than three months: one month is devoted to conducting the field survey (collection of primary data), one month to data tabulation and analysis, and one month to compiling the profile report.

**Inventory of Resources**

In addition to undertaking traditional commodity- and discipline-oriented research activities in Indonesia, we need to develop a systematic way of arriving at priorities for adaptive agricultural research for all disciplines within the Agency for Agricultural Research and Development (AARD). It is the view of AARD that agricultural research should precede agricultural development projects and even provide the initiative for such projects.

The first priority at the national level is to prepare an inventory of natural resources and of the present agricultural situation. The final stage in the process usually consists of developing a "land use capability
map." Such maps have been developed for Indonesia and are useful. But for researchers the information needed for the development of such maps may be more valuable than the final product. A series of overlays presenting a sequence—from the edaphological classification of land, through the physical determinants, and finally to the land uses for individual food crops and farming systems—would be more useful. Such a sequence would help researchers orient themselves and determine what research topics might have more relevance for all the disciplines involved in the research effort.

**Edaphological Classification of Land.** This classification attempts to delineate land areas that differ in the chemical and physical characteristics of the soil and in the water environment. Areas are classified without reference to climate or other overlapping factors such as slope or land form. As a first approximation, on the basis of experience and data available, Indonesia is classified by region according to upland, lowland (with various categories of irrigation), swamp, tidal, and mangrove areas.

**Environmental Determinants.** This section of the inventory is based on the most important environmental factors that determine the suitability of land for crop production and that will modify the edaphological map. The key factors are soil, rainfall, elevation, and slope.

**Present Land Use.** For the development of land or research objectives within an area, the most significant information on present land use and on cultivation practices is obtained from farmers. Research-extension linkages allow the information to flow upward from the farmers to the regional extension workers, to the provincial extension workers, and then to the researchers; in some cases, researchers obtain the information directly from farmers. The linkages are:

- Surveys of farmers and studies done by researchers and the extension workers in selected areas
- Seminars, workshops, technical meetings, and agricultural meetings attended by farmers, extension workers, and researchers
- Field days conducted by the research institutes (these usually take place once a year and focus on food crops), at which extension agents and key farmers discuss their technical problems and constraints on production with researchers
- Communications from extension workers and key farmers to researchers—at the institutes, at research stations, and at outreach sites in farmers’ fields—who are always willing to discuss agricultural questions.

On a national scale, the following land use classifications may be useful:

- Upland food crops
- Lowland rice (including *gogo rancah*, swamp, and *pasang surut* rice)
- Mixed *alang-alang* (*Imperata cylindrica* grass) and brush
- Forest (primary and secondary)
- Perennial estate crops
- Pasture.

The land use information delineated in preparing the land use capability map can be valuable in two ways. First, it is useful to relate land use for distinctly different crops or vegetation with different ecological needs to a physical setting that can be characterized. Further breakdown by crop or species of plant provides the “standards” for evaluating land capability and gives a basis for modifying present land use or for extrapolating a particular kind of land use to new areas having similar agroclimatic conditions. Second, production figures for different food crop commodities from different areas of the country provide a basis for comparison. If production figures for areas with similar agroclimatic conditions differ greatly, there is an ideal opportunity for analyzing the yield gap through relevant basic and applied research projects. Land use information classified in this way provides a rational basis for clarifying research priorities.
Table 7-1. Research-Extension Interface in Different Phases of a Cropping Systems Research Program in Indonesia

<table>
<thead>
<tr>
<th>Target area selected</th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Phase IV</th>
<th>Phase V</th>
<th>Technology transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSWG</td>
<td>CSWG</td>
<td>CSWG</td>
<td>CSWG</td>
<td>CSWG</td>
<td>CSWG</td>
<td>CSWG</td>
</tr>
<tr>
<td>Extension</td>
<td>Extension</td>
<td>Extension</td>
<td>Extension</td>
<td>Extension</td>
<td>Extension</td>
<td>Extension</td>
</tr>
<tr>
<td>Local government</td>
<td>Local government</td>
<td>Farmers</td>
<td>Farmers</td>
<td>Farmers</td>
<td>Farmers</td>
<td>Other</td>
</tr>
<tr>
<td>National government</td>
<td>Local government</td>
<td>Local government</td>
<td>Directorate of Food Production</td>
<td>National production program</td>
<td>National government</td>
<td>agencies</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

CSWG: Cropping systems working group, the multidisciplinary research group that coordinates and carries out the plans of cropping systems research programs in a target area.

Note: This schematic represents the research-extension workload distribution and interaction with farmers and other government agencies in different phases of cropping systems research and implementation.
Selection of Target Areas for Applying Integrated Research

Integrated research is a coordinated and cohesive effort to develop technology that will enable farmers to increase production. The technology eventually recommended must be acceptable to the farmers who will use it. In some cases it may be desirable to identify and remove constraints to increased production through government programs. Production may be increased if present farming systems are better managed, an extra crop (or crops) or form of husbandry is introduced each year (intensification), or agricultural activities are expanded into newly opened or underused land areas (extensification).

The integrated research is carried out by a coordinated, interdisciplinary group of scientists. It concentrates on specific target areas to make more efficient use of limited research staff and funds. The target areas for applying integrated research must be carefully selected.

The Indonesian research program emphasizes the following criteria for the selection of target areas.

- The area should have government priority for the production of food crops.
- In the case of large areas, soils and climate should not vary markedly.
- Prior evidence should indicate the feasibility of intensifying cropping patterns and farming systems.
- Markets and infrastructure should be available.

A diagram of cropping systems research in Indonesia (table 7-1) shows five distinct phases and research activities (and the groups of people associated with each) that occur after the target area has been selected and before the improved technology can be transferred.

Table 7-1 can also be viewed as a general description of the activities and intentions of farming systems research. It illustrates how research is integrated with other government agencies, with farmers, and with private enterprise in all phases of research and development—a linkage that is vital for the identification of research problems and for the subsequent implementation of results. In specific target areas, different research activities and approaches will need to be emphasized because of the varying natural conditions, stages of development, and availability of technology.

Concepts for the Design of Cropping Systems. In some instances, crop or cropping systems research simply amounts to testing crop sequences in the farmers’ fields under different environmental conditions. The approach in Indonesia has been to test different categories of patterns that depend on the level of technology sought or available.

When the Indonesian program started in 1975, three cropping patterns were tested in each category (items 1, 2, and 4 of table 7-2) for each target area. Each trial was replicated by three farmers. The cropping sequences tested in each category were not necessarily the same but were chosen on the basis of the same criteria. The categories and the rationale for each are presented in table 7-2.

The use of these categories for the design of cropping patterns has been successful. It has allowed researchers to be objective and has prevented them from becoming bogged down in evaluating small differences in results from using different species of legumes or varieties of rice while they are testing many different cropping sequences. Such refinements are necessary but are the kind of component studies that are never finished.

In our studies, however, we have been aware of the severe economic stress faced by many Indonesian farmers. They simply do not have the money for material inputs or, if they do have the money, they are afraid to take the risk. This is particularly true of farmers who have seldom worked with the extension service. It was therefore necessary to develop cropping patterns that could be adopted at low cost and with little risk. If the technology is good and shows evidence of being profitable, poor farmers will accept it and gradually learn how to use additional inputs.

For this reason we added category 3 to the design process (table 7-2). It has helped us find ways to make more efficient use of the tremendous energy, land, water, and labor resources in Indonesia and to induce farmers to adopt the technology developed.
The Rationale for Farming Systems Research

The physiological, agronomic, and technical aspects of agricultural research may be studied in the laboratories and research stations. The potential for increasing total production is evident from this kind of conventional research, even if many times the technology used is inappropriate for adoption by small farmers in the developing countries of the tropics. The contrasting situations of the developed and less developed areas of the world must be recognized even at the risk of oversimplification. In developed countries, where farmers are likely to be well educated and economically strong, published and disseminated research information may be sufficient to meet the farmers’ needs. Farmers are able to apply the technology, assume the risk, and readily evaluate the technology within their context. In developing countries, however, farmers in general are undereducated, financially weak, and may often be afraid to assume the financial risk and peer pressures associated with change. In this case, technology must be developed and tested systematically and extended to farmers in a simplified form, in line with the constraints they face and the ability to remove those constraints.

Production programs have been developed and financed to solve some of these problems. Technological packages were made available to farmers with credit facilities through such programs as MASAGANA 99 in the Philippines and BIMAS' in Indonesia that increased production of individual crop commodities. Although these steps forward were successful, many farmers did not greatly benefit from the efforts and did not continue to participate. The basic problems of development and adoption of appropriate technology by farmers were not solved by these early production programs.

Before programs for crop commodities and cropping systems reach the stage of implementation, they must be preceded by research conducted under conditions approximating those of the farmers to be served. The research and implementation must be target-area specific. The first step, as has been described earlier, is to conduct preliminary research in the farmers’ fields under the researcher’s management to get some idea of crop performances and production potential within a target area. If this looks promising, the cropping patterns that have been designed should be further tested, as much as possible, under prevailing conditions in farmers’ fields.

Methodology Used for Research on Farmers’ Fields

In western Java, Lampung, South Kalimantan, and Southeast Sulawesi, the Indonesian cropping systems program has been effective in developing and implementing research in farmers’ fields with the following methodology.

Table 7-2. Categories for the Design of Cropping Systems

<table>
<thead>
<tr>
<th>Category of cropping pattern</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Farmer’s present cropping pattern (monitored)</td>
<td>To establish a baseline for comparison</td>
</tr>
<tr>
<td>2. Cropping pattern farmer would choose if input and market constraints were removed</td>
<td>To evaluate the farmer’s pattern in the absence of constraints, to evaluate the farmer’s level of competence and managerial skill, and perhaps to uncover hidden socioeconomic constraints</td>
</tr>
<tr>
<td>3. Introduced pattern with low-cost inputs</td>
<td>To induce the farmer to try new technology gradually</td>
</tr>
<tr>
<td>4. Introduced pattern with input and market constraints removed and technical assistance provided</td>
<td>To determine production and economic potential and the ability of research to remove constraints</td>
</tr>
</tbody>
</table>

1. In the BIMAS program the government provides farmers with credit for seeds, fertilizer, and insecticides, while the extension service instructs them in the application of fertilizer and water, the use of insect controls, and soil management to grow the recommended varieties of rice. The BIMAS program could be successful only if farmers could be assured of a good market for their rice. Unfortunately, the price of rice has gone down in the peak harvest season, so that farmers have not increased their incomes even though they have increased rice production to reach national goals. Sustained adoption thus depends on an assurance that the additional investment will be more than compensated by significant additional returns.
A team (cropping systems working group, or CSWG) comprising a coordinator, agronomist, plant protection specialist, and socioeconomist was stationed in each target area. A team leader and field assistants for agronomy and economics were put in charge of the fieldwork and the collection of input-output data within each site in the target area. A system for collecting daily farm records for all buying and selling activities was implemented in cooperation with farmers (about thirty) in each target area to obtain a larger base for socioeconomic evaluation—especially to determine whether the technology is culturally acceptable and manageable within the community.

Our experience is that the organization of the research and of the research team should be as simple and self-contained as possible. The team coordinator should have the flexibility to implement the research once the general guidelines for trials, patterns, organization, and staffing have been decided. He should have mobility so that he can visit the sites and research plots frequently, talk with the farmer cooperators, and develop linkages with the extension service and local government officials. He should assume the responsibility for summarizing and preparing a draft report of the research results. Above all, he should, in consultation with his staff, critically analyze the research in progress and prepare a tentative project proposal for the following year. The involvement of those close to the field research activities is the key to successful and relevant research and staff development.

The Indonesian program has usually replicated the field trials in the fields of different types of farmers. This has been successful primarily because the target area had been partitioned into categories. For each cropping pattern tested, three farmers within a category were randomly selected as cooperators after screening by criteria relating to land tenure, size of farm, cropping system, location, and desire to cooperate. Each farmer agreed to permit 0.1 hectare of land to be used for the research. He provided the labor, and the project provided the necessary inputs. The farmer was compensated for any losses and extra labor caused by the project. All data concerning labor and input costs were collected. The cash flows of the farmers cooperating in the agronomic test group and of those cooperating in the economic test group were monitored. The data were reported in terms of yields, gross returns, labor costs, material costs, and net returns for each pattern in each category. The data from farmers cooperating in the economic test were summarized in the same way to establish more precisely the economics of the farmers’ cropping patterns and to understand their farm operations.

The Flow of Research Information: What Private and Public Sectors Should Do

In our experience, the smooth and continuous flow of agricultural research information between the source and the user is always a problem. Even in the most developed countries there is usually a feeling that the dissemination process could be made more efficient and the feedback more relevant. There is a common feeling among researchers, on the one hand, that the extension agents do not see the broader issues and that extension workers should not only transfer information but also adapt the available information to meet the users’ needs. Extension workers, on the other hand, feel that much research is not relevant to the needs of their clientele and that researchers are so far removed from the farm that they do not appreciate the farmers’ problems.

There is some truth in both views. The important thing to remember, however, is that both research and extension workers are equally concerned about doing a good job and that more frequent formal and informal work contacts can do much to solve communication and linkage problems.

In general, the institutional linkages between research and extension are about the same in developed and developing countries. Yet linkage seems to be a bigger problem in developing countries.

The difference lies not in the official linkages but in the lack or scarcity of informal means of communication. Much of the dissemination and extension of research findings in many of the developed countries is done through commercial publications, agribusinesses, and credit institutions. Commercial publications are usually much faster in communicating new findings from public and private research institutions than are the official dissemination sources. Agribusinesses such as fertilizer and seed suppliers are equally fast
Identification of Farmers' Production Problems

and effective in disseminating technology and information through personal contacts and publications. Most banks and loan agencies also have field agents who work hard to see that credit is used wisely and effectively. Consequently, the public research and extension agencies in the developed countries are complemented by privately funded activities that provide good linkages between the two groups, the developers and users of technology. The technology flow and feedback is effective, even though the linkages are not rigidly institutionalized.

Developing countries, however, do not have a strong private sector. Therefore it is important that public institutions in these countries make a greater effort to see that mechanisms for the flow of technology and feedback are more highly developed and institutionalized. In this way, the problem of communication between institutions can be solved.

Table 7-3. Research-Extension-Institutional Linkages in Cropping Systems Research and Development for Selected Target Areas, Bogor, Indonesia, 1979

<table>
<thead>
<tr>
<th>Components Activity</th>
<th>Phase I Site selection and description</th>
<th>Phase II Biological and economic evaluation</th>
<th>Phase III Design and testing of cropping patterns</th>
<th>Phase IV Preproduction testing</th>
<th>Phase V Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Physical Soil taxonomy Rainfall distribution Irrigation Other climatic data</td>
<td>Sequential agronomic testing on small plots Varieties Fertilizer response Crop combinations Other component technology</td>
<td>Partition of target area Water availability Soil capability Market accessibility</td>
<td>Research managed plots on 3–4 Increase visibility and demonstrate potential</td>
<td>BIMAS' type of program for cropping patterns, not commodities</td>
</tr>
<tr>
<td>Economic Agroeconomic profile</td>
<td>Economic farm recording Income Labor Market price</td>
<td>Pattern design Farmers' design—monitor only Farmers' design—optimum management Improved design—low input Improved design—optimum management</td>
<td>Village level Identify biological and institutional constraints to large scale production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methodology Data collection and survey</td>
<td>Secondary data and small plots Agroeconomic evaluation in farmers' fields</td>
<td>Field-level evaluation</td>
<td>Production program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsibility Research and extension</td>
<td>Research Research All relevant agencies</td>
<td>All agencies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time frame Initial</td>
<td>Years 1–2 Years 1–3 Years 3–5</td>
<td></td>
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</tr>
</tbody>
</table>

a. In this and succeeding phases, all planning must be coordinated by the Provincial Planning Agency (BAPPEDA).
b. Production program for lowland rice.
c. Standardized data collection, data handling, data processing, and reporting.

Source: Central Research Institute for Agriculture (Bogor, Indonesia), July 1979.
There is still, however, a problem of communicating with the farmer and learning his needs. In many instances this requires on-site research. One of the purposes of cropping and farming systems research is to solve these problems of research and research dissemination. Table 7-3 illustrates the phases of a cropping system research project in a selected target area. Linkages are established among farmers, research, extension, and other government agencies as each group carries out its responsibilities within the project activities. The relative proportions of the workload distribution between research groups (CSWG) and the other responsible groups are illustrated in table 7-1. The important point that needs to be emphasized with respect to linkages is that closed and more constant contacts are necessary if farmers' needs are to be communicated to researchers and other government institutions and if technology is to be effectively transferred from researchers through extension to farmers.

Figure 7-1. Parallel Biological and Socioeconomic Activities Required for the Five Research and Implementation Phases of a Farming Systems Program

<table>
<thead>
<tr>
<th>Socioeconomic research</th>
<th>Phase</th>
<th>Biological and soil research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agroeconomic profile</td>
<td>I (initial)</td>
<td>Data collection:</td>
</tr>
<tr>
<td>Site reconnaissance</td>
<td>Selection and description of site</td>
<td>Soil classification</td>
</tr>
<tr>
<td></td>
<td>Partitioning of area</td>
<td>Climate</td>
</tr>
<tr>
<td>Economic data collection</td>
<td>II (years 1–5)</td>
<td>Soil and water losses</td>
</tr>
<tr>
<td>Technology transfer IN</td>
<td>Identification of economic and biological potential</td>
<td>Identification of technologies and institutions</td>
</tr>
<tr>
<td>Farm recording</td>
<td>Quantification of problems</td>
<td>Test farms</td>
</tr>
<tr>
<td>Economic analyses of systems</td>
<td>III (years 2–5)</td>
<td>Expansion program</td>
</tr>
<tr>
<td>Farm recording</td>
<td>Design and testing of farming systems</td>
<td></td>
</tr>
<tr>
<td>Evaluation of technologies and institutions</td>
<td>IV (years 3–6)</td>
<td></td>
</tr>
<tr>
<td>Agricultural statistics</td>
<td>V Implementation and technology transfer OUT</td>
<td></td>
</tr>
</tbody>
</table>

Note: The program is designed both for little inflow and for significant inflow of technology from research to farmers. With a significant transfer of technology, the research time in a target area may be reduced by two or more years.
Technology Transfer

There are two effective ways to improve the efficiency of the development and use of agricultural technology.

*Research Coordination*

This term has been used many times and will be used again to emphasize the importance of providing a format by which researchers have some feeling of research priorities but are not constrained by rigid boundaries of inquiry. Coordination can provide the framework that encourages collaboration not only among researchers but between them and extensionists and farmers. It discourages repetition of preliminary and shallow research yet provides a mechanism for the transfer of technology among scientists.

*Site Description and Technology Transfer*

Systematic socioeconomic, soil, and biological descriptions of research sites provide the basis for technology transfer to target areas with similar conditions. Figure 7-1 illustrates the mechanism and time frame for this kind of technology transfer. It is not necessary to repeat all the research phases of a farming systems project in each target area. It is important, especially in Indonesia and other developing countries, to make efficient use of research funds by laying out a series of observation trials on farmers' fields that can be used quickly to adapt information gathered over a longer time in a similar agroecological zone.
A Farming Systems Research Approach to Identifying Farmers' Production Problems

Arturo A. Gomez

The process of identifying farmers' production problems is one of the most important activities in farming systems research (FSR). Implementation of the process must therefore be consistent with the central rationale of the research approach. I briefly review such a rationale here and then derive from the features of FSR a detailed methodology for identifying farmers' most pressing production problems.

It should be emphasized at the outset that the methodology proposed here is only one of several alternatives. This particular alternative, however, has been used and tested extensively in the Philippines (see IRRI 1979 and Quisumbing 1983), and the results suggest that it is applicable to and appropriate for the entire Asian region.

Rationale and Features of FSR Approach

The rationale and basic features of an FSR approach are as follows:

- The ultimate objective of FSR is to increase farm productivity and income. Traditional agricultural research has been concerned mainly with the development of technology and the increase of knowledge; the dissemination of such technology and knowledge has been seen as beyond the domain of research. The FSR approach, however, views increasing farm productivity as its final goal, one that can be attained only with the farmers' acceptance and use of the newly developed technology. The link with agricultural extension and the realities of the local farm community is therefore implicit, although such linkage is often neglected.

- The biophysical and socioeconomic environment of each farm is different from that of any other, and the appropriate production technology for each farm is also expected to be unique. Whereas the objective of traditional research has been to provide one or two sets of recommended practices to cover a large number of farms in a country or region, FSR recognizes the uniqueness of each farm and strives to devise a congruent, appropriate package of practices for each.

- The optimal package of technology for each farm cannot be derived solely from the results of trials conducted at experiment stations, but must also be based on existing farm practices and the results of actual farm trials. Whereas traditional agricultural research has relied mainly on research station experiments, the FSR approach requires more work with farmers on their own farms.

- The design of optimal production packages for a large number of farms requires the participation of a large number of workers to conduct farm-level research. Whereas traditional research has usually been conducted at a few locations by a few highly trained scholars, the FSR approach requires more people. Consequently, the methodology should be simple enough to be followed easily by the majority of the additional agricultural development workers needed.

Identification and Quantification of Farm Production Problems

The questions that might be addressed in designing a methodology for identifying farmers' production problems are:
Identification of Farmers' Production Problems

- Who can identify the problems and in what capacity can they do so?
- What are these problems, whose are they, how can they be identified?
- Who then solves the problems?
- Is the research system responsive to changing farm circumstances?

The Basic Premise

If the primary goal of FSR is to increase farm productivity and income, it follows that production problems should be ranked according to their potential for increasing productivity and their “researchability” (potential for being solved through research). Researchable production problems with the greatest potential for increasing farm yield and income should clearly be given the highest priority.

A similar definition of farm production problems has been arrived at by researchers at the International Rice Research Institute (IRRI) in their work on constraints to increasing rice yield (Gomez and others 1979). By defining several yield levels (figure 8-1) and the gaps between them, researchers can identify the farm production problems that are preventing farmers from maximizing farm productivity and income. By this definition, the yield gap of critical importance is the difference between the economic farm yield and the actual farm yield, and the farm production problems given priority are those that prevent the actual farm yield from reaching the economic farm yield.

With this objective basis for ranking problems, the question who identifies the problem and whose problems are being identified becomes less critical. By definition, the importance of a problem rests on its contribution to bridging the yield gap and not on who experiences the problem. Furthermore, with the objective basis with which problems are quantified, the ranking of such problems should remain the same.

Figure 8-1. Conceptual Model of the Constraints on Farm Yields

Source: Adapted from Gomez (1977).
regardless of who makes the measurement. To answer the remaining questions, the next sections focus on the methodology for identifying and quantifying priority farm production problems and on the structure of a research organization that is responsive to a dynamic farm environment.

A Methodology

The FSR approach to identifying and quantifying farm production problems includes the following steps (shown in figure 8-2):

**Figure 8-2. Flow Chart of Procedures for Identifying Farm Production Problems**

**STEP 1**

- Conduct farm survey
- Inventory existing data
  
  - Biophysical and socioeconomic environment of farms
  - Existing production practices
  - Actual farm yields

**STEP 2**

- Inventory results of technology-generation experiments
  
  - Improved production practices

**STEP 3**

- On-farm verification trials
  
  - Total yield gap
  - Biophysical farm production problems

**STEP 4**

- Economic analysis of yield gap
  
  - Component technologies that are economical for farmers to adopt
  - Economic causes of biophysical farm production problems

**STEP 5**

- Follow-up study
  
  - Reasons for nonadoption of improved technology
  - Socioeconomic causes of biophysical farm production problems

*Note: Procedural steps are shown in the boxes; the output of each step is indicated by the arrows connecting successive boxes.*
**Step 1.** Take an inventory of the existing farm environment and farm management practices:

a. Conduct a thorough search of available information about the farm environment in question. Data on rainfall, solar radiation, soil characteristics, average crop yield, and market outlets may be available.

b. Conduct a farm survey that focuses mainly on the existing farm practices and farm productivity, farm resources, and usual input and output markets. All data not available in (a) should be addressed by this survey. For example, if soil characteristics cannot be ascertained in (a), soil samples for laboratory analysis may be taken during the survey process.

**Step 2.** Conduct a thorough search of available production technologies that are applicable to the farm environment as defined in step 1. Use this information, together with that obtained in step 1, to design a set of recommended practices that are expected to improve yield and farm income.

**Step 3.** Conduct on-farm trials to determine actual farm yields under existing practices and the corresponding yields for the practices recommended in step 2.

**Step 4.** From the results of the farm trial in step 3, identify the components of existing farm practice that cause large reductions in yield.

**Step 5.** Conduct a follow-up study to determine why farmers are not adopting the recommended practices that have been shown to increase yield and farm income.

Note that the above procedure uses both agronomic experiments and the farm survey. The agronomic experiments are designed primarily to measure the biophysical constraints, and the farm survey is designed to identify the farmers' socioeconomic and institutional constraints to achieving higher yields and incomes.

**An Example**

The procedure described above has been applied to a monocrop of rice in several countries in Asia (IRRI 1979), to a monocrop of corn in several locations in the Philippines (Mercado 1981), to a rice-based (but not monocrop) cropping system in Central Luzon (Gomez and Gomez 1983) and, more recently, in all of the more than seventy provinces of the Philippines (Quisumbing 1983). The example described here is the experience in a town in Central Luzon (Urdaneta, Pangasinan).

The primary crop in the target area is rainfed rice. Average yearly rainfall is 1,816 millimeters. The topography is flat, and the soil texture is primarily sandy loam.

A farm survey concentrating on the enterprises and productivity in a sample of 200 farms was conducted in one week by four junior researchers. Shown in Table 8-1 are the kinds of questions the researcher asked of the farmer on each sample farm. The average time required for an interview was thirty minutes per farmer. The important information derived from these interviews (Tables 8-2 and 8-3) was the following:

- Rice-mungbean is the most commonly used cropping pattern, followed by rice-rice and rice-fallow.
- Rice yield usually exceeds 3 metric tons per hectare per crop, but mungbean yield is only about a tenth of that for rice (300 kilograms per hectare).
- Improved varieties are used for rice but not for mungbean.
- Fertilization is quite high for rice but almost nonexistent for mungbean.
- Hardly any weed control is given to mungbean.

On the basis of the above findings and knowledge of the physical environment of the target area, it was decided that rice-mungbean was a suitable cropping pattern for the farming system and that farmers' priority production problems revolved around improving the yield of this pattern.

The results suggested that the main limitations and technologically inappropriate features of the farmers' current ways of cultivation were use of low-yielding varieties, poor pest control, and lack of fertilizer for mungbean; and low fertilizer application and poor pest control for rice. Given these problems, a set of
Table 8-1. Farm Features and Corresponding Kinds of Questions Included in Farm Survey for Verification of Technology, Urdaneta, Pangasinan, Philippines, 1978

<table>
<thead>
<tr>
<th>Farm feature</th>
<th>Question asked</th>
<th>Number of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household members</td>
<td>Age, occupation, educational attainment</td>
<td>3</td>
</tr>
<tr>
<td>Whole farm</td>
<td>Area, number of parcels</td>
<td>2</td>
</tr>
<tr>
<td>Largest farm parcel</td>
<td>Area, soil texture and fertility, slope, irrigation, distance from road, cropping patterns</td>
<td>9</td>
</tr>
<tr>
<td>Most important cropping pattern</td>
<td>Management practices for each crop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crop, variety, planting area, date planted and harvested, tillage, planting method, fertilization, insect control, weed control, rodent control, adequacy of inputs, pest and other problems.</td>
<td>39</td>
</tr>
<tr>
<td>Credit</td>
<td>Amount borrowed, source, terms, adequacy</td>
<td>6</td>
</tr>
<tr>
<td>Production</td>
<td>Total yield, operator’s share, labor’s share, amount sold, price, transportation to market</td>
<td>5</td>
</tr>
<tr>
<td>Expenses</td>
<td>Farm and nonfarm</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>Power source, farmer’s willingness to cooperate in field trial</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Multiple Cropping Section, Department of Agronomy, University of the Philippines at Los Baños.

Table 8-2. Hectarage and Yields of the Five Major Cropping Patterns in Urdaneta, 1978

<table>
<thead>
<tr>
<th>Cropping pattern</th>
<th>Hectarage (percent)</th>
<th>Yield (metric tons per hectare)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice-mungbean</td>
<td>30.9</td>
<td>3.404</td>
<td>0.324</td>
</tr>
<tr>
<td>Rice-rice</td>
<td>17.0</td>
<td>3.392</td>
<td>2.786\textsuperscript{a}</td>
</tr>
<tr>
<td>Rice-fallow</td>
<td>15.1</td>
<td>3.435</td>
<td>n.a.</td>
</tr>
<tr>
<td>Rice-mungbean-corn</td>
<td>9.7</td>
<td>3.852</td>
<td>0.752\textsuperscript{b}</td>
</tr>
<tr>
<td>Rice-tomatoes</td>
<td>6.0</td>
<td>3.726</td>
<td>2.021</td>
</tr>
</tbody>
</table>

n.a. Not applicable.  
\textsuperscript{a} Second rice crop.  
\textsuperscript{b} Combined yield for mungbean (0.316) and corn (0.436).  
Source: Multiple Cropping Section, Department of Agronomy, University of the Philippines at Los Baños.

recommended practices (Table 8-4) was designed using the procedure shown in figure 8-2, and the corresponding minimum yield increase over the farmers' actual yield needed to make the new practices profitable was estimated (Table 8-5).

An agronomic test was then conducted on several farms to compare the yield of the recommended practice with that of the farmers' practice. The results (Table 8-6) showed that substantial improvements in yield and profit were possible for mungbean but not for rice. Better fertilizer application and pest control for rice would increase yield but would increase production costs even more—and therefore would not be economic. This finding meant that farmers' practices for rice were adequate (that is, production problems for rice were few), but that practices for mungbean had large potential for improvement or had several important production problems.

A follow-up study focusing on farmers' reasons for not using improved practices on their mungbean crop, although not implemented because of the lack of time and funds, could have identified the socioeconomic constraints that prevented farmers from taking advantage of improved practices.

<table>
<thead>
<tr>
<th>Management practice</th>
<th>Rice</th>
<th>Mungbean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation and tillage</td>
<td>Puddling</td>
<td>Dryland tillage</td>
</tr>
<tr>
<td>Variety</td>
<td>Improved</td>
<td>Local (78 percent)</td>
</tr>
<tr>
<td>Cost of chemicals in U.S. dollars per hectare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilization</td>
<td>56.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Insect control</td>
<td>6.35</td>
<td>10.17</td>
</tr>
<tr>
<td>Weed control</td>
<td>7.59</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Source: Multiple Cropping Section, Department of Agronomy, University of the Philippines at Los Baños.

Table 8-4. Components of New Production Technology Designed for Verification in Urdaneta, 1978

<table>
<thead>
<tr>
<th>Component technology</th>
<th>Rice</th>
<th>Mungbean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>Farmer’s level(^a)</td>
<td>CES 55</td>
</tr>
<tr>
<td>Fertilizer (N-P-K, kilograms per hectare)</td>
<td>90-30-30</td>
<td>45-45-45</td>
</tr>
<tr>
<td>Insect control</td>
<td>Furadan + Brodan (two times) + Gusathion (two times)</td>
<td>Fungitox (two times)</td>
</tr>
<tr>
<td>Weed control</td>
<td>Handweeding (four times)(^b)</td>
<td>Farmer’s level(^b)</td>
</tr>
<tr>
<td>Planting method</td>
<td>Farmer’s level(^a)</td>
<td>Zero tillage and seeds dibbled</td>
</tr>
</tbody>
</table>

\(^a\) "Farmer’s level" indicates existing practices for varieties and cultivation methods used (as specified in table 8-3).
\(^b\) From planting up to forty days after transplanting.

Source: Multiple Cropping Section, Department of Agronomy, University of the Philippines at Los Baños.

Toward a Research System Responsive to Farmers' Production Problems

Agricultural research has traditionally concentrated its efforts in research stations, a concentration motivated by the rather doubtful assumption that the priority production problems and the best production technologies on research stations are the same as those on actual farms. It is this false or unproven assumption that is the primary culprit behind the nonresponsiveness (or inadequate responsiveness) of the agricultural research system to changing conditions on the farms.

My proposal is to augment the existing research stations with a network of on-farm trials that has the following features:

- Actual farms would be the test sites. The existing biophysical and socioeconomic farm environment would be maintained, and no substantial modifications in grading, irrigation facilities, access to markets, or labor availability should be attempted.
- Sample farms would be selected to represent the strata of the farming system and the environment being evaluated. The number of sample farms is expected to be large and to be distributed over a wide geographical area.
- Existing rural development workers, instead of newly hired research personnel, would be the primary source of manpower for implementing the on-farm trials.
- Verification of the superiority of the new technology over the existing farming practices would be the primary objective of most trials.
- Farmers would be involved in the evaluation process through the use of experimental plots that they themselves manage.
Table 8-5. Economic Feasibility of Component Technologies for Rice-Mungbean Cropping Pattern for Verification Trials in Urdaneta, 1978

<table>
<thead>
<tr>
<th>Component technology*</th>
<th>Added cost (U.S. dollars per hectare)</th>
<th>Break-even yield increase (metric tons per hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice crop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer</td>
<td>26.63</td>
<td>0.16</td>
</tr>
<tr>
<td>Insect control</td>
<td>22.98</td>
<td>0.14</td>
</tr>
<tr>
<td>Weed control</td>
<td>5.74</td>
<td>0.03</td>
</tr>
<tr>
<td>Mungbean crop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variety</td>
<td>10.50</td>
<td>0.01</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>64.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Insect control</td>
<td>15.50</td>
<td>0.02</td>
</tr>
</tbody>
</table>

a. As described in table 8-4.

Source: Multiple Cropping Section, Department of Agronomy, University of the Philippines at Los Baños.


<table>
<thead>
<tr>
<th>Item</th>
<th>Rice</th>
<th>Mungbean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of trials</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Yield of new technology (metric tons per hectare)</td>
<td>3.65</td>
<td>1.08</td>
</tr>
<tr>
<td>Yield of farmers practice (tons per hectare)</td>
<td>3.10</td>
<td>0.76</td>
</tr>
<tr>
<td>Yield gap (tons per hectare) due to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All test factors</td>
<td>0.55</td>
<td>0.33</td>
</tr>
<tr>
<td>Insect control</td>
<td>-0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Fertilization (rice)/variety (mungbeans)</td>
<td>0.17</td>
<td>0.32</td>
</tr>
<tr>
<td>Weed control (rice)/land preparation (mungbean)</td>
<td>-0.35</td>
<td>0.05</td>
</tr>
<tr>
<td>Added output value (US$ per hectare)</td>
<td>73.00</td>
<td>176.00</td>
</tr>
<tr>
<td>Added input cost (US$ per hectare)</td>
<td>237.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Added return (US$ per hectare) from:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All test factors</td>
<td>-164.00</td>
<td>175.00</td>
</tr>
<tr>
<td>Insect control</td>
<td>-104.00</td>
<td>53.00</td>
</tr>
<tr>
<td>Fertilization (rice)/variety (mungbean)</td>
<td>-47.00</td>
<td>160.00</td>
</tr>
<tr>
<td>Weed control (rice)/land preparation (mungbean)</td>
<td>-121.00</td>
<td>48.00</td>
</tr>
</tbody>
</table>

Source: Adapted from Santos and Gomez (1981).

Thus, the primary function of the on-farm trials would be to validate the applicability of research station results in the actual fields of farmers and to feed back to researchers the farmers' production problems that need immediate attention. A two-way continuum for furthering agricultural development would thus be established. By this mechanism it is expected that the agricultural research system can continuously improve its responsiveness to both existing and changing farm conditions.
Conclusions

From the perspective of the rural development worker, the production problems that beset his farmer clientele are often too numerous to be effectively addressed simultaneously. It would be most useful if these problems could be quantified and arranged according to their urgency so that only a manageable fraction of them could be addressed at one time.

The FSR approach offers a simple procedure for quantifying farmers' production problems. This research approach is characterized by its focus on the farmer and his existing practices in order to arrive at new production technologies that can increase farm productivity and income. In accordance with the FSR approach, the steps described in this chapter and shown in figure 8-2 can be followed in identifying and quantifying farm production problems.

Although this procedure was developed by a team of highly trained, interdisciplinary researchers, in its present form it is simple enough to be used and applied by a large number of rural development workers. Furthermore, on-farm trials conducted for technology verification should provide useful linkage and feedback to the traditionally strong research undertaken at experiment stations. On-farm trials and experiment station research form a two-way continuum that should provide the developing countries of Asia (and of other regions) with an agricultural research system that is highly responsive to both existing and changing farm circumstances.

References


The term farming systems research (FSR) is used to describe a range of activities with varied objectives and approaches, although these usually have been associated with agricultural research. This diversity has caused confusion over the role of FSR in agricultural development. Projects to devise new, often technically sustainable or economically optimal farming systems have come under the FSR umbrella. The “Unités Experimentales” in the agricultural research programs of francophone West African countries are examples. Some international agricultural research centers, such as the International Institute of Tropical Agriculture (IITA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), have embraced soil and water resource management programs within an FSR program.

Increasingly, FSR refers to the application of a systems perspective in identifying technologies appropriate for location-specific farm situations or systems. Both Arturo Gomez, in chapter 8, and Glenn Denning, in chapter 12, provide significant evidence from the Philippines, particularly from the International Rice Research Institute (IRRI), that confirms our experience in Mexico and Kenya as to the contribution of FSR to specifying emerging technologies in line with variable local farm circumstances. By acting as an interface between the technical perspective of researchers and the managerial perspective of small farmers, FSR helps build up a continuum from the identification of farmers' priority problems and opportunities, through the research and extension process, back to the farmer. Perhaps the greatest potential of FSR lies in the insight it can provide into existing smallholder systems; this is the role addressed here.

In the present early stage of the application of FSR to agriculture in the developing countries, it is still safest to look behind the phrase to the objectives of the research and of the research approach being applied to avoid confusion over the term itself.

The closer that farmers operate to the subsistence level, the more important is effective problem identification. It is obvious, although often overlooked, that farmers themselves make the decisions about what is good for them. Among other things, they decide whether to adopt innovations in the light of the economic circumstances within which they operate. A thousand and one problems can be observed on any farm, all reflecting eventual development opportunities. But small farmers will be most willing to reallocate limited resources—whether of cash, labor, or land—to implement appropriate solutions to current problems that most inhibit a better realization of their priorities. Hence, there is a need to understand farmers' priorities, and how current management practices and the resource allocations these imply limit their satisfaction, in order to identify the problems farmers would be most interested in solving.

This chapter has six sections. The introductory paragraphs that follow outline the sections, touch on the issue of terminology, and emphasize the importance of effective problem identification to the development of smallholder agriculture. The second section outlines some important concepts underpinning the application of FSR as a means of effective problem diagnosis. The third and fourth sections detail, respectively, an FSR approach and FSR methods. The fifth section reviews the potential for FSR in technology generation (and, through this, in linking research, extension, and farmers in an interactive continuum), in project identification and preparation, and in policy formulation. The final section sets out some current and longer-term needs if the potential of FSR is to be realized.

Underpinnings to the Use of an FSR Approach

The first and most fundamental fact to recognize in attempting to understand small farming systems is that small farmers behave rationally and purposefully.
Small-Farmer Rationality

As in any population, levels of motivation and ability vary among small farmers, but within this diversity and within the limits of the knowledge available to them, small farmers work toward the achievement of their own goals. These goals change with development. Small farmers with a low resource base and low incomes are dominated by the priorities of subsistence farming: producing a supply of food, day in and day out, for their families. As income levels rise, subsistence priorities are first balanced, and then outweighed, by cash-earning goals. Farmers’ priorities can be thought of as the “engine” of their farming systems. Where subsistence dominates, risk aversion (avoiding a failure in food supply in all likely circumstances) dictates many farmers’ decisions, their management strategies, and much of their resource allocation, and thus the organization of their farming systems.

Small Farms as Systems

As has been repeatedly intimated, small (and large) farmers operate their farms as systems. This is the second underpinning to the use of FSR, and all concerned with agricultural research and development should know what this implies for both understanding and improving farmers’ performance. Farmers do not seek technical optima, or even optimal economic results, from a single activity. They seek to satisfy their priorities through a combination of activities. Such activities compete for land, labor, and cash—one or more of which are always scarce—often at the same time in the season. This competition obliges the farmer to compromise the quality of his management of a particular farm activity in the interest of the performance of the system as a whole. Husbandry of poor quality is not necessarily bad farm management; it may in fact be good management, given the farmer’s situation. Nevertheless, such compromises, once understood, often represent effective leverage points for the improvement of farm performance.

A clear conceptual model of a farming system is an essential foundation of FSR. The one I have found useful is presented in figure 9-1. The diagram is read from the top down, and it illustrates the following exigencies of the farmer’s experience:

- The farmer faces a set of local circumstances that he cannot significantly influence, certainly in the near term.
- His management task is to exploit these circumstances to meet his family’s priorities with family resources.
- Those circumstances underlined (climate, biology, and prices) are common sources of uncertainty that complicate his task.
- Being aware of family priorities and resource endowments, the farmer makes decisions on what activities to follow out of the set of opportunities presented by local circumstances, and on what methods and timing to use in following them, given family endowments of land, labor, and cash and his own knowledge and skill.
- His decisions result in resource allocation to a combination of activities that reflect his farming system.

Clearly this decision process is not followed by every farmer each season. A traditional pattern evolves locally, and for many farmers these “general-level” decisions are habitual. Day-to-day decisionmaking, adapting to the circumstances of the particular season or to exigencies arising from special family needs, preoccupies the traditional farmer. With changing local circumstances, new market opportunities or price ratios, or different knowledge, however, leading managers in the community will retread all or part of this decision path to evaluate how these changes should influence their activities and methods.

This type of general model is essential for researchers attempting to apply FSR in small-farm systems. It serves as a framework in which to place pieces of information as they become available in the research process.
Sources of Variation among Farming Systems

A third underpinning for the use of FSR in small-farm systems is an awareness of sources of variation among systems. Much of the current interest in FSR stems from a realization that small farmers differ, that their problems differ, and that improving the effectiveness of the development effort depends on identifying important differences and tailoring initiatives more closely to local needs. Clearly, every farm differs from every other; equally clear is the fact that interventions cannot be tailored and administered so subtly. A good compromise may be to tailor programs to farmers operating the same system. Research and programming applied across systems can be wholly confounding, both to farmers and to developers. This said, it is important to be aware of four main sources of variation among farming systems.

- Natural circumstances of climate, soil, and biology create the basic set of opportunities open to farmers and vary geographically.
- Economic circumstances external to the farm restrict the basic activities to those that can profitably be pursued. Economic circumstances often vary geographically, although it is common to find differences facing farmers in the same area. Proximity to the main road offers wider market opportunities, for example, while access to production quotas or credit is frequently restricted.
- Social and cultural circumstances may further restrict the set of opportunities open to farmers or the ways in which they can exploit these opportunities. Tribal origin frequently influences food preferences; community obligations may dictate animal disposal; and some farmers, because of religious custom, may never keep pigs, no matter how good the market. These cultural differences tend to vary geographically. Where people of different cultures have intermingled, variation—with its effects on activity patterns and methods of production—may occur in the same area.
- Households with relatively high income and high resource endowments may have a different balance of priorities and consequently a different pattern of activities. Greater resources may encour-
age different methods (with capital substituting for labor) and an increase in scale (by the use of
capital to draw in extra land and labor). Such differentials in income and resource endowments
will often be found side by side within the same geographical area.

Differences in systems can be traced back to one, or more than one, of these four sources. Identifying the
source will allow better evaluation of the nature of the differences among groups of farmers to determine
the need for discrete research and development programs.

How Small Farmers Change

A fourth and final underpinning in the effective application of FSR is an appreciation of how small
farmers change. Smallholders evolve step by step from their existing situation. Changes that may better
satisfy their priorities are tried on a small scale. If a change meets expectations on the output side and either
appears compatible with present resource allocations for meeting priorities or is clearly a superior way to
use resources, the scale of adoption is expanded and sustained.

The "package" idea has come into some disrepute. Usually it is not the package principle—of a
synergistic effect from multiple components—that is at fault. It is the tendency to offer farmers "a final
solution" (to maize growing or whatever). In such packages, either particular components make resource
demands beyond the farmer’s resource endowment or implementation requires radical resource realloca-
tion within his system. Dramatic resource reallocation is too risky for the small farmer, represents too
complex a management task, or is simply too costly in terms of other production opportunities forgone.
None of these constraints can be taken into account in technology generation without an understanding of
the client’s farming system. The approach to FSR described in the next section is based on the four broad
concepts just discussed.

A Farming Systems Research Approach

This section sets out the sequence of an FSR approach to understanding an existing small-farm system.
The next section discusses alternative methods for applying the approach and sets out the methodological
sequence followed by the Centro Internacional de Mejoramiento de Maiz y Trigo (International Center for
the Improvement of Maize and Wheat; CIMMYT). The approach rests on the underpinnings outlined
above and is applied by an interdisciplinary FSR team (CIMMYT favors an agronomist and a social
scientist, with an animal production scientist where the farming system includes livestock activities).

A preliminary step is to acknowledge both geographical and hierarchical specificity and to identify a
group of farmers operating the same system—referred to as a “recommendation domain” in CIMMYT
jargon related to technology generation. The approach is most easily applied in a single farming system.
The conceptual model rendered in figure 9-1 and elaborated above guides the approach, which is applied in
four stages:

* Understanding the main management challenges for local farmers by investigating the circum-
stances of their production environment
* Describing what farmers are doing, and how they do it, to meet their priorities within this en-
vironment
* Understanding why they do these things in these ways to meet their priorities
* Identifying constraints that prevent them from achieving their priorities more effectively.

Three facets of the conceptual model are relatively visible to researchers: local circumstances, farmers’
activities, and farmers’ production methods. The key to the approach is to describe these visible facets and,
by interpolating them into the relationships of the conceptual model, create hypotheses on the less visible
facets of the model and subsequently verify them. The starting point, then, is a description and understanding of the local production environment.

**Understanding Farmers' Circumstances**

Farmers use their knowledge and management skills to exploit their natural, economic, and social circumstances to satisfy their family needs. Farm system researchers investigate farmers' circumstances from this perspective. Their goal is to identify the production opportunities offered and, particularly, the challenges posed by the environment, in the knowledge that these opportunities and challenges will dominate farmers' management strategies.

**Natural circumstances.** The review of the natural circumstances of the local environment—climate, soils, and biology—falls within the purview of the agronomist on the team. All three categories will be important in bounding and ranking the production opportunities facing the farmer. Usually one or two will be crucial in managing these opportunities. It is beyond the scope of this chapter to elaborate all the challenges created by the natural factors in the production environment. But perhaps the major factor challenging small farmers with high levels of risk aversion, because of the acute uncertainties it creates, is the reliability of the rainfall. It is of widening importance as more and more marginal areas must be farmed because of population expansion. Variation in the amount of rainfall to be expected, variation in the timing of both the start and finish of the rains (and, thus, in the length of the growing season), periodic within-season droughts—all these represent difficult management challenges for farmers and are readily identified by the agronomist. Where these sources of uncertainty exist, preemptive strategies (for example, insurance cassava) or reactive strategies (for example, early-planted sweet potatoes) will be a feature of farmers' management. The more frequent and severe the uncertainties and the closer farmers are to the subsistence level, the more such strategies will dominate farmers' decisions and resource allocations. Within this category of natural circumstances, other important sources of challenge are soil status and the local plant and animal pest and disease complexes (see Mehta 1983).

**Economic and social circumstances.** Using the same perspective (the description of production opportunities and the identification of challenges to farm management), the farm economist of the team reviews the local economic and social circumstances. The need for integrating economic and sociological analysis deserves some emphasis because of the importance of sociocultural influences in small farmer decisionmaking. Most often, the process cannot afford more than one social scientist. Where this is an economist, he must be fully aware of the importance of the modifying influence of sociocultural circumstances on economic decisions. Where it is an anthropologist or sociologist, he should have a clear view of economic rationality and see sociocultural circumstances as a modifier of these underlying principles.

The economic circumstances that need to be reviewed include formal and informal market opportunities, producer and retail price movements for farm products (both over the long term and seasonally), and the effectiveness of enabling and marketing services in both the formal and informal sectors. On the social side, off-farm employment opportunities, specialization of function among farm families, customs related to land and animal holdings, and other social or cultural factors affecting farmers' decisionmaking and management are reviewed. Serious challenges to management from economic and sociocultural circumstances are uncertainty of retail food supplies, wide seasonal variations in food prices, uncertainty of informal market opportunities, uncertainties of payment through normal market channels, fragmented decisionmaking from absentee household heads, competing economic and noneconomic needs of family members, and the like.

In this review of local farmers' circumstances, the perspective is all important. The farmer operates within this context. Knowledge of the context is an initial step toward understanding his activities and decisions. The identification of management hazards, whether from natural, economic, or social sources,
provides foci for subsequent investigation. For FSR teams posted regionally, there is an initial investment in understanding the varied production environments throughout the region. Periodic monitoring of the important and changing facets of these environments keeps this understanding up to date.

Describing Farmers' Activities and Methods

Farmers' activities and methods are a second relatively visible part of the conceptual model. They show what farmers are doing and how they do it. Describing these is the next step in applying the FSR approach. Some useful ways of looking at activities and methods are summarized below:

- **Activity listing.** Describe the crop, livestock, and off-farm activities pursued by farmers in the system. Assess the relative importance of these activities in terms of the approximate land area committed to each and the approximate income levels arising from each. Establish which activities are pursued by most farmers, which are pursued by only a few farmers, and what is special about these few (for example, location next to water for vegetable growing). For each activity, enumerate the uses made of the output; in particular, note multiple uses (for example, the use of both maize grain and stover) and alternative uses (for example, the use of finger millet to make starch flour in years of maize failure, to brew beer, and to hire casual labor in years when maize is plentiful).

- **Activity calendar.** Draw up a monthly calendar of the operations involved in managing each productive activity, including the methods and purchased inputs related to each operation. Add to the calendar the timing of identified outputs from the activity.

- **Food and feed calendars.** List and rank in importance the starch and protein foods used in the common dishes eaten by local farm families. Note particularly the substitute starch and proteins used when preferred foods are not available; note also which are homegrown and which purchased. Add to the food calendar the timing of the use of homegrown and purchased foods, noting periods when homegrown foods are plentiful, uncertain, or not available. Draw up a similar calendar showing the main sources of animal feed over the year, including fall-back sources when major sources dry up.

Descriptions of the local production environment and of farmers' activities within this environment provide the FSR team with the basic facts needed to understand the farming system.

Understanding a Local Farming System

The two sets of descriptions are interpolated into the conceptual model. Local circumstances have stimulated farmers' decisions, and farm activities have resulted from those decisions. The research approach has so far filled in the origins and outcome of the farmers' decisionmaking process. It remains for the FSR team to understand that process.

Some clues will have been gained from the identification of management challenges during the review of local circumstances. Two other important sets of clues about farmers' priorities emerge from the description of farmers' activities and methods. First, farmers' priorities are reflected in the use of the outputs from their activities. Second, each activity undertaken—and the timing and method of each operation for each activity—represents a commitment of resources as a result of farmers' decisions on resource allocation. The social scientist's experience and skill are needed to estimate the resource commitments implied by the method used in an operation for any given activity (for example, to be aware of the order of magnitude of labor inputs required to hoe an acre of light soil or to weed an acre of finger millet). Given the land normally allocated to the various crops, an estimate of livestock numbers and uses, and an idea of the importance and timing of off-farm activities, the social scientist builds a rough profile of land, labor, and cash commitments over the year for the farming system being researched. These commitments also reflect farmers' priorities.

The social scientist follows through his research by identifying levels of farmer's resource endowments—the amount of land, labor, and cash available. Relating this to his estimates of commitments, the social
scientist hypothesizes how resources are constraining system activities, then verifies his hypotheses by further research.

This completed, he has an understanding of three causatives dictating farmers' management strategies: achievement of their priorities; challenges thrown up by the production environment; and limitations because of land, labor, and cash resources. Any of the three may create compromises in farm management that are usually manifested in suboptimal technical practices.

A common example of such a compromise is late maize planting. Although late planting can, of course, be a result of low motivation or low management ability, it can also result from any of the three causatives—alone or in combination—dictating farmer management strategies.

- A farmer's priority. A late planting gives prolonged supply of green maize, either as a preferred food or for high-priced sales on the local market.
- An environmental challenge. A late planting avoids maize tasseling and silking during the midseason drought. Late maize carries over the drought more successfully at an early stage of growth when transpiration is more limited.
- A limited resource endowment. Limited labor but plentiful land makes it profitable for the farmer to continue to establish maize well past its technically optimal planting time.

It must be emphasized that an understanding of the reason for late planting is essential to the choice of an intervention. A different orientation in the search for interventions would be appropriate in each of the three cases.

It is useful for the agronomist and animal scientist to follow through this sequence and for each to understand the system. However, they will tend to identify management compromises by a different route. Part of their required experience is an awareness of sound technical management practices for crops and animals under local conditions of climate and soil; often the current recommendations form a basis for such awareness. In addition to gaining an overview of the system by interaction with the social scientist, they investigate the detailed management regimes for the crop and livestock activities that are absorbing high levels of limited resources. Using their knowledge of sound technical management as a frame of reference, they identify the compromises in present management practices. Thus, the social and natural scientists on the team arrive at the shortcomings of management practices in the main farming activities by different routes but with an understanding of the farmers' decisionmaking processes and the origins of such shortcomings.

**Problem Identification**

The FSR process identifies two sets of problems: management compromises and resource constraints.

**Management compromises.** Development opportunities are related to two of the three sources of compromise: can farmer priorities and environmental challenges be met in other ways that obviate the need for compromises in management? Alternatives may be sought in technology (materials and methods that alleviate the compromises) or in policy and programs (which modify local circumstances, shifting farmers' priorities or removing the challenge from local circumstances). A reliable, fairly priced retail source of starch staple is an example here. The focus and appropriate content emerge from an understanding of the system.

**Resource constraints.** The management strategies and husbandry practices absorbing high levels of limited resources—whether land, labor, or cash—represent a second set of development opportunities. Again, changes can be researched in technology, in looking for materials and methods that either are more efficient in their use of limited resources or raise productivity without using limited resources. Changes can also be researched in policy and programs to supplement the farmers' resource base. Credit and farm
equipment programs are obvious examples. Again, and most important, the focus and the appropriate content emerge from an understanding of the system.

The research process brings with it an understanding of the interactions within the system. Interactions are important in two ways. First, a problem that often arises in evaluating new technologies is not the actual cash costs of the purchased inputs, but the opportunities that must be forgone by reallocations of land, labor, or cash to the innovation. An understanding of the interactions in the system allows researchers to identify properly the opportunity costs of a reallocation of resources to absorb a new technology.

Second, understanding the system's interactions opens up possibilities for indirect intervention and thus widens the spectrum of potentially relevant technologies. A classic indirect intervention is to intensify or merely change management on the food crop side of the system in order to release limited resources to allow the introduction or improvement of a cash crop. A more detailed example is useful. Whereas herbicides may not economically solve a weeding problem for the maize crop, applying herbicide to the cotton in the system may release enough labor to improve the weeding regime on the maize to make the use of maize fertilizer economically attractive. (See chapter 14 for related findings in Pakistan.) An awareness of this kind of competition for resources allows consideration of interventions for both crops, not just for the one seen to be suffering from the competition.

Finally, understanding the system's trends—that is, understanding which activities and methods are failing and which are gaining in popularity among farmers—can be a valuable aid in the choice of interventions. Reinforcing or reversing trends provides further focal points for change.

**Farming Systems Research and Farm Management**

Two approaches have dominated farm management in Europe and in the United States. First has been comparative analysis, in which performance data for a single farm are compared with averaged data for farms of that type to identify strengths and weaknesses in the farm's business. The farm management specialist advises the farmer accordingly. Second has been individual farm planning, in which the resource endowments and input-output coefficients of the farm itself form a starting point for analysis. Both approaches involve direct contact between the farm management adviser and the individual farmer. Neither approach can be cost-effective in small-farm sectors of the developing countries, where farm management advisers are rare and increments in productivity on the very small farm units could never cover the cost of professional advice. The FSR approach applies farm management principles at the system level, allowing the cost-effective use of very scarce manpower.

The controversy over the most useful approach for the discipline of farm management in small-farmer agriculture in the developing countries is unresolved. A stimulating discussion can be found in Johnson (1981). He argues, I think convincingly, that production economics abducted farm management at the end of the 1930s. FSR is an attempt to reassert the original, interdisciplinary nature of farm management in a milieu—the small-farm sectors of developing countries—in which approaches based on production economics are difficult to implement and often do not provide useful answers. The controversy inevitably spills over into methodology.

**Methods for Implementing FSR**

There are two interacting areas of controversy over alternative research methodologies. First, the objective functions of small farmers are strongly influenced by subsistence and risk considerations and are very complex. The production environments of small farmers are fraught with uncertainties, and farmers' reactions to these environments are often conditioned by social and cultural circumstances. Under these conditions the economic principles on which most analytical tools in farm management depend have limited relevance. Only a detailed prior understanding of the farming system can bring even the limited relevance to bear in analysis. Anderson (1978) has discussed this system-modeling issue thoroughly.
Second, data collection among a wholly literate population accustomed to recording information about their farm activities is relatively easy. This task becomes both complex and expensive among an illiterate population: enumeration of verbal responses or direct measurement by the research team is the only means of recording. The World Bank’s experience—its detailed data collection for monitoring and evaluation of projects such as the Lilongwe Development Program in Malawi, the Regional Integrated Development Projects in Tanzania, and the Northern Nigerian Agricultural Projects—demonstrates the bottlenecks in processing and analyzing detailed data, which compound the time and expense of collecting them. Again, a sound understanding of the system is needed before the parameters requiring detailed measurement can even be specified.

**CIMMYT Choice of Methods**

CIMMYT economists have been guided in the development of their FSR methods by the following precepts:

- A good understanding of a system is required before the appropriate parameters for data collection and analysis can be identified.
- The economic principles underlying most traditional analytical tools have difficulty embracing the complexities of smallholders’ motivations.
- Accurate data are very difficult, time consuming, and thus expensive to collect and to process.

Given the few professionals in developing countries who are available to undertake these activities, CIMMYT feels justified in the use of a rapid, low-cost sequence of methods to obtain a sound understanding of the local farming systems. Detailed data collection and analytical methods including modeling may improve that understanding, but the extra cost of this effort is not justified (Byerlee and others 1982). This is especially true when the opportunity costs of professional time are considered. One set of professionals may implement CIMMYT methods in several different systems in the time that it would take to measure and model accurately one system with the use of sophisticated, traditional farm management methods (Collinson 1980).

**Sequence of Low-cost, Rapid Methods**

A low-cost, rapid sequence of methods for FSR has been detailed elsewhere (Byerlee, Collinson, and others 1980; see also chapter 8). The sequence is iterative, steps are increasingly focused, and the methods used are increasingly expensive. More expensive methods are thus reserved for data collection on the few parameters found to be vital to the objectives of the research effort. The sequence of methods is outlined below.

**Defining Recommendation Domains.** As already mentioned, the implementation of FSR is preceded by an identification of discrete farming systems, or recommendation domains. This is a stratification in the true statistical sense and is intended to maximize the variations between domains and to minimize variations within each. Such stratification may be achieved by the use of secondary data, by a preliminary regionwide survey, or by discussion with knowledgeable local informants. Any initial stratification may be regarded as preliminary and subject to refinement as the sequence of investigation proceeds. The stratification should, however, specify as far as possible the area and the target group in that area within which FSR will subsequently be undertaken.

**Understanding Farmer Circumstances.** The first step of the FSR approach proper is to understand the local production environment. A review of available secondary data forms the basis for this understanding and is supplemented when necessary by interviewing reliable local informants. Published
data are often available on climate and soils and on markets and prices. The informal market and local sociocultural circumstances are often less well documented, and key informants (for example, merchants and village elders) often can expand the research team's insights into those facets of the system. This step represents less than a week of work for the team, including visits to the research area.

**THE INFORMAL SURVEY.** The informal survey is essentially a rapid rural appraisal device (Chambers, forthcoming) and is the pivotal step in the sequence of methods that can lead to an understanding of the farming system. Fieldwork centers around the team's discussions with farmers in the target group. Such discussions can be preceded by a review of available agricultural surveys of the area. These surveys often provide information about on-farm and off-farm activities, including areas cropped, number of animals, quantities produced and sold, inputs purchased, and equipment owned and used. Such reviews make the team familiar with the farming system and, together with a knowledge of local circumstances, form a basis for subsequent discussions with farmers.

These discussions occupy some six to ten days among farmers operating the system under research. Unstructured interviews are based on a set of guidelines (Collinson 1982) that are divided into sections and designed to elicit a description and understanding of the system and to identify local development opportunities. The interviews are best conducted during the growing season, a timing that aids verification by observation. The informal survey can, however, be carried out at any time. The research team interviews a farmer on one or more sections of the guidelines or the same farmer or different farmers on the same sections and make notes. At the end of each day, after each member has talked to perhaps three farmers about the same (or different) sections of the guidelines, the team meets and jointly evaluates the information obtained. Additional farmers are interviewed about each section of the guidelines until researchers are satisfied that they know and understand those aspects of the system.

The guidelines are designed to move from description to understanding to problem identification. Farmer interviews follow this sequence, with researchers seeking to verify the understanding gained and the problems identified in subsequent interviews. The output from the informal survey is a joint team report with the content described in the preceding section (subsections on farmers' activities, the farming system, and problem identification).

**THE FORMAL SURVEY.** The formal sample survey among the target population is carried out to verify facets of the system important to meeting the objectives of the research. Such facets include the homogeneity of the recommendation domain, farmers' priorities and decision criteria, their resource endowments and limitations, the incidence of key management compromises and of resource-intensive management practices, the effects of particular external circumstances on farmers' resource allocation, and the importance to farmers of the problems identified. Where researchers are confident that they understand these facets of the system and that the facets are uniform throughout the target population, there may be no need for a formal survey in the research sequence. Where a formal survey is implemented, some facets of the system may be explored more deeply and perhaps some parameters measured for further analysis to aid the objectives of the research.

A single-visit survey method is used for verification. The questionnaire, developed from the informal survey findings, is completely location specific and is highly selective in content. Within a single recommendation domain a sample of fifty to sixty farmers will be adequate. Working at a rate of two to three farms a day, twenty to twenty-five enumerator days will be needed to complete the survey—about a week of work for four or five enumerators.

Overall, the sequence of methods—including the review of secondary sources, the informal survey, and the verification survey—will occupy the team for a minimum of six weeks, and they will also need some lead time to prepare the community for the activities of researchers among them. This time may be halved if the team judges that the informal survey is adequate for their needs.
Potential for FSR in a Farmer-Research-Extension-Farmer Continuum

To date FSR has been used largely as a tool of agricultural research. This role is clear, and alternative institutional niches are beginning to emerge. It also seems probable that FSR can make contributions to project preparation and management and to overall development strategy. Its roles in these areas are less clear, but some possibilities are briefly examined below.

FSR in Technology Generation

New technology, as the only type of intervention capable of changing technical input-output relationships (and, therefore, the physical productivity of small farmers' resources), is of central importance to agricultural development. Agricultural research, as now established in developing countries, is based on a technical perspective of agricultural problems. This perspective manifests itself in research recommendations that are unfinished products with respect to the needs of the small-farm managers they seek to serve.

- Farmers never use a purely technical perspective in managing their farms and consequently never use it in evaluating new technologies recommended to them by the extension services.
- Recommendations inevitably take the form of "final solutions"—the "best way" to produce. They seek full exploitation of biological potential under the present state of the art. Farmers may be willing and able to handle only intermediate or partial solutions because of both the managerial perspective they use and their limited resource endowments.
- Recommendations are made on a "blanket basis," at best, for a specific agroecological zone. This fails to recognize that economic and cultural circumstances dictate farmers' decisions and modify, often drastically, these agroecological influences.

Agricultural research is tied to a technical perspective and technical criteria by the essential features of experimental methodology. In the course of the research and extension sequence, which is directed toward the development and dissemination of new technology appropriate for farmers, the perspective and criteria have to change from the technical ones inherent in experimentation to the managerial ones used by farmers. FSR uses a managerial perspective to review technical research outputs and identify, and where necessary modify, those most relevant to the current needs of specific groups of farmers. One major role for FSR is to help finish the research products to meet the demands of differentiated farmer markets.

Its second major role is to identify technical problems crucial to the rapid development of farming systems and to feed these back as agenda to commodity and disciplinary research specialists. This feedback is the other side of the technical and managerial loop and focuses technical research effort on farmers' most important management problems.

In Africa and possibly in other places as well, the institutional linkage failures between extension and research are relatively superficial. The fundamental problem in the research-extension sequence commonly followed in Africa is the failure to use a managerial or systems perspective in the diagnosis of farmers' problems and in the development of recommendations for farmers.

Neither research nor extension establishments are truly farmer oriented because of the dominating technical perspective. In many countries, research and extension staff remain skeptical that small farmers

1. The managerial perspective is exactly the same as the systems perspective, and the term was used here to emphasize the identity. However, systems perspective has more validity in the small-farm sectors of developing countries. To be cost-effective, the perspective must be brought to bear at the level of aggregation of a number of farmers operating the same system. Management perspective is appropriate in developed countries where the professional farm management adviser interacts with the individual farmer. Very small farms and a dearth of professionals mean that this individual treatment is not operationally viable in developing countries.
are managers in any accepted sense of the word. Such skepticism leads to the assumption that “we know what is best for you.” This, in turn, inhibits the extension services from understanding small farmers and feeding back key problems to research. Further, technical compromises (often the essence of good management) are inevitably seen as farmer shortcomings. Such attitudes reduce the credibility of the extension staff in the eyes of the local community.

Similar anomalies occur in disseminating recommendations. The contact extension officer or the contact farmer, who lives in and must live with the community, is often charged with promoting new technologies he sees as inappropriate for his neighbors. He is caught in a squeeze between his bosses and his neighbors. Since the bosses hold the purse strings, their view prevails, but at high cost to the credibility of the contact person in the community and his own morale.

This fundamental problem of perspective is certainly reinforced by the characteristic institutional and operational gap between research and extension services, and by the physical isolation of station-based researchers from their farmer clients. Integration of the planning and operation of research and extension is clearly desirable. However, only the introduction of a managerial perspective to generation and dissemination will solve the technology transfer problem. Farmers’ management priorities must be given full weight—first, in modifying technical research findings to meet the needs of differentiated technology markets, formed by sets of farmers operating the same system; second, in the planning of research agendas for commodity and disciplinary specialists at research stations. The FSR procedures described are a cost-effective means of interfacing the technical and managerial perspectives.

Because the use of FSR in technology generation is fairly well accepted, it may be worthwhile to follow the sequence of activities that the research team goes through after it has gained an understanding of the existing system. The team reviews materials and methods, the output from national or international technical research. It identifies those technologies that appear potentially relevant as solutions to identified management compromises, as more efficient alternatives to practices absorbing high levels of constrained resources, or as interventions to improve productivity by taking up only slack resources. The team casts its net as widely as possible, seeking several alternative strategies to solve each problem. The more options it identifies, the more likely it is to find solutions appropriate to the local situation.

Take, for example, the problem of declining ox draft capacity in a community: fewer and weaker animals at the start of the rains will have repercussions on the timeliness of planting and the quality of seedbed preparation. Two broad, initial approaches are to improve dry season feeding and to reduce the demand on animals. The first leads to consideration of a wide range of possible feed sources—crop residues, by-products, planted grass or legumes, improved pasture, and so forth. The second leads to consideration of reduced draft requirements through better harness, lower draft implements, minimum tillage techniques, or alternative tillage timing (and its consequences) to reduce the peak demand on oxen at the start of the rains. A whole gamut of possibilities unfolds—at this stage the wider the better. The FSR team then follows through a prescreening process, essentially an ex ante evaluation of the appropriateness of each possible solution to the local farm situation. The process has both technical and economic dimensions and requires close cooperation within the team and with appropriate technical specialists. In the example above, such specialists would, at a minimum, include pasture and forage agronomists and an agricultural engineer.

Steps in the prescreening process are summarized below.

1. The technical scientists on the team will review the relevant output from technical research, often with the specialist responsible for the work. They will seek answers to two questions:

   • Considering the context in which these technical results were obtained—climate, soils, and input regime—can the relationships be expected to hold when findings are implemented in the local farming situation?
   • What are the detailed management requirements for implementing the technology, how flexible are these requirements, and how will invoking that flexibility modify the results?

2. The social scientist on the team will study the resource and management requirements of the technology, and the expected output, and will try to answer three questions:
• Are the resource demands of the technology reasonable, given the endowments of the local farmers?
• What resource reallocation within the system is implied by the management requirements of the technology—that is, what are the opportunity costs of its introduction?
• How far do the flexibilities in management requirements for the technology allow better compatibility (and thus lower opportunity costs) with the system?

3. For technologies that pass through this filter, the technical scientists must decide—on the basis of their level of confidence that the relationships found experimentally will hold when the technology is applied locally—what type of experiment is required? If their confidence is low, they may find it necessary to run a relatively formal experiment to identify the relationships locally, under farmer conditions. If their confidence is high, they will move directly to a farmer-managed comparison of the new and the existing technology. The higher their confidence, the more rapidly will the on-farm research program generate technology for the extension and diffusion process.

**FSR and the Research-Extension Linkage**

The use of FSR to generate appropriate technology brings researchers to the local level in direct contact with local extension staff. Both are working with and for the same farmers. FSR has the potential to solve the outstanding problems of research-extension linkage (see also chapter 12). Historically, research has stopped too early in what should be a continuous and dynamic process of development and diffusion of new technology. Researchers have been physically and mentally isolated from farmers and have handed down an unfinished, untested product to extension staff. Extension contact staff—squeezed between farmers they live among, who often ridicule the technologies they bring, and their superiors, who demand results—have been caught in a crisis of morale. With few exceptions, extension staff have sought refuge among those in their communities—often businessmen and teachers—who have maintained them as advisers for the more direct benefits (access to credit, inputs, and information) these benefactors might bring.

In an on-farm research and FSR approach, the continual interaction between farmers, researchers, and extension staff allows a ready consensus when improved technology is ready for dissemination. The most obvious sign is host farmers beginning to use experimental techniques on their own crops and animals. Extension staff who have been involved with the on-farm research program have an intimate knowledge of the managerial implications of the new techniques, as well as the ability to conduct demonstrations on farmers fields and widen exposure to the interventions across the community. Where a relatively senior cadre of extension staff are involved in the on-farm research program, those who perform the role of subject matter specialists within the training and visit (T&V) approach are obvious candidates. They will emerge as ideal trainers of contact extension staff throughout the target group area.

Two points should be emphasized about the approach described. First, extension staff have a great deal of confidence in recommendations developed in this participatory way on local farms. Second, the approach pulls down into local farm situations whatever technology is diagnosed as appropriate. This is the main difference between the FSR approach and the current, top-down pushing of technologies at farmers, regardless of the specifics of their local situation.

**FSR and Project Preparation and Management**

FSR has not yet found a place in project identification and preparation. If technology selection is the “engine” of agricultural development projects, however, FSR must surely have a place because of its effectiveness in technology development. The FSR approach would seem an appropriate sequence for project identification and preparation where an evolutionary strategy for small-farm development is to be pursued. It can accommodate both the technology and the service and infrastructural needs for technology
mobilization through the evaluation of local farmers' circumstances. These form the two essential sides of project content. The time frame for the application of the FSR methods set out in the preceding section—from three to six weeks depending on the need for a formal survey—seems readily compatible with existing project preparation commitments.

I believe that the recent interest shown by the World Bank in within-project research capacity is an important development, as long as this capacity operates from a systems perspective. It could be used to introduce the concepts and organization of on-farm research and FSR into national agricultural research services and to build, through counterpart staffing, a national capacity to implement an FSR perspective. T&V extension, institutional arrangements for monitoring and evaluation, and (infrequently as yet) on-farm research and FSR methodologies have been part of project organization. These three have arisen over the past decade as fairly discrete components. To my mind, we need to take a hard look, forgetting the labels, at the way the functions of these three components can best be integrated and staffed. If a capacity for technology generation is accepted as necessary for agricultural projects, this need might indeed influence how projects are prepared and managed. If one speculates a little, one can see that, if an FSR team is put in place in a region, a project might unfold from findings on technology and its servicing and policy requirements. Evolution of a national FSR capacity to do such location-specific project formulation could be a means both to more active national project preparation and to the decentralization of planning that currently are being widely advocated.

Several points come to mind in pondering the idea of integrating T&V, monitoring and evaluation, and on-farm research and FSR.

- A systems perspective is the new element that FSR brings to extension projects. FSR researchers should be the repository and promoters of this perspective.
- Programming procedures should be arranged so that on-farm researchers at the local level and the technical researchers at research stations are mutually dependent. One half cannot operate without the other.
- With on-farm researchers, subject matter specialists (SMSs), and field extension staff working in the same locale, research-extension liaison posts should be unnecessary; the continuity of the interactive process of technology generation-verification-dissemination-modification should suffice.
- Once on-farm researchers see that the thirty or so farmers who are hosting their trials are using the technologies themselves, the SMSs, having monitored the technology-generation process, will embark on extension training and diffusion. This indicates the division of responsibilities between on-farm research and SMSs in the T&V approach or corresponding roles in other extension approaches.
- Monitoring and evaluation assesses both the generation and diffusion of technology. If monitoring and evaluation can be satisfied with a fairly unsophisticated approach to evaluation, there may be opportunity for integrating the monitoring and evaluation and on-farm research work under a single social scientist, particularly where such professionals are scarce.

FSR and Development Strategy

Improved productivity of small-farmers' resources and, therefore, technology generation and transfer are clearly crucial to agricultural development. FSR can make a substantive contribution to the relevancy of farming technology. At the same time, FSR procedures are effective vehicles for both decentralization and participation, currently stressed as desirable in the development literature. Indeed, the raison d'etre of FSR is the end for local specificity, and the methods used in FSR are essentially a series of interactions between researchers and local farmers. The FSR perspective recognizes that local farmers know a great deal more about their own situation and needs than does anyone else, and that these exigencies can and should form the basis of local development projects in the sector. These properties of FSR create an opportunity for a better reconciliation between local and national development priorities. They allow a move away from the top-down imposition of projects based on national priorities, which often are far removed from local needs and, consequently, are ignored by local farmers.
Better Exploitation of FSR

Several writers (Hildebrand 1978; Chambers 1980) have noted the contrast between the willingness of small farmers to absorb innovations that help them and the reluctance of scientists and bureaucrats to change. The introduction of FSR as an agricultural research tool often puts research administrators on the defensive; there is an implication that all is not well with their departments. In addition, over the past few years of recurrent budget crises, administrators have been reluctant to accept the need for professional staff working among farmers and absorbing large amounts of funds. Since 1976 CIMMYT has increased recognition of the need for on-farm research and FSR in East Africa in five stages:

- Finding national research administrators who identify with the problem of poor development and transfer of technology and with the need for local specificity
- Demonstrating an FSR approach to improving the relevance of technology to local situations, with the help of national research professionals
- Promoting the inclusion of social scientists (economists and/or sociologists or anthropologists) in agricultural research
- Providing training to build up an on-farm research and FSR capacity in national agricultural research services
- Encouraging the reorganization of research planning and operational procedures and the restructuring of research services to accommodate two tiers of researchers and to guarantee their interdependence.

Although the potential of FSR perhaps extends beyond agricultural research alone, CIMMYT's brief, of course, is agricultural research. Moreover, it is felt that attempting such innovation across a wider front (several departments and perhaps several ministries) would multiply the barriers to acceptance. The strategy has therefore been to seek a narrow entry for FSR, with the possibility of expanded applications once a capacity is established.

Problems of introducing FSR methods have been increased by the ambivalence of major donors to agricultural development efforts. Although donor projects are a valuable vehicle for introducing the FSR concepts and approach to national agricultural administrators, major donors showed little interest until 1979–80. They have belatedly confronted the thorny problem that inappropriate technology is a major reason for poor agricultural project performance. Donors now rightly see FSR as a route to appropriate technology, and heavy interest is creating its own crisis. FSR in the near future will have problems in maintaining its credibility because of poor implementation and possible disillusion with its approach.

Merely changing the jargon and printing new business cards for contracted professionals will not do the job. There is a very limited experience in the use of FSR, particularly in the necessary use of the essentially anthropological methods of the informal survey described above, which are finding favor for their low cost and rapid turnaround. Training in FSR approaches and practices is the single most urgent prerequisite for the effective use of the methodology.

Training in FSR is ongoing, but the resources devoted to it are limited. CIMMYT, for example, with three FSR professionals in eastern and southern Africa, is providing the following types of training:

- Short orientations (two to three days) for new project staff
- Short-term instruction in approach and methods (two regional workshops a year in cooperation with the University of Zimbabwe, totaling five to six weeks with some thirty participants from a dozen countries)
- In-country, on-the-job training and retraining programs for national agricultural professionals (in two countries at any one time).

Effective short-term and on-the-job training is somewhat inhibited because systems concepts and perspectives are new to agricultural graduates of the established universities. Arguably, all undergraduate
curricula in agriculture in developing countries should give a grounding in such concepts and perspectives, which would contribute a significant context for subsequent specialization. FSR courses are increasingly finding a place at the graduate level in agricultural faculties of U.S. universities. Universities in the developing world are, with some exceptions, reacting to the need more slowly.

Practitioners are confident that FSR has great potential for more rapid development of small farms because it allows farmers to participate in technology generation and project preparation. It has special relevance for farming communities whose management strategies and resource allocation are dominated by subsistence needs, high levels of uncertainty in local circumstances, and shortages of cash and labor in the face of relatively plentiful land. In these situations, the conventional criterion for the choice of technology—output per unit of area—is only indirectly relevant and needs strong qualification. Farming systems researchers, by putting themselves in the shoes of farmers operating such systems, are well equipped to make such qualifications.

References


Many factors contribute to the generation of improved agricultural technology. There is the desire of researchers to capitalize on the results of basic research, as demonstrated by the tremendous activity in genetic engineering. There is the innovativeness of farmers, as shown by the wide variety of farm equipment, cultivation techniques, and farming systems that they have developed. There is the attraction of private industry toward market opportunities, which has resulted in high investment in agrochemical development. There is the desire of governments to improve and diversify agriculture and to generate revenue and foreign exchange; hence, for example, the investment in export crops. Finally, there are the needs of the farmers themselves, who demand new technology to solve existing constraints and provide new opportunities for increased production and productivity. In most developing countries, the farmers are not equipped to address these constraints alone; government research and extension agencies therefore take on this responsibility and tend to concentrate on improving technology.

In chapters 10 and 11 Rahman and Wirasinghe, Weerasinghe, and Fernando examine the mechanisms these agencies use to test possible technical solutions. Rahman discusses how technology is generated to fit the local circumstances of the farm in various zones of Bangladesh and emphasizes the need for a clear understanding of the biophysical and socioeconomic environment of the individual farmer. On-farm research has been emphasized in Bangladesh, and the central planning of research programs has been replaced by planning at the regional and local level. The value of farmers’ innovative practices for wider technology testing has also been recognized.

Variations in farm size and agroecological diversity—common to rainfed agriculture in the tropics—are highlighted by Wirasinghe, Weerasinghe, and Fernando. Sri Lanka’s approach consists in dividing the country into eight regions on the basis of agroeconomic criteria; each region has a research center, a training center for extension staff, and working group of technical officers for research, extension, and education and training. The function of this group is to identify and allocate priorities in research, extension, and education. The results of the adaptive research trials on farmers’ fields are aggregated by the national coordinator, and the decisions on the release of a new variety, for example, are made for national and regional levels. Thus, although the testing of new technologies is done at a local level, final recommendations are made at the national level.

The chapters in this section concentrate on what is usually termed adaptive research (that is, research to modify or adjust already available technologies to farmers’ conditions) and on its role in refining or validating new technologies on the farm. Adaptive research is normally used to manipulate or test such technologies as new varieties, fertilizer recommendations, recommendations for the control of pests, and new combinations of crops. This then raises the important issue of the need to have a backlog of technical innovations, new crops, and improved varieties that have some promise for adaptation in the target area. The new varieties developed at IRRI formed the essential building blocks for new farming systems and were a critical factor in IRRI’s work in developing more productive farming systems for the rice lands of Asia.
This leads to an interesting point raised in Denning's chapter in Section IV: there is strong evidence that farmers in traditional communities use their existing resources efficiently and that technological breakthroughs (for example, a new variety or a widened resource base such as credit or new market opportunities) are necessary for a significant increase in productivity. This suggestion contradicts the conventional advice that farmers should be taught to adopt simple, low-cost practices such as timely weeding or line sowing on the assumption that the constraint is the lack of knowledge of these practices rather than the lack of resources to carry them out. The experience of IRRI researchers suggests that before a new cropping pattern is accepted the net return needs to be at least 30 percent higher than the farmers' current system.

New technology—whether imported, generated on local experiment stations, or developed on the farmers' fields—has to be tested under conditions that approximate those experienced by the farmer. The views expressed here on the functions of on-farm testing and validation are perhaps best summarized by saying that on-farm research is necessary to refine technologies developed on research stations, to test the relevance of promising technologies under farmers' situations, to obtain farmers' reactions to the technology under tests, and to educate farmers and extension and research workers during the process of technology development.

Perhaps the main issue in on-farm testing and validation is who should be responsible for designing, managing, and interpreting the process. Obviously the researcher, subject matter specialist, extension agent, and farmer will have a primary interest in the process. Some believe that on-farm testing and validation of potentially useful technologies is a simple process and thus that staff need relatively little training to carry it out. The papers of this section, and others in this volume, leave no doubt that this activity requires considerable competence in both the social and biological sciences. The selection of sites, the design and organization of the testing and validation program, and the collection and interpretation of results encompass a variety of skills and need well-trained staff. These are time-consuming tasks that cannot be treated as a spare-time activity.
The Generation of Improved Technology in Bangladesh

M. Motlubor Rahman

It may be pertinent to begin by asking, What is improved technology? Is it one that increases production by 50 percent under ideal farming conditions or one that consistently gives a 30 percent increase under varying farming situations? Which is more appropriate and acceptable to a large group of farmers? An understanding of this question should provide a general guide to the process of generating improved technology, appropriate for the farmers.

Unfortunately, few have fully understood or recognized the need to look into this question seriously. Traditionally, research topics are selected without a proper understanding of the farmers' problems and their farming environment, because researchers have no contact with farmers and are not exposed to the actual conditions under which small farmers operate. The feedback of production problems through the extension system has also been rather ineffective and inadequate. Under such circumstances, the outcome of research, whether conducted over the long or short term, cannot always be relevant to the needs of the farmers and, consequently, to the national development goals.

A technology, to be relevant, must be adaptable to local agroclimates and suited to the needs and capabilities of the resource-constrained farmers. To develop such technology requires extensive knowledge and a clear understanding of the local farming situation and the biophysical and socioeconomic environment of individual farms. The ability to draw on this understanding to formulate a research program is essentially the starting point for the generation of improved technology.

In Bangladesh, however, agricultural research has been carried out in the experimental station under ideal management conditions, which in no way represent the actual farm situation. As a result, the traditional system of research has failed to respond to the needs of the farmers under changing farm conditions. This system is characterized by several structural weaknesses, such as:

- Top-down planning for research, in which research programs are drawn up by scientists at headquarters with very little or no participation of the scientists at the outlying stations.
- Total absence of participation by the extension workers and the farmers in the research planning process; little understanding by researchers of the sociological and economic characteristics of the farmers and of their farming systems.
- Isolated research thrust on a specific crop without due regard to its association with other crops in the farming system.

All these shortcomings have negatively affected the development of technology that can be easily adapted to actual farm situations.

The New Approach: Experience in Bangladesh

There is an increasing awareness of the need for participatory research and for a conscious move to modify the old approach on the basis of the participatory concept. The rationale of the new approach is to create a system in which maximum interaction can take place at the farm level between the researchers, the extension workers, and the farmers. Several approaches have been tried in the past decade in an effort to develop such a system, the latest being the training and visit (T&V) approach. In spite of certain difficulties in the application of the T&V system in a complex and diverse farming situation, it is, in many ways, helping to establish a more organic connection between the research establishments, the extension workers, and
the farmers, especially through the institutionalized feedback mechanism built into the system. It is primarily through the cropping systems research approach and the T&V process that the traditional research system is being dovetailed with the farmers' field trials. In the new approach, particular attention is given to:

- Organization of on-farm research
- Formal research-extension-farmer linkages
- Participation of all development forces in research planning and in the review of research findings.

**On-Farm Research**

All farmers' field trial activities under different ad hoc projects have been officially merged into the On-farm Research Program. This program is organized in representative farmers' fields in different agroecological zones. Its initial emphasis was on cropping systems research (CSR) with particular attention to agronomic problems only. From this effort is evolving a farming systems research program that is gradually including socioeconomic studies on such issues as resource constraints of the farmers; patterns of resource allocation to different on-farm and off-farm activities; demand for, supply of, and use of inputs including credit; price and market opportunities; farmers' responses to new technology in terms of stability of production, economic gains, and social preference. These studies, together with studies on the diffusion of a new technology and its impact, are being done jointly by the agronomist and the economist posted at each CSR site. They are assisted and guided by the senior economist of the research institute. The program is being expanded to include garden crops, quick-growing fruit and fuelwood trees, and livestock at some of the present CSR sites. A strategy is being developed to organize a full-scale farming systems research program.

There is, at present, a network of 200 multilocation testing (MLT) sites spread throughout the country. The suitability of these sites is currently being examined by a committee in an effort to reduce their number to a more manageable figure. Seventy-nine have been identified as being representative and useful, but they are under further scrutiny. The mature technology is tested, verified, and adapted at these sites to develop location-specific recommendations.

**Research-Extension-Farmer Linkages**

Formal linkage between researchers and farmers has been established at the CSR and MLT sites. Direct interaction with the farmers also takes place through field days, workshops, farmers' training, field visits, and demonstrations. Contact between researchers and extension workers has so far been maintained through various technical committee meetings, field days, internal review, workshops, training for subject matter specialists (SMSs) and subject matter officers (SMOs) at the research stations, monthly meetings of SMSs and research staff, and other formal and informal discussions and reports. The need for active participation of the SMSs and SMOs in research at CSR and MLT sites is recognized but has yet to be made effective to complete the linkage between research and extension workers at the program level on the farm. It is also recognized that the CSR and MLT sites should be the major sources of the impact points for the SMOs and SMSs and the information banks on production problems for the researchers. In certain areas, this is happening through individual initiative, but is not common practice.

**Participation in Research Planning**

The traditional system of central planning has been replaced by local planning. Research plans are now prepared at the regional and local levels, largely in workshops where research workers, extension staff, farmers, input agencies, and rural development workers identify researchable problems and determine priorities.
In these workshops, production problems are discussed as they occur to the participants and when presented from other sources. The identified problems are grouped into researchable and nonresearchable problems. A third category includes problems that do not require further research attention and can be solved with the available technology and information. In most cases, these problems are attended to locally by the research and extension staff. Nonresearchable ones are not considered. If there is any cause for concern, it is reported to the appropriate agency (such as the Water Board, input suppliers, or credit agency). The researchable problems are assigned priorities on the basis of the following considerations:

- Is the problem seriously affecting the ongoing local or national priority production plan?
- What could be the extent of loss in production? (If the loss is substantial, the problem receives high priority.)
- Could the solution of the problem have an immediate impact on production and income?
- Is it going to benefit the majority or a significantly large number of farmers, especially the small and marginal ones?
- Is it possible to solve the problem locally with available means and resources?
- Is it of national importance and relevant to national development goals?
- How much time and resources will it demand? Do we have the expertise and means to handle the problem immediately?

Once problems are identified, research programs are prepared along broad outlines for scrutiny by the Central Program Review Committee composed of members from research institutions, the Extension Department, Planning Commission, and input agencies. The committee examines the program to ascertain its relevance to national development goals and farmers’ needs and specifically considers whether the problem is researchable and has high potential for increasing farm production and the income of the farmers.

For local planning, the basic units are the CSR and the MLT sites. Feedback is also received from the contact grower blocks and extension demonstration plots.

**Important Sources of Information**

The researchers’ most important sources of information are formal and informal meetings and discussions with farmers and extension workers, internal review of the seasonal programs and research results, field days and farm visits, workshops and seminars, training sessions, extension demonstrations, visits of farmers and extension staff to research stations, radio broadcasts on farming, monthly reports and other publications, and informal communications.

This system of feedback of information is working fairly well in some districts and the CSR areas with the collaboration of the extension workers and the farmers. Although participation is not total, the present formal and informal research-extension-farmer linkage plays an important role in maintaining the flow of information from the field and helps researchers design and redesign their trials. The information is reviewed by the research managers and used in planning new trials as well as in modifying existing trials.

For example, in a cropping pattern trial on medium-high land, mungbeans were replaced by broadcast aus (dry-season rice) after the farmers of the locality reported that mungbeans suffered from “wet feet” in that area. Maize did very well in certain areas, but it was dropped from the pattern because the extension workers reported that there was no market for it. Similarly, many trials have been dropped and new trials initiated on the basis of reports from the field and observations at the CSR, MLT, and demonstration sites.

The field reports deal mainly with varietal adaptability and agronomic problems, especially under rainfed farming. Accordingly, research plans have been made for extensive varietal screening and agronomic adjustment. Information on some basic problems also comes from the field through this linkage. For example, the new high-yielding mustard variety SS-75 is reported to be heavily susceptible to alternaria, especially in the high-rainfall zone of Kishoreganj District, and is attacked by aphids because of the longer
duration of the rainy season. The oilseed research team is now redirecting its selection work on the basis of this information. Another important development as a result of this interaction and feedback is the opportunity to learn about the farmers’ own innovative practices. Information comes mainly through discussion in workshops with the leading farmers, followed by research-extension staff visits to specific fields to learn more about the practices at first hand. Some examples are double harvesting of potatoes from the same crop and direct seeding of high-yielding mustard (SS-75) in aman (rainy-season rice) fields. These and similar innovative practices by farmers have been identified and incorporated in the on-farm trials for verification in other districts.

The main features of the new approach being taken in Bangladesh to generate improved technologies are:

- Establishment of a network of on-farm trials sites (CSR and MLT) in farmers’ fields
- Linking these sites with the research stations
- Testing the applicability of technology generated at the research stations to actual farms
- Associating extension workers and farmers in the review and evaluation of the test results
- Feedback to the research stations about production problems that need immediate attention.

The heart of this approach is the decentralization of research efforts. The regional and subregional research stations and centers and the On-farm Research Program are being strengthened and given more facilities. At some of the outlying stations, staff housing and children’s educational opportunities have already been improved. Scientists at the outlying stations are given preference over those at the central station in matters of promotion and overseas training. They get an additional point in the selection process for working with the farmers in the regions. Another new measure has been approved to move the scientists out from headquarters: it provides that those who have not worked in outlying stations for at least five years will not be considered for promotion to the next higher grade.

These measures have been taken to establish a dynamic system that can aptly and adequately respond to the changing farm environment. The decisions are in the process of being implemented, which might take time—for the simple reason that attempts to reform the system are impeded by bureaucracy, opportunism, and lack of integrity in the system.
On-Farm Validation of Technology
in Heterogeneous Sri Lankan Environments

Suranimala Wirasinghe, S. P. R. Weerasinghe, and M. H. J. P. Fernando

In this chapter we present Sri Lankan experience in confirming, on farmers' fields, the recommendations that issue from the linkage of agricultural research and extension. The first section presents an overview of Sri Lankan agriculture, of the extension service and its links with research institutions, and of the actual process of linkage through (1) identifying farmers' production problems, (2) formulating appropriate recommendations to meet farmers' needs, and (3) validating these recommendations under actual farming conditions. Problems encountered with the process are also set forth. The following sections show the process at work in two regional research centers, at Bandarawela and at Maha Illuppallama. The last section also proposes significant improvements in existing conditions.

Overview

Sri Lankan Agriculture

Of the 16.2 million acres of land in Sri Lanka, about 5.4 million acres, or 34 percent, are used for agriculture. About 1.64 million acres of the agricultural land, or 30 percent, are asweddumized land (that is, land that has been bench-terraced and surrounded by bunds), in general under rice cultivation. The distribution of crops on the agricultural land is given in table 11-1.

The population of the country in 1981 was 14.9 million, and the average rate of population increase then was 1.7 percent. The Sri Lankan economy is dependent mainly on agriculture. The 16.2 million acres of land fall into three main agroclimatic zones: a wet zone of 3.8 million acres in the southwest quadrant; a dry zone of 10.3 million acres, comprising the bulk of the island, in the northeast, northwest, and southeast; and an intermediate zone of 2.1 million acres. A wide range of crops (such as chilies, onions, maize, coarse grains, cowpea (green gram), soybean, black gram, groundnuts, gingelly (sesame), potato, cassava, sweet potato, and turmeric) are grown in the country. These crops are generally grown during the maha season (from October to January, the principal rainy season in areas where the northeast monsoon rains are experienced; yala is the other season) on highlands under rainfed conditions.

Table 11-1. The Distribution of Crops on Agricultural Land in Sri Lanka

<table>
<thead>
<tr>
<th>Crop</th>
<th>Extent (acres)</th>
<th>Percentage of total agricultural land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice (asweddumized land)*</td>
<td>1,641,000</td>
<td>30.1</td>
</tr>
<tr>
<td>Coconut</td>
<td>1,150,000</td>
<td>21.1</td>
</tr>
<tr>
<td>Tea</td>
<td>570,000</td>
<td>10.4</td>
</tr>
<tr>
<td>Rubber</td>
<td>560,000</td>
<td>10.3</td>
</tr>
<tr>
<td>Other tree crops</td>
<td>187,000</td>
<td>3.4</td>
</tr>
<tr>
<td>Grassland and shrubland</td>
<td>1,350,000</td>
<td>24.7</td>
</tr>
<tr>
<td>Total</td>
<td>5,458,000</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* Land that has been bench-terraced and surrounded by bunds; in general, under rice cultivation.

Source: Sri Lanka, Department of Census and Statistics, 1981 data.
Table 11-2. Size and Number of Agricultural Holdings in Sri Lanka

<table>
<thead>
<tr>
<th>Size and class of holding (hectares)</th>
<th>Number of holdings</th>
<th>Percentage of total</th>
<th>Total extent (hectares)</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00-0.20</td>
<td>496,478</td>
<td>30.1</td>
<td>36,851</td>
<td>2.4</td>
</tr>
<tr>
<td>0.20-0.40</td>
<td>250,317</td>
<td>15.2</td>
<td>62,195</td>
<td>3.9</td>
</tr>
<tr>
<td>0.40-1.22</td>
<td>504,249</td>
<td>30.6</td>
<td>333,767</td>
<td>21.4</td>
</tr>
<tr>
<td>1.22-2.03</td>
<td>196,384</td>
<td>12.0</td>
<td>292,406</td>
<td>18.8</td>
</tr>
<tr>
<td>2.03-4.05</td>
<td>147,933</td>
<td>9.1</td>
<td>278,389</td>
<td>24.3</td>
</tr>
<tr>
<td>Over 4.05</td>
<td>47,899</td>
<td>3.0</td>
<td>455,107</td>
<td>29.2</td>
</tr>
<tr>
<td>Total</td>
<td>1,645,260</td>
<td>100.0</td>
<td>1,458,715</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: Estates (holdings of over 20 acres with ten or more resident employees) are excluded.
Source: Sri Lanka, Department of Census and Statistics, 1981 data.

Agriculture in Sri Lanka is characterized by the large number of small farmers engaged in production (see tables 11-2 and 11-3).

About 80 percent of the total population is rural, and about 49 percent is engaged in agriculture. It is estimated that 1.7 million farm families are engaged in agricultural production. Thus the extension services have to meet the requirements of this many small farmers.

The Ministry of Agricultural Development and Research is responsible for agricultural production in the rural sector of the economy (that is, the food production sector). The Department of Agriculture, which comes under administrative control of this ministry, is responsible for all agricultural research on food crops, for extension in these crops, and for training of personnel engaged in agricultural production and in provision of live inputs such as seeds and planting materials. The organization of the Department of Agriculture is given in figure 11-1.

Organization of the Extension Service in Sri Lanka

The Extension Division is under a deputy director (DD) of agriculture, who is in overall technical, administrative, and financial control. The DD is assisted at the headquarters level by three additional deputy directors (ADDs), who are in charge of two to four administrative districts. There also are other technical and administrative support staff at headquarters.

The country is divided into twenty-four administrative districts, but the district boundaries do not coincide with the agroecological regions. The district agricultural extension program has one assistant director of agriculture (ADA), who is in overall technical, administrative, and financial control. The organizational structure of extension in the country is given in figure 11-2. Each district has been divided into one or more segments, and an agricultural officer (AO) is directly in charge of the technical programs in each segment (under the guidance and control of the ADA). All segment AOs are either university

Table 11-3. Number and Extent of Paddy Land by Size of Holding in Sri Lanka

<table>
<thead>
<tr>
<th>Size class (hectares)</th>
<th>Number of holdings</th>
<th>Percentage of total</th>
<th>Extent (hectares)</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 0.20</td>
<td>289,766</td>
<td>34.7</td>
<td>39,306</td>
<td>7.6</td>
</tr>
<tr>
<td>0.20-0.40</td>
<td>253,581</td>
<td>30.3</td>
<td>69,251</td>
<td>13.4</td>
</tr>
<tr>
<td>0.40-0.81</td>
<td>148,343</td>
<td>17.0</td>
<td>102,203</td>
<td>19.8</td>
</tr>
<tr>
<td>0.81-2.03</td>
<td>177,491</td>
<td>14.0</td>
<td>178,191</td>
<td>34.6</td>
</tr>
<tr>
<td>2.05-4.05</td>
<td>22,388</td>
<td>2.7</td>
<td>78,108</td>
<td>15.2</td>
</tr>
<tr>
<td>Over 4.05</td>
<td>4,439</td>
<td>0.5</td>
<td>48,407</td>
<td>9.4</td>
</tr>
<tr>
<td>Total</td>
<td>896,008</td>
<td>100.0</td>
<td>514,466</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Sri Lanka, Department of Agrarian Services, 1981 data.
graduates in agricultural science or senior officers who have earned a diploma in agriculture and have had considerable experience in the field as extension officers.

Each segment is supported by a team of subject matter officers (SMOs; Subject Matter Specialists, SMSs, in Sri Lanka). SMOs are appointed for crops or for disciplines that are of importance in the segment. They are the officers responsible for training the field extension workers, such as the agricultural instructors (AIs) and the village extension workers (VEWs; Krushikarma Viyapthi Sevakas, KVSs), and for liaison with research to bring research findings to the field-workers and to take problems from the field back to the researchers for investigation. The SMO holds a diploma in agriculture and has had further, short-term training in the subject of specialization.

The unit of agricultural planning is the Agricultural Service Committee (ASC) area. Each ASC comprises farmer representatives and government officials, the latter responsible for organizing the agricultural production programs within their area of jurisdiction. There are more than 500 ASCs in the country. The ASCs maintain a central building, called the Agricultural Service Center, where all connected departments are housed. Each center has an AI, with an office KVS to assist him; seeds and planting materials are also sold at this office. There are, on the average, six to eight field KVSs attached to each AI, and each KVS has about 750 farm families to serve. The number of families per KVS ranges from about 350 in the areas of high potential to about 1,200 in the areas of less potential; it also depends on the density of population, the nature of the terrain to cover, and the distance between farms. The KVSs hold diplomas in agriculture or have had a year of practical training in agriculture.

The Training and Visit System in Sri Lanka

The Training and Visit (T&V) system of agricultural extension was adopted for nationwide implementation from maha of 1979-80 onward under the Agricultural Extension and Adaptive Research Project (AEARP), assisted by the World Bank. Under this system, training is undertaken in two parts.

Figure 11-1. Organization Chart of the Department of Agriculture, Sri Lanka

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Ministry of Agricultural Development and Research

Department of Agriculture

Director of Agriculture

Administration  Finance  Extension  Research  Education and training  Farming and horticulture  Agricultural economics  Agricultural engineering
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Figure 11-2. Structure of the Extension System, Sri Lanka

Level

1. National
   - Director of agriculture
   - Deputy director of extension
   - Other deputy directors of extension

2. District
   - Assistant director of agriculture
   - Supporting staff, including agricultural instructors and clerks

3. Division or segment
   - One agricultural officer for each of 63 segments
     - An average of two subject matter officers per segment

4. Agricultural Service Center (ASC)
   - One agricultural instructor for each of 496 ASCs
   - One office KVS for each ASC

5. Village
   - 2,137 village KVSs (excluding 496 office KVSs) each serving an average of 750 farm families
   - Each cluster will contain about 125 farm families and will be visited one day each fortnight (750 families + 6 clusters per KVS)

6. Clusters
   - 76,932 contact farmers (2,137 KVSs x 36 groups) at full development
   - Contact and follower farmers will cover the entire farming population of 1.6 million farm families and provide a feedback mechanism

7. Groups and contact farmers with follower farmers
   - 21 follower farmers

a. KVSs (Krushikarma Vyapthi Sevaks) are the Indonesian equivalent of village extension workers.

Source: Sri Lanka, Department of Agriculture, Extension Division, "T&V Guidelines."
In preseasonal training, segment AOs, and other AIs, and KVSs are given training before the commencement of each cultivation season at the Regional Training Center (RTC) on the impact points (technical recommendations; called stress points in Sri Lanka) decided by the Regional Technical Working Group (RTWG). The duration of these regional training sessions is three to five days.

As the season commences, fortnightly training of AIs and KVSs is regularly conducted by SMOs. The training imparted at the fortnightly training sessions is relevant to that period and to the activities in which the farmers are then engaged; the subject matter for the training is based on the cropping calendar.

In addition, two training sessions—for the segment AO and for the SMOs of the districts—are held on a fixed day of the month with research officers, either at the Regional Research Centers (RRCs) or at any predetermined field location, to discuss problems encountered by the extension staff.

The visit programs of the AIs and KVSs have been systematized and follow a regular schedule. They visit groups of farmers on fixed days of the fortnight that are known by the farmers. On these visits, the KVSs carry specific technical messages relevant to the farming operations on which farmers are engaged at that time. In every group of farmers one farmer is identified as a contact farmer. Contact farmers are exposed to all the messages throughout the season and are motivated to try most of the recommendations. Each KVS meets with about 72 contact farmers; ultimately there will be about 160,000 contact farmers covered throughout the country. In practical terms, each contact farmer will be a “demonstrator farmer.” By this process the extension services are in a position to reach a larger number of farmers effectively and efficiently and to provide feedback to research. The KVSs undertake negligible nonextension duties; their main purpose is extension.

The Regional Technical Working Group

On the basis of agroecological zones, the country has been divided into eight regions, with RRCs, RTCs, and Regional Agricultural Research Stations at Bandarawela, Maha Illuppallama (see the two sections that follow), Angunakolapelessa, Gannoruwa, Bombuwela, Karadian Aru, Makandura, and Kilinochchi. Three to five districts are attached to each region. Each RRC will ultimately be fully equipped with staff and facilities to conduct all agricultural research for the region. The RTC will meet the training needs of the districts within the region, and the regional research station will conduct adaptive research. These regional centers are pivotal for planning and conducting research, extension, and training. All T&V activities originate and feed back to this level (see figure 11-3).

Because the district boundaries do not coincide with those of the agroecological regions, where a district falls into more than one agroecological zone that district may come under the area of operation of more than one RTWG. Each region has an RTWG, which is a group of technical officers from the Research, Extension, Education and Training, and Farms and Horticulture Divisions of the Department of Agriculture who are working to bring about a closer coordination between these divisions in the region. The functions of such groups are to identify and allocate priorities in research, extension, and education for the districts that make up the region and to decide on appropriate action programs for them.

The group will also include officers from other departments, such as the Minor Export Crops Department and the Coconut Cultivation Board, for whom agricultural extension is undertaken by the Department of Agriculture. At the RTWG meeting the research, extension, and training programs of the past season are reviewed. Later, the problems identified by extension in the current season are presented and discussed. The last stage in the deliberations of the meeting is to decide the stress points, research program, and training needs for the oncoming season.

Two meetings of the RTWG are held per cultivation season. The first meeting is the preparatory team meeting, which takes place approximately 150 days before the oncoming season. This meeting is attended by the teams of SMOs in the crops and disciplines within the districts of the region, the segment AOs, the adaptive research teams, the research officers of the RRC, and the training officers of the RTC. These
Figure 11-3. Flow Chart of the Agricultural Extension, Research, and Education and Training Process, Sri Lanka

- **Regional and national research results**
- **Technical agricultural problems identified by extension service and evaluation of extension**
- **Evaluation of training**
- **Adaptive research results and research information**
- **Government farm problems and evaluation of seed production**
- **Seed certification**

**Input**

- **Regional and national research priorities**
- **Government farm program**
- **Seed production**

**Output**

- **RTWG**
- **Government farm research stations**
- **Results of varietal adaptive trials**
- **Research results**
- **Evaluation of government farm problems**

**Research and training cycle**

**Nonagricultural cycle**

**Extension cycle**

**Indirect coordination**

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**a.** The Regional Technical Working Group (RTWG) identifies and allocates priorities in the research, education, and extension requirements of the districts and decides on appropriate action programs.

**b.** The District Agricultural Committee is chaired by the government agent (collector) and consists of all district-level government officials concerned with agriculture, a few farmer representatives, and members of parliament. It meets every four months.

**c.** National goals are to increase food production and improve the quality of life by raising farmers' incomes.
personnel meet and discuss their experiences from the previous seasons and then prepare the proposals for extension stress points and targets, the topics to be dealt with by the adaptive research teams, and the subject matter for preseasonal training of officers.

The second meeting of the RTWG is held about a month later (125 days before the oncoming season). Representatives from the regional headquarters of the Department of Agriculture and related divisions are present. At this meeting the previous season's extension performance, research results, and training are reviewed. The problems encountered during the season are discussed. The work programs recommended by the preparatory teams are presented, discussed, and finally ratified by the RTWG. These become the action programs for the Research, Extension, and Education and Training Divisions in the region.

The RTWG also decides on the adaptive research program. Adaptive research trials are conducted in farmers' fields to test the validity of research findings from the regional agriculture research stations and to determine the farmers' acceptance of the research findings. The practices of progressive farmers are also tested to judge general acceptance. Simple test plots are cultivated to determine the validity of a recommendation before it is released to extension personnel for inclusion as a stress point in the extension program. More and more of this kind of adaptive research is being conducted on farmers' fields. The trials provide simple data on yields and input requirements whereby the performance of the recommendation can be compared with the farmers' present practice.

Adaptive research is a joint effort on the part of Research and Extension Divisions and with active participation of research officers and extension field personnel (segment AOs, SMOs, AIs and KVSs). The adaptive research program is designed by the research officers. The selection of farmers and plot location, as well as the day-to-day supervision and conduct of operations, are done by the extension officers. Simplified data sheets to AIs and KVSs are provided for their recording of field observations. If there are difficult operations, the SMO or research officer visits the field. Research officers, AOs, and SMOs visit the trial plots regularly during the season to ensure that the trials are conducted correctly.

The Variety Adaptability Trial (VAT) is another research plot on which varieties recommended by research are tested in farmers' fields to determine acceptance and suitability for dissemination as a departmental recommendation. The VAT is a standardized test. Plots of uniform size are laid in the agroecological regions for every season and variety. No variety is released for wider cultivation without undergoing the VAT. For example, in a rice VAT there will be a maximum of four plots of 10 by 20 feet per season and region: one rice variety will be the farmer's own, one a regional entry, and the other two the varieties best known in the national breeding program.

\textit{Linkage between Extension, Research Institutions, and Farmers}

The monthly dialogue conducted under the auspices of the RTWG provides a forum for discussions of farmers' problems encountered in the field and forms an organic link between the research, extension, and training units of the Department of Agriculture at the regional level. All extension programs, stress points, and production targets are decided by this group. The group also determines the research needs of the region on the basis of the expressed needs of the farmers as encountered in the field. The training programs are designed to meet extension needs that are based on the stress points and targets decided at the RTWG meeting. One of the strong points that favors the continuity of such close linkages between the functions of research, extension, and education and training in Sri Lanka—aside from their inherent affinity within a process or continuum of agricultural development—is that all three of these major activities are carried out within the administrative organization of a single department. The dynamic mechanism of this linkage has three parts: diagnosis of farmers' problems and continuous feedback on this, refinement of recommendations or referral for further research, and on-farm validation of revised or new technology.

\textit{Identification of farmers' production problems.} Once the stress points are decided at the RTWG, the segment POs and SMOs draw up the extension program for their respective segments. Every fortnight the KVSs visit the farmer groups. During the visit the KVS first speaks to the farmers to inquire...
about the performance of the crop during the past fortnight and to verify whether the farmers have adopted the recommendations given by him during the last fortnight. In the course of this visit the KVS inspects the crop in the fields; invariably some of the farmers are met while they are tending their fields. By this on-site observation he ascertains the technical production problems and other related problems that farmers faced at that point in time. From his knowledge and competence the KVS provides the solutions he can. If he is unable to do so, he brings these problems to the attention of the Al and SMO at the fortnightly training class.

The first item taken up at the fortnightly training class is a review of the performance of the past fortnight, farmer adoptions, and the production problems encountered. Serious discussions take place about the problems identified by the KVSs. The segment AOs, SMOs, and AIs try to find solutions if they can; failing to do so, they verify and study these problems by visiting and seeing the problems themselves. More background information—such as predisposing factors, rainfall, and the like—is collected and recorded. The AIs help in finding the extent of the area affected by the problem, and in this process the AOs and SMOs further clarify the field production problems of the farmers.

**Generation and Prerequisites of Recommendations.** This stage of the linkage process functions at two levels. Once the farmers' production problems are identified, recommendations are made at the primary level by the district extension staff (the AD, AOs, SMOs, and AIs). Minor problems are discussed in the light of the data and observations made by the AD, AOs, and SMOs. From their knowledge and information, this group makes recommendations, and these are given at the fortnightly training classes to field extension officers. The main criteria in making any recommendation are (1) economic soundness (in the light of factors such as marginal revenue, cost per unit, return per unit of capital, return per unit of land, return per unit of labor, risk, and so forth), (2) technical feasibility (the adaptability of any recommendation to a given physical environment), and (3) social acceptability (of which the extension officers are well aware).

At this primary level, the extension officers base their recommendations on the criteria above in the light of the adoptions by progressive farmers observed in the field. Most of these recommendations are for agronomic practices (such as time of planting, plant spacing, tillage, seed rate, selection of crops and cropping mix, use of traditional varieties, and the like). Most of the recommendations given at the primary level are for highland cultivation, for which little research information is available. For example, a cowpea variety in the Puttlam District that was not released by research was found to be doing better than the recommended variety; as such, this local variety was recommended by extension personnel.

At the secondary level, the problems that cannot be solved at the primary level are brought to the monthly research-extension dialogue. In this discussion only the problems unsolved during the season are confronted (for example, yellowing of rice plants because of nitrogen deficiency).

Problems that cannot be provided with immediate solutions are taken up by the RTWG. At the RTWG's preparatory meeting the research officers are given the problem with all the relevant data. If solutions are available, solutions are provided. These solutions enter the program for the ensuing season. In the process of finding solutions, the research officers consult other research stations and researchers who are working in relevant disciplines. If solutions still are not forthcoming, the decision to conduct on-station research or adaptive research is made at the RTWG meeting. In deciding priority, the magnitude of the problem, the area covered, the number of farmers affected, and the problem's effect on increasing farmers' incomes are all taken into consideration.

At the RTWG meeting (see the subsection above), the AOs and SMOs present problems to research, and lengthy discussions take place. When a solution is provided, the extension officers verify its economic soundness, field adaptability, and social acceptance. If there are any doubts, whether to undertake further testing—either on the research station or in the farmers' fields—is decided at the RTWG meeting.

**On-farm Validation of Recommendations.** The final stage of the linkage process confirms practices to be recommended. Most recommendations are tested in farmers' fields before they are included
in the extension program to be taken to the farmers. This testing is called adaptive research. The varietal screening is done on the farmers' fields through VATs, described earlier. At the end of the season, the data from VATs and other adaptive trials are sent to the respective research officers. During the season the research officers visit these experiments to verify their conduct and to observe conditions. The segment AOs and SMOs are expected to visit these plots more frequently than the research officers to supervise and observe progress. In the case of the VAT, the national research coordinator for the crop collects all the information from all the districts and puts the recommendations to the Varietal Release Committee at the national level. This committee meets twice a year and recommends varieties to be introduced nationally or regionally.

The varieties recommended are taken up for multiplication by the Research Division for its breeder seeds and are registered by the Farms Division. New insecticides are not recommended for the regions until the Formulary Committee releases them; however, any promising insecticide or other agrochemical that has been tried out by the regions is reported on. Similarly, fertilizer recommendations are coordinated by the chief chemist of the Department of Agriculture. In this manner the adaptability of recommendations is tested and regional and national coordination of recommendations is effected. Both farmers and extension workers are closely associated in this testing process. In some instances, farmers whose fields provided test plots have started adopting new varieties and practices without further encouragement. This has been particularly the case for some of the long-lasting varieties (for example, Bg 94-1 rice).

Problems and Issues in Generation of Technology and Its On-Farm Validation

This overview would be less than candid if it did not include a description of the weaknesses in the linkage process that generates and validates technical recommendations for improved agricultural practice. These weak links may be identified as follows:

- A cropwise—not on-farm, farmer-oriented, farm plan, or farming systems—approach to the farmer's problems has been the norm. Similarly, extension programming has emphasized crops, crops acreages, and adoption of specific recommendations rather than the implementation of a whole package of recommendations for a given situation.

- Study of the economic soundness of recommendations—their marginal costs, costs per unit produced, returns per unit (of labor, of land, of capital) and risks—has been inadequate. The formulation of recommendations has emphasized technical feasibility and adaptability to farmers' field conditions. The total farm family's income has not been studied. For instance, for rainfed crops the emphasis is on crop acreage and on adoption of a practice areawide. Similarly, growing other field crops in rice fields is evaluated by how many acres were planted with other field crops.

- There seems to be a belief that extension staff should receive training only in extension methodology, and that SMOs should be trained only in their various disciplines. This leads to an inferiority complex on the part of the extension officers and to insularity on the part of SMOs—as well as to frustration, unproductive tension, and conflicts with research officers. The impasse would seem a chicken-and-egg problem. The most successful extension officers at the senior level are those who have had strong background and training in crop production and agronomy as well as in extension methodology. Such extension officers are able to sort out farmers' production problems and to present them to research officers in a way the researchers appreciate and understand. Thus, more meaningful research, both on-station and adaptive, can be undertaken. Such extension officers can also identify farmers' sound practices, which are as good as adaptive research, for inclusion in the extension program. Such extension officers also can conduct and supervise adaptive research in the field more effectively. This reaffirms the need for continuous training and upgrading of staff.

- Research on extension methodology in relation to the social reasons farmers do not adopt practices given to them needs to be conducted within the T&V system. When a practice is not adopted, the general reasons given are either economic or technical. Whether farmers understood the practice or whether socioeconomic factors inhibited adoptions is hardly reviewed. The reason for this negligence may be the absence of rural sociologists among the research officers and exten-
sion officers. There is a need to bring the social sciences to bear on the problem of nonadoption through interdisciplinary study. Data on known socioeconomic variables for a given area need to be classified to help research officers tailor their work to the social fabric of that area. Such deeper study of how and why a farmer behaves as he does when given a recommendation may reveal new concepts that may help both researchers and extensionists to strengthen their respective programs.

In summary, for the working understanding of the particular agricultural context that is essential to effective research, the farming situation must be taken in its biological, physical, and sociological totality. We as researchers address our minds mostly to technical aspects of the farmers' lives and of the problems they face daily. Research officers look at farmers' problems on technical grounds, neglecting the socioeconomic aspects. Extension officers also lack an appreciation of these aspects. Why have sociologists and economists not been more systematically involved in efforts to understand farmers' production constraints? Why are their recommendations not adopted? The extension workers' ability to capture the socioeconomic variables that affect a farmer's production has been inadequate. The technical, social, and economic complexity of a farmer's situation must be studied as a unified problem, a systems problem, by both research specialists and extension personnel if agricultural development is to proceed more effectively.

**Generation and Validation of Technology: Experience at the Bandarawela Regional Research Center**

As mentioned, with the identification and demarcation in Sri Lanka of distinct agroecological regions, agricultural research was decentralized; eight RRCs were established to facilitate research in close proximity to the socioeconomic and ecological environment of the farmer. Satellite agricultural research stations were also established in regions where there was a significant deviation from the environment in which the RRC was situated. The RRC at Bandarawela was instituted in 1973.

**Physical Environment**

The RRC at Bandarawela is situated in the intermediate zone in the central highlands of Sri Lanka. The terrain in this region is distributed on steep slopes, moderately steep slopes, and gently rolling slopes. The soils are predominantly red-yellow podzolics with a variable "A" horizon. The physical environment, notably the temperature, is modified by altitude (1,200-1,500 meters above mean sea level). The two monsoons—Northeast during the maha and Southeast during the yala cultivation seasons—influence the cropping patterns in the region. Rainfall is bimodal but is unevenly distributed during the two monsoons; it is higher in maha than it is in yala.

**Farming Systems**

In this region the greater part of the land area is under well-maintained tea plantations and unproductive natural grasslands (patnas) on highly eroded and windswept soils. Consequently, the land area that can be profitably used to produce the wide array of annual and perennial fruit crops that have been adapted to the environmental conditions in the region—and more important, that can fetch premium prices in the local market—is restricted. Surveys have revealed that the average landholding of a farmer in the region ranges between 0.125 and 0.25 hectare, or even less, and is often distributed in several locations. Rarely will a farmer own a full hectare of land in a contiguous block for arable cropping.

The highland crops are usually rainfed, grown by timing the cultivation because there are few or no facilities for irrigation. Several high-value cash crops (potatoes, tomatoes, capsicum [hot peppers], beetroot, cabbage) are produced by the farmers. Most farmers possess a small plot of paddy land that provides the staple food, rice, for family subsistence. These paddy lands often have assured access to whatever
irrigation water exists and are planted in the high-value cash crops soon after the rice harvest. The restricted landholdings have, therefore, led to the evolution of intensive farming systems for the economic well-being of farmers in this region.

**Strategies in Regional Research**

The farming systems that are operative and the diversity of crops that are produced in this region demonstrate the ingenuity and innovative ability of farmers. This being so, the challenges to research scientists are many and varied. First, research has had to be well planned and formulated to complement the achievements of the farmer and to direct his efforts toward increasing productivity from a high level to a higher level. Second, the technological advances made by the scientists have had to be related and applicable directly to the social, economic, and ecological environment of the farmer.

During the formative years of the RRC at Bandarawela, every endeavor was made to monitor and to understand the climatic variables and the cropping patterns adopted by the farmers. Investigations were simultaneously carried out at the center to obtain basic information on the growth and development of the diverse crops grown in the region. On the basis of some of the preliminary observations, on-farm trials were started in 1974 and were followed by the Cropping Systems Program in 1978. Thus, early in the development of this center an attempt was made to interact with the farmers at a quite localized level and to get a clear perspective of their production problems, thereby to formulate and direct research programs to resolve these problems.

**Adaptations under the T&V System**

With the institution of the AEARP, funded by the World Bank in 1980, the T&V system has provided a forum for the closer and more intensive interaction of officers in the Extension, Research, Education and Training, and Farms and Horticulture Divisions of the Department of Agriculture. These divisions are closely associated with, and their representatives comprise, the RTWG in each region (see the preceding section).

At the inception of the T&V system there was much apprehension and cynicism concerning the efficacy of the system per se in making an impact on the agricultural production program in the country. The years of strict bureaucratic compartmentalization had engendered the establishment of ivory towers among the respective divisions. It is now gratifying that these misconceptions have progressively waned, and there is an appreciation of the beneficial effects that have ensued from the T&V system. Yet, as one would expect in any new development, there is room for improvement. The officers in the regional RTWG are confident that, with time, there will be greater collaboration and reciprocity among them for attaining the desired objective of increasing agricultural productivity in this region.

**Production Problems of Farmers**

Farmers have many production problems. Some are associated with the availability of inputs, storage, and marketing and do not strictly fall within the purview of a researcher, who concentrates on the agronomic mechanisms of increasing agricultural productivity. Or a problem may be a global one that is receiving the attention of both local and international institutes and that has no solution at the present time. Bacterial wilt in potatoes is one such intractable problem. (Ironically, however, this disease is now acute in localized areas because the farmers have failed to adopt the advice of the technical officers in research and extension that close attention be given to field sanitation and proper crop rotation. It has been repeatedly emphasized that wilt-infected fields should not be planted with solanaceous crops for at least five years, but farmers continue to plant more frequently, until there is a total crop failure, because potatoes, tomatoes, capsicum, and the like are high-value cash crops that garner premium prices in the local market.)

Despite these drawbacks, there are many ways in which farmers cooperate with, and adopt technologies
Improved Technology and Its On-Farm Validation

disseminated by the technical officers. For example, in the past few seasons a major problem associated with the production and storage of seed potatoes has been resolved quite effectively by the establishment of “rustic stores.” Many other instances can be cited. As noted in the preceding section, the preparatory team meetings, which are held twice a year and lead up to the RTWG, provide an important forum for the SMOs, scientists, and training and other technical officers in the region to discuss, plan, and formulate over a period of two days the extension, research, and training program for the ensuing season. This meeting enables the extension officers, who have been closely associated with KVSs and farmers during the season, to present the production problems that were encountered, thus providing an opportunity for the scientists to obtain feedback on the new technologies or messages that were recommended for adoption and to learn of farmers’ production problems that have been identified.

The monthly research-extension dialogues of the members of the RTWG provide further opportunity for presentation, discussion, and resolution of farmers’ problems. There is much latitude in the venue at which this dialogue is held—at the RRC or satellite research station, the in-service training institute, or a farmer’s field. Similarly, there is no restriction on the content of discussion. The topic can be a farmer’s problem, the content of the messages for the ensuing four weeks, a new research finding, or a methodology or technique developed by a farmer that might be effective in increasing agricultural production.

Generation of New Technology and On-Farm Testing

At the RRC and its satellite research station in the region, new technology is generated by scientists who are specialists in the principal disciplines and are under the direction of the deputy director of agricultural research. These scientists are encouraged to give priority to crops, agronomic practices, and pest or disease problems that will have a direct effect on increasing the productivity of the farmers within the framework of the social, economic, and ecological conditions of the region rather than to expend their energies to attain academic distinction.

Several significant achievements have been made during the past few years and have now been readily adopted by the farmers. An early maturing, high-yielding rice variety, Bg 94-1, with a higher yield potential than the late maturing H-4 variety was developed by the rice breeders and accepted by the farmers. Similarly, a new variety of tomatoes, Biansz, with very acceptable fruit quality and higher yield than the locally grown KWR cultivar, was developed by the breeders to suit the conditions of the region and is now in great demand. Several agronomic practices—spacing of beans, introduction of new crops into the cropping pattern, and the like—are also now being adopted by farmers. These advances are being disseminated through the extension officers and the T&V system.

On-station results are at present channeled to farmers through the adaptive research trials conducted on farmers’ fields. Whenever a new technology is generated at the RRC, simple trials are designed that include the farmer’s present practice as the control. These trials are then laid out in farmers’ fields in widely dispersed locations. The trial sites are selected by the extension staff, who are closely associated with the adaptive research staff in the entire operation from planting to harvest. All the inputs are provided by the RRC; the farmer is involved in the preparation of land, maintenance, and marketing of the produce. These trial plots serve two purposes; first, to monitor the adaptability of the technology in the environment of the farmer; second, to disseminate it rapidly through “field days” to other extension personnel and farmers in the area. The researcher, the extension officer, and the farmer are thus directly and closely associated in the adaptive research trials that are executed in the region.

The results obtained from these adaptive research trials are then evaluated at the RRC with the observations and reactions of the farmers and the extension officers. If the new technology has given positive results and is acceptable by the farmers, it is then presented at the RTWG, through the preparatory meeting, as a positive research recommendation for adoption in specified locations. For localized problems of farmers that cannot be resolved at the RRC, investigational work is done on the farmers’ fields where the problem exists. Farmers have been most cooperative in these circumstances. For example, there are localities where iron toxicity has reduced yields dramatically. The research developments on this problem
in another region were taken and are being tested with modifications made to suit the ecological environment in the region. Varieties that have proved to have some degree of tolerance to iron toxicity elsewhere are being tested locally.

Here again we see that, since the introduction of the T&V system, there has been a close interaction among officers in research, extension, and training—within and among regions—in the evolution and translation of technology to assist farmers.

Formulation of Extension Messages

The framework of the T&V system in Sri Lanka has been described in the preceding section, but the function of the RTWG is worth noting again. At the preparatory meeting, the extension staff provide a summary of the program undertaken during the previous season with specific reference to achievements, if any, and the problems that were encountered in achieving the set targets. Similarly, the research scientists present their achievements and advances both on-station and on-farm. The training staff present their progress in training related to these issues. After these presentations, the members of the group are divided into groups by crop. Each group includes a representative from the several divisions of the Department of Agriculture.

Whenever a specialist officer is required in several groups, he rotates so that he can be available for consultation. Each group then elects a chairman to lead the discussion, which is designed to draw up a program of research, extension, and the training for the coming season. The discussion elicits positive extension messages, and these recommendations are then formally compiled and presented to the whole group. Three weeks later, the RTWG meeting is held and the programs again are presented for ratification, with amendments when deemed necessary, by consensus. At each RTWG meeting several extension messages are ratified.

In summary, this section has attempted to place in perspective the extension-research linkage as it operates in the region. From the experiences gained during the short period of three years since the institution of the T&V system, it is gratifying to note that a pragmatic approach to agricultural production has been established by creating an awareness of the basic necessity to have such close links between extension and research. From the directions and enthusiasm that exist at present, such linkage shows every sign of evolving into a structural, symbiotic relationship within the next few years.

Generation and Validation of Technology: Experience at the Maha Illuppallama Regional Research Center

This section discusses the interaction between the agricultural research and extension services to determine the adaptive and basic research needs of the region under the purview of the agricultural research station at Maha Illuppallama. Some of the problems encountered in conducting adaptive research under the AEARP, and suggestions to overcome these, are highlighted.

Process of Determining Adaptive and Basic Research Needs in the Region

Adaptive research may be defined as a methodology for testing in farmers’ fields the technologies developed at the research stations, explicitly to arrive at rapid solutions to problems posed by the extension staff in the light of their interactions with the farmers. Therefore, adaptive research itself can be viewed as a link between extension and research, with the prime objective being the rapid spread of new information.

In the past, there had been research-extension dialogues at the agricultural research station at Maha Illuppallama at which staff of both Research and Extension Divisions met together to discuss the field problems of farmers and new ideas for future research. Although these meetings were held at almost regular intervals, the solutions for the problems highlighted had not met expectations. Because of various
constraints it had not been possible to undertake adaptive research or new lines of research at the station. Nevertheless, although at times the meetings were confined to dialogue, they greatly helped in making research officers aware of the various agricultural problems that existed in the field.

At present, under the AEARP, the preparatory team meeting of research officers, SMOs, and training officers, and the RTWG meeting that follows, has been more productive in clarifying the research, extension, and training needs for the area.

One facet of the preparatory meeting not mentioned in the preceding sections is that the ADs in the respective districts send their research, extension, and training requirements to the chairman of the RTWG at least two weeks before the scheduled date of the preparatory team meeting. For the research component, the chairman arranges the agenda by crop and research discipline to facilitate a smooth discussion at the meeting. This has become necessary because some of the research questions raised are common to several of the districts. It is expected that the research needs in the farmers' fields—and farmers' requests for new technologies such as new varieties, pest-control methods, and machines and implements—will have been compiled during the routine activities of the SMOs, AIs, and KVSs.

These problems are then handed over to research officers in the appropriate discipline with the request to prepare possible solutions for discussion at the meeting.

Once the research officers have studied the problems, it is possible to group them roughly into three categories—immediate, short-term, and long-term—on the basis of availability of information to solve them and to make recommendations. A few examples in these categories will be presented later. At the preparatory meeting it is possible to agree after discussion that some of the research problems submitted by the extension staff are not to be considered for further action because they are insignificant or irrelevant. The other problems for which immediate recommendations could not be found are forwarded to the RTWG for action. The farmers' problems that are highlighted at the monthly research extension dialogues held at the RRC or RTCs, sometimes coupled with field days at RRCs or farmers' fields, are also documented. But these problems will be included in future research programs only if they are formally presented and accepted at the preparatory team meeting.

Adaptive Research Conducted at the Maha Illuppallama Center and Its Achievements

At Maha Illuppallama the work on AEARP was first started in yala season of 1980. At that time there were no adaptive research officers to conduct the adaptive research program discussed at the RTWG meetings. Studies were undertaken, however, by the research officers at the satellite station. It must be stated that, because of the lack of personnel and facilities and because of earlier commitments of the research staff, not many of the research problems communicated by the RTWG could be studied. After the appointment of adaptive research officers in July 1980, from the maha season of 1981 onward, however, the adaptive research work in this region accelerated. It is expected that these studies will be further improved once the new adaptive research centers in the district are fully staffed and equipped. The commitment to such centers appears to be firm; so far there have been only procedural delays.

The research trials carried out have been in farmers' fields, on the research station, or both, depending on the level of evaluation and experimentation required. The adaptive research trials in farmers' fields have been done mostly on a nonreplicated, multilocational basis. This simplicity enables the farmers to observe and understand the investigations carried out.

As stated earlier, the research problems submitted and accepted for investigation fall into three categories (immediate, short-term, and long-term) depending on the availability of recommendations. After investigation, these recommendations are then released as extension messages and are also included in the training program of the RTC at Maha Illuppallama. At this juncture a few cases from each category will be taken up for discussion.

**IMMEDIATE.** These research problems submitted by the SMOs and ADs (extension) in the districts have had an apparent solution or an existing recommendation or have had to be discarded. Because the
research officers are given prior notice of problems, with the already available research information it is easy to resolve such problems at the monthly dialogue. One might question, however, why such information has not been available to the extension staff before they submitted the topics for investigation. This may be because the information was (1) not published but available in research reports, (2) published but not well known because of communication or dissemination difficulties, or (3) of low priority at the time of problem identification.

The ill-defined and low-priority problems are discarded. A few examples in which solutions were made available immediately are:

- Dapog nursery management (a nursery technique whereby paddy rice seedlings are raised close to homesteads in a small substratum, usually on banana leaves without soil, and can be transported to the field for transplanting in about fourteen days): this is already included in the training program.
- Keeping a dapog nursery beyond fourteen days: this can be done only with the use of liquid fertilizers.
- Water requirement of rice in low humic gleys soils under a rotational system of water issue in the Mahaweli area (a major irrigation scheme assisted by the World Bank): a report was submitted to the Mahaweli Development Board through the DD (Mahaweli).
- Feasibility of growing subsidiary food crops in the Mahaweli areas: although sufficient information is available, it was decided to investigate the problem further, but the topic is already included in the training program.
- Incidence of Agromyza attack on pulse crops: recommendations were available, but research still continues at the station. The topic is also included in the training program.
- Control of chili leaf curl from thrips and mites: information was available, and it was included in the training program.
- Growing of onions in the dry zone: because research was not being conducted at Maha Illuppallama, it was decided to follow earlier recommendations.
- Application of rhizobial inoculant for soybean grown with irrigation water: this practice was not recommended; guidelines for effective use of rhizobial inoculant in soybean under field conditions were included in a booklet already published.

**Short-term.** The recommendations for this category of problems could be given within a season by testing them in the field or laboratory, through a literature survey, or through consultation with experienced officers. Sometimes these recommendations could be made at the start of the season for which the meeting was held. Some examples follow:

- Damping off of chilies: although a recommendation was available, trials are being continued.
- Flower and tender pod drop of chilies: this was identified as an attack by anthracnose fungus; a recommendation is now available.
- Reduction of percolation, and leaching losses of fertilizer in chilies and onions in regosol at Kalpitiya: suitable remedies were recommended.
- Reevaluation of recommended spacing for paddy rice: the spacing of 8 × 4 inches proved to be the best after comparison with spacings of 4 × 4, 5 × 5, 6 × 4, and 6 × 6 inches.
- Malformation of leaves of chili: zinc deficiency was found to be the cause of this problem.
- Investigation on the yield gap between research plots and farmers’ fields in soybean: the gap was shown to be caused by inadequate management in cultivation by the farmers.

**Long-term.** Problems of this category take a long time to solve—possibly two to three seasons (for pesticides) or much longer (for development of plant varieties with different traits or for soil problems). Examples of investigations under way within this category follow:

- Integrated control of weeds
• Causes and remedies for development of alkalinity and salinity in major irrigation schemes (a booklet has already been prepared to present available information)
• Recommendation of cropping pattern under tubewell irrigation
• Development of an early maturing variety of chili for Mahaweli-irrigated areas
• Development of an early maturing variety of paddy rice for rainfed areas
• Development of a variety of green gram that is tolerant or resistant to attack of mungbean yellow mosaic virus
• Development of varieties of cowpea and mungbean to fit into maha and yala rainfall patterns
• Evaluation of saline-resistant paddy rice varieties for the Mahaweli area
• Development of a variety of soybean with high yield and longer seed viability under normal storage conditions.

Formulation of Extension Messages

The completely new technologies that have been developed and thoroughly tested in farmers' fields, and also the farmers' problems solved through discussions or research programs, are presented at the preparatory team meeting where the previous season's work is reviewed. At this meeting, after discussion, the findings that can be extended to the farmers are put up to the following RTWG meeting for final decision. At this meeting they are transformed into extension messages to be released to the farmers. At the same time, the recommendations are released to the RTC for inclusion in the future training programs for extension workers at all levels.

Recently, the Agricultural Economics Division of the Department has been drawn into this program to evaluate the economic feasibility of most, if not all, of the findings before making recommendations. This should go far in remedying the past neglect of this aspect of farmers' production problems (see the first section of the chapter).

Once the extension messages are formulated, the Education and Training Division (at the headquarters of the Department of Agriculture) publishes them in monthly magazines and in leaflets for distribution.

Other Advantages of the AEARP

• As mentioned earlier, at this early stage in the project, some research findings have already gone forward as extension messages and as topics for preseasonal training programs.

Other, less technical benefits have accrued through the AEARP and the T&V System.

• Improvements have been made in the method of identifying and forwarding field problems by the extension staff: (1) the problems submitted are classified according to crop and discipline; (2) consideration is given to the magnitude and representativeness of the problems; (3) problems are better defined for easy identification at the regional meetings; (4) problems already solved are discarded.

• Research programs are developed that are mainly problem oriented.

• Use of central adaptive research trials for joint field days has provided an opportunity for farmers to meet both extension and research staff in their own fields to discuss the problems, thus improving the credibility of officers of the Department of Agriculture, and has provided feedback from the farmers on the acceptability of the technologies tested as potential recommendations.

• Adaptive research has been accepted by the extension staff as a part of the T&V system.

• Awareness has grown among research officers of the socioeconomic implications that the technologies recommended may have for farmers' daily lives.

• A closer relationship among the research, extension, and training officers has been forged, and rivalry and exclusivity have consequently diminished.
Recommendations for Further Improvement

Nevertheless, refinements in the workings of the system can be made.

- The preparatory meeting should be advanced, to be held at the end of each season, and the RTWG meeting to be held at the beginning of the season. This would give officers the opportunity to have a more meaningful discussion, since the season’s problems would be fresh in their minds.
- A thorough awareness among the field staff of the need for better identification and classification of field problems is essential.
- For better organization and execution of field trials, regular contact between the adaptive research officers should be encouraged.
- A better understanding of the conduct of simple field experiments by the field staff, perhaps through the training program, would help in obtaining more reliable research data.
- The participation of the research officers in training programs should be restricted to the training of SMOs only; to facilitate training of other officers, documentation and publications are necessary.
- The participation of AIs in the adaptive research trials has not been encouraging because the AIs are overburdened with trials for the Food and Agriculture Organization, National Fertilizer Secretariat Trials, and VATs in addition to their normal duties; this situation should be rectified.
- Upgrading the research staff at RRCs should be a priority; most of the time the research officers at the RRCs are untrained junior officers whose capacity to handle multidimensional field problems is limited.
- The inclusion of Farm Machinery Research Centers in the AEARP is considered to be essential for the development of less costly and more efficient farm implements for the dry-zone farmer.
- The provision of suitable marketing facilities for farm produce at reasonable prices to a large extent determines the success or failure of programs to increase productivity, and such facilities should be given greater priority.

In summary, over the past two years, AEARP activity has shown the likelihood of a substantial improvement in taking to the farmer more relevant technology at a faster rate.

But developing suitable technology in itself is not a measure of success. To be useful, this technology needs to be accepted by the farmer. Farmer acceptance is dependent, among other things, on how appropriate the technology is within the farmer’s context, as well as on whether the information reaches him and whether the supplies that go with the technology are conveniently available.

It has been reported that at least fifteen public organizations and institutions service the Sri Lankan farmer at the local level. Even within the Department of Agriculture, four divisions (Research, Extension, Education and Training, and Farms and Horticulture) are directly involved in these services. In this stratified context, how does one evaluate the contribution of a certain component to the improvement that has been achieved?

To be able to adequately evaluate the contribution of any one organization, technology, or recommendation, it will be necessary to develop (perhaps even through computer modeling) a methodology that can correctly measure not only the strength but also the weaknesses of a dynamic, ongoing program. It is proposed that a unit or organization be structured specifically to record and evaluate the effective contribution of each component in the process of technology transfer, with its mandate being to identify weak or deficient components so that suitable remedial measures can be undertaken. Such a unit would serve both as a screening device and as a referral system and would greatly facilitate the many efforts to achieve common goals.
SECTION IV

The Formulation of Extension Recommendations

Editors' Note

This section examines the problem of framing extension recommendations: those that are too global or use a top-down approach often are not adopted by farmers. Past weaknesses in extension services and insufficient testing of technologies on farmers' fields have contributed to ill-fitted recommendations. All authors comment on the need for recommendations that can be adjusted to suit particular types of farmers or varying seasonal conditions, the need for formal structures to produce and review the technical recommendations, and the need to oversee implementation and monitor experience. A recurring theme is that farmers themselves should participate in formulating recommendations. A number of different ideas on how this is being done and could be improved are propounded.

Denning (chapter 12) has a wealth of detail on how to go about formulating recommendations and on the special problems of rainfed areas, where an apparently profitable technology may be too risky for farmers to adopt. He describes a “constraints methodology” that can be used to define the problem and establish future extension or research priorities. He also comments on the economic incentive required by farmers if they are to adopt new cropping patterns. IRRI experience has shown that net returns per hectare need to be at least 30 percent above the farmers' current system, and that they should be at least twice the cash cost. Denning argues that recommendations should be regularly reviewed and, where necessary, revised, and that fallback positions are needed to take account of within-season variability. He points out the desirability of strategies that minimize risk via cutoff dates. Since farmers have varying resources, it is more important to know, for instance, the minimum level of fertilizer needed to obtain a significant response, and the likely increase in responses over a range of fertilizer applications, rather than the single optimum level that is commonly recommended. As reported in these papers, the experience of various successful extension services suggests that disseminating a single “best” package is not as effective as providing farmers with a range of options from which they can choose the ones that suit their needs or that can be adapted to fit them.

Salmon (chapter 13) critically analyzes Indonesia’s previous paternalistic top-down approach, which was to frame recommendations without ever consulting the farmer. In the past, researchers retreated into an ivory tower because extension was weak and they did not know where or how to deliver their results. Bashir (chapter 14) relates a similar experience from Pakistan, where technology remained stagnant owing to the lack of any feedback, and the same messages continued to be passed out year after year. Many of these messages were not adopted as they had never taken into account the variability among agroecological zones and socio-economic situations, or the availability of inputs and services. This paper describes highly relevant and specific cases where adaptive research, carried out by subject matter specialists, was used to refine technical messages; in these cases recommendations were formulated on the basis of effective field trials.

Hoare (chapter 15) presents empirical evidence from Thailand to document that, where key recommendations are not framed for an area that the average farmer can manage in a season, the result may be minimal adoption. When the program in Thailand was changed after careful discussion with farmers, a package requiring both strenuous labor (terracing) and a long-term payoff (tea) was adopted with surprising rapidity.

Overall, this section’s papers offer several recommendations concerning the formulation of extension messages: start by gaining a thorough understanding of the existing farming systems and their environment;
formalize the process of framing the extension recommendations by institutionalizing the research-extension continuum; develop more flexible recommendations and vary them for different farm types or local conditions; involve the farmer more fully in all stages of the process; and set up improved structures to implement delivery of recommendations when embodied in an extension program.

As barriers break down between research and extension institutions and they both learn to work more closely with the farmer, more effective recommendations can be formulated to fit farmers' needs. The papers that follow document persuasively how this is being achieved in some parts of Asia and what difficulties are being encountered. It is now widely recognized that farming systems research needs to be used more extensively in framing appropriate recommendations within broad production programs. In particular, adoption rates should be closely monitored to update recommendations constantly and keep the system dynamic, and staff should be upgraded to enable them to provide farmers with more flexible advice.
Integrating Agricultural Extension Programs with Farming Systems Research

Glenn L. Denning

Programs in agricultural research and extension represent formalized efforts to increase the incomes and living standards of farmers through technical improvements in agricultural production practices. Increases in agricultural productivity through changes in farmers’ practices likewise contribute to national economic, social, and political stability. For these reasons, national governments and international research and development institutions have in recent years directed greater attention to increasing the effectiveness of both research and extension. Russell (1981) argues that an improvement in the quality and relevance of research is a prerequisite for improving extension work in developing countries.

In the past decade, the “farming systems” approach has emerged in agricultural research as a means of focusing research efforts to recognize “the interdependencies and interrelationships that exist among elements of the farm system, and between these elements and the farm environment” (CGIAR 1978). Development and promotion of methodologies for farming systems research (FSR) have been pioneered by a number of international agricultural research centers, such as the International Rice Research Institute (IRRI), Centro International de Mejoramiento de Maiz y Trigo (International Center for the Improvement of Maize and Wheat, CIMMYT), International Institute of Tropical Agriculture (IITA), and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). This effort in turn has led to the adaptation and application of a farming systems approach by many national research programs. In Asia, IRRI coordinates a Rice Farming Systems Network (Carangal 1977), established in 1974 and now including twelve participating countries (Philippines, Indonesia, Vietnam, Thailand, Burma, Bangladesh, Sri Lanka, Pakistan, Nepal, China, India, Malaysia). In these countries FSR is being employed as an adaptive research tool to varying degrees, from a small number of research sites in China to more than eighty-five research sites in the Philippines. An FSR site is an area—a village or group of villages—in which a research team works to design, test, and evaluate new farming systems. The introduction and, in some cases, institutionalization of the FSR approach in several Asian countries represents a significant improvement of the conventional and essentially one-way model of technology development and transfer, which is from research station to extension demonstration to farmer.

Extension has also been the subject of dramatic rethinking and reorganization in recent years with the introduction of the training and visit (T&V) system of agricultural extension in several countries in Asia. This extension methodology requires a systematic program of training of the village extension worker (VEW), together with frequent visits by him to the fields of certain “contact” farmers (Benor, Harrison, and Baxter 1984). Introduction of the T&V system has required substantial institutional reorganization to accommodate stronger research-extension interaction, manpower redeployment, alternative management systems, increased training demands, and increased mobility of supervisors and extension workers. As in the case of FSR, the T&V extension methodology has been accepted by national programs to varying degrees, from pilot project areas (for example, in the Philippines) to widespread acceptance in India, where thirteen states have adopted the T&V system (Pickering 1983).

In accepting the FSR approach or the T&V extension system, or both, national programs have to a large extent been attracted by the inherent logic and future promise of the respective methodologies. Such a conclusion is based on the dearth of definitive studies that quantitatively document the benefits of

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employing these methodologies in comparison with the methods and techniques they are meant to complement or replace. Similarly, it appears that the introduction of FSR and T&V extension could and should be better coordinated and sequenced to take maximum advantage of the obvious complementarity that exists. Eklund (1983) has observed that methodologies for on-farm adaptive research have not been adequately linked or institutionalized within extension systems.

A major source of the current dilemma of poor research-extension linkages is that separate, rather than integrated, methodologies exist for improving research and extension effectiveness. This chapter proposes that a systems approach to both technology development and transfer is required. Such an approach seeks to integrate the T&V extension system with an FSR methodology, while emphasizing increased farmer participation in technology testing and evaluation, thus establishing more dynamic interactions among researchers, extension workers, and farmers.

The discussion follows the classical FSR sequence, commencing with the identification of priority areas for development, then proceeding through several steps in technology testing and evaluation to the production program—for which the T&V system will be assumed to be the primary extension methodology employed.

Farming Systems Research: Collaboration of Researcher, Farmer, and Extension Worker

Agricultural households in developing countries undertake a range of production, consumption, savings, and investment activities. These activities are conditioned by the farm families' needs and aspirations and by the biological, physical, and socioeconomic constraints under which the farmer is operating. Because of the complex interrelations among farm-household activities and the environment, the systems approach appears to offer greater promise than the commodity approach when the objective is to increase farm productivity and to improve the welfare of the farm family (Dillon 1976).

In recognition of this promise, national and international research programs in recent years have invested heavily in the farming system approach to technology development (Norman 1978). This approach requires researchers to examine more closely the components of a farming system and their interrelations; to identify constraints to, and opportunities for, increased farm productivity; and to design, test, and evaluate technical innovations under actual farm conditions. The farmer, the farm, and the surrounding physical, biological, and socioeconomic environments become the foci of research efforts.

IRRI's cropping systems research methodology (figure 12-1) involves a stepwise procedure of design, testing, evaluation, and transfer of technology appropriate to small farmers in a given area. The target area is identified before the site is selected and described, and it is further defined through the subsequent stages of technology testing and evaluation. Reference to the methodology as pertaining to "cropping" rather than "farming" systems reflects IRRI's mandate to focus on the crop component of rice-based farming systems. The research methodology does, however, take account of the importance of noncrop enterprises (livestock, off-farm employment, cottage industries, and the like) in the description, design, testing, and evaluation phases. While its strength as an adaptive research methodology for identifying, testing, and evaluating crop interventions in a whole-farm context remains, it is essential that further methodological development be undertaken to broaden its applicability to technical interventions not directly related to crop production. A research project has recently commenced at IRRI to explore further the methodological issues of crop-livestock interactions in rice-based farming systems.

Selection of Target Area and Research Site

The initial step in applying IRRI's cropping systems research methodology is usually described as "selection of sites with potential." Research sites are selected primarily because they are representative of larger potential target areas into which the technology generated can be introduced with relative ease. A
site may consist of one or more villages where a research team works to design, test, and evaluate alternative cropping patterns and cultural management techniques.

Selection of a research site is, however, subsequent to the selection of a target area for development. For selecting a target area, considerations may include national and regional development priorities as well as existing and planned physical and social infrastructure. The size of a target area ranges from 20,000 to 200,000 hectares. A further requirement is that there should be an existing or planned research capability in the area. It is also an advantage if there is a backlog of technical innovations (new crops, varieties, and so forth) that show promise for adaptation in the target area.

In general, selection of the target area is primarily the responsibility of government planners, administrators, and scientists. In developing countries farmers seldom have a political voice strong enough to influence the location of efforts in agricultural development. Indirectly, of course, economically depressed areas may attract the attention of government administrators. Economic development through agricultural research and development is often seen as a remedy for possible political instability in a region. Governments often make available generous funds and encourage donors to assist in the development of areas that are politically hostile. The alleviation of problems in such areas through this strategy has been difficult, however, because the better trained and more experienced scientists and administrators prefer to work in and visit more favorable areas.

Although direct farmer participation in the selection of the target area is not always feasible, once such an area is selected it is generally both feasible and highly advantageous to consult farmers about the location of the research site. Farmer cooperation and participation become critical, however, during the later stages of site description and in technology design, testing, and evaluation. Thus, a decision to proceed with site research without first receiving a strong indication of farmer interest and support may be unwise. Although the primary consideration in selection of the research site must be the representativeness of the chosen
Formulation of Extension Recommendations

villages, the very nature of FSR requires that a close rapport be developed with those farmers on whose fields the research is to be undertaken.

Likewise, researchers must gain the respect and confidence of extension workers who have responsibility for advising farmers in the research villages. This process is made easier if extension workers participate in the selection of the villages. Extension workers generally have had a longer association with the proposed site and are often in a better position than the researchers to assess and compare the farmers' likely responsiveness.

Collaboration by researchers, extension personnel, and farmers in selection of the research site represents an important initial step in securing strong linkages in the research-extension-farmer continuum.

Description of Target Area and Research Site

The objective of describing the research site is to provide an information base for the design of a research program. A basic tenet of FSR is that the researcher must first understand the farmer and his family's resources, environment, and objectives before proceeding to design and test technical alternatives. Several useful methods for describing target areas and research sites have emerged in recent years. These include CIMMYT's survey procedure (Byerlee and others 1980; Collinson 1981), the sondeo approach of the Instituto de Ciencia y Tecnologia Agricolas (ICTA) in Guatemala (Hilderbrand 1981), and IRRI's survey for design (Zandstra and others 1981).

A descriptive phase such as this is a seemingly neglected component of the T&V extension methodology. Information collected in describing the target area and research site can be valuable in establishing "recommendation domains" for extension (Collinson 1981) and in identifying constraints to and opportunities for improved technology transfer. A better understanding of traditional communication networks in villages can clearly enhance the effectiveness of T&V extension (Cernea 1981). Techniques for describing and developing such networks, however, are seldom used (Peter E. Kenmore, personal communication). With some adaptation of the descriptive phase of FSR, the information gained can serve not only as a basis for more relevant research, but also as a reference in designing village-specific extension strategies.

The IRRI methodology is designed to collect only that information required for the design of alternative cropping patterns and for defining research priorities at the site (Zandstra and others 1981). Description of the research site and target area continues, however, throughout the design, testing, and evaluation phase, and often focuses on special features of the farming system that have emerged in the process of researcher-farmer-extension worker interaction in the area.

Site description involves gaining an understanding of the physical, biological, and socioeconomic environment. To a large extent, information on the physical environment is obtained through secondary data sources (aerial photographs, soil maps, climatic records, and the like). However, the case for farmer participation even in the description of the physical environment is strong. Where climatic records are poor, as is often the case in less developed areas, farmers' recall of environmental conditions, particularly of catastrophic events, may be more valuable.

An example of this can be drawn from IRRI's cropping systems research site in the Cagayan Valley in the northern Philippines. Farmers in the area grew mainly traditional rainfed rice varieties, and an opportunity was seen whereby early maturing, non-photoperiod-sensitive rice varieties could be introduced to intensify crop production in this economically depressed region. After three years of site research, little progress was made toward achieving this objective. Severe floods and frequent dry spells rendered the "promising" varieties quite unsuitable for that environment. The frequency and intensity of the floods and dry periods were not anticipated on the basis of the climatic data alone. Farmers, however, have an excellent recall and appreciation of the climatic variability of their location. In hindsight, this source of information could have been of considerable assistance in research design and, more important, in site selection.

The participation of farmers in the description of the biological and socioeconomic environment is a generally accepted practice both at IRRI and in the various national research programs in Asia. The primary research tool is the farmer survey.
To obtain a description of the biological environment, crop protection specialists (having knowledge of entomology, plant pathology, and weed science) survey farmers to determine their awareness of insect, disease, and weed problems. In addition, information is collected on the farmers’ existing crop protection practices.

Litsinger, Canapi, and Alviola (1982) reported one such study that examined farmers’ perception and control of rice pests in the Cagayan Valley. Farmers were asked to name or describe (in their local dialect) the problems they encountered at each stage of crop growth. After enumerating the pests, farmers ranked them in order of importance. Farmers used a number of terms to describe whiteheads, but most did not know that the symptom was caused by an insect (stem borer).

An objective of such surveys, therefore, is to translate farmers’ observations and experience into the researcher’s terms. This is where the VEWs have a useful role to play. Their close familiarity with farmer attitudes, expressions, and terminology, together with some degree of technical knowledge and an appreciation of the researcher’s objectives, will contribute to a more realistic assessment of the farm environment (that is, of the research environment). This contribution will, of course, depend strongly on the education, training, experience, and attitudes of the village-level workers.

Participation of the extension worker in the site description may introduce a possible bias, however, brought about by either or both of the following:

- The farmer’s desire to please the extension worker by overstating the farmer’s acceptance of recommendations
- The extension worker’s zeal to impress the researcher by translating a high level of acceptance of recommendations.

Although participation of farmer and extension worker at the stage of research site description can be valuable, the power of farmer surveys in giving the researcher a clear and realistic understanding of farmers’ practices and perceptions is limited. J. A. Litsinger (personal communication) has remarked that the major advantage of such surveys (conducted by the researchers themselves) is that they bring the researcher in close contact with the farmer, a relationship that is of value in designing and undertaking future research at the site. Greater use of participant observation techniques has been suggested as a more meaningful descriptive tool (P. E. Kenmore, personal communication).

A further aid to describing target areas and research sites is the employment of the “constraints” methodology developed by IRRI. The general objective of constraints research is to identify the factors explaining the difference between actual and potential (rice) yields in selected farm environments (De Datta and others 1978). The constraints model recognizes two yield gaps (figure 12-2). (See also, and compare, the analysis by A. A. Gomez in chapter 8.) Yield gap I represents the difference between potential yields from experiment stations and rice farms because of differences in the environments and the resource bases. The constraints methodology focuses on yield gap II, which is the difference between potential and actual yields in farm environments. Yield gap II exists because farmers use inputs or practices that result in lower than potential yields. Gomez (1977) divides yield gap II into two components: that which can be closed economically by farmers, and that which is biologically feasible but not profitable to close. The major contribution from extension would appear to come from efforts to close the former rather than latter component of yield gap II.

The IRRI constraints methodology is carried out through on-farm experiments and surveys to identify technical and socioeconomic reasons for existing production levels. Constraints research also makes it possible to identify the key components of a recommended technology “package.” With this information, extension can focus its efforts on a relatively small number of component technologies that show the greatest payoff. The methodology has been successfully applied to nonrice crops such as mungbeans (figure 12-3) and recently has been modified to identify constraints to the adoption of currently recommended cropping systems.

Full details of the methodology are found in De Datta and others (1978); examples of its application in
several Asian countries are documented elsewhere (IRRI 1979; Bhatti and others 1981; Ghodake and Walker 1982).

In situations where an apparently profitable technology is available and farmers are not adopting it, the application of the constraints methodology may be an appropriate tool in identifying the research priorities and in sequencing development efforts—be it research, extension, input and credit supply, or marketing support.

**Design of Technology**

For the design phase of cropping systems research, Zandstra and others (1981) have described two distinct but closely related activities: the design of alternative cropping patterns to be tested and the formulation of the overall research program. The design process is repeated before each cropping season, making use of the results of previous years' research. The initial design phase uses information obtained from the farmer surveys during description of the target area and research site. With this and with information from previous experience at other research sites, the researchers develop alternative cropping patterns to be tested in farmers' fields.

In practice, it is rare for researchers and farmers to sit down together and develop new cropping patterns for testing. The design process is, to a large extent, the responsibility of an interdisciplinary team involving both biological scientists and social scientists (and including extension workers). To obtain some farmer input, it has been the practice at IRRI research sites to request local extension workers to call meetings of farmers to discuss the designs that have been developed by the researchers. In theory, the views of the farmers are sought and utilized, although in most cases the cropping pattern initially implemented remains relatively unaltered. The exception is where a new and potentially unmarketable crop is suggested for inclusion in a cropping pattern (for example, sorghum in the Philippines). In such cases farmers have voiced their opinions by not volunteering to test the patterns on their fields.

A high level of farmer participation (or control) at the design phase has its disadvantages. Farmers may
reject testing technical innovations with which they are unfamiliar. In this way new crops, whose feasibility under farmer management is not known, may not enter a testing phase. Also, farmers may accept designed patterns for testing if adequate incentives and insurance (guarantees) are given, but this should not be seen as strong evidence of their acceptance of the technology.

Certain researcher-managed and "superimposed" trials are formulated to provide information on technology components (fertilizer, insecticide use, plant variety, and the like). Researcher-managed trials, as the name suggests, are designed and implemented by researchers. Superimposed trials are technology tests conducted on the same fields used in the cropping pattern trials. Farmer participation in the design of both researcher-managed and superimposed trials is probably even more indirect than in the case of cropping pattern trials. "Farmers' level" treatment (the farmers' own current practice) may be included by the researcher as one of the trials. Information on what constitutes the farmers' level (for example, the amount of nitrogen used and its timing) is generally obtained through surveys during site description. Because of the heterogeneity of farms and farmers, more than one farmers' level treatment may need to be included in the experimental design.

The status of existing and planned infrastructure will influence the range or realistic options included in the research plans (Flinn and Denning 1982). Researchers must be made aware of how critically their technology depends on the performance of support services. The design of a research program (on-station or on-farm) will influence the nature of the messages (recommendations) that emerge from it.

Zandstra and others (1981) have described three types of recommendations that require actions of varying complexity:
Formulation of Extension Recommendations

- Fixed actions—general recommendations that could apply throughout the target area, regardless of soil type, landscape position, and the like (for example, “Plant IR60 rice variety”)
- Actions conditioned to fixed resources—recommendations made on the basis of generally nonvariable factors such as soil type, landscape position, and the like (for example, “For heavy-textured bottomlands, plant a rice-rice cropping pattern, but for light-textured plains and light- and heavy-textured plateau soils, plant rice followed by mungbean”)
- Actions conditioned to variable factors—the most complex type of recommendation, in which the farmer, extension worker, or both must be able to recognize and respond to the variation of a given factor (for example, “Apply 0.75 kilograms a.i. endosulfan per hectare to control stem borers if there are more than 5 percent deadhearts at the booting stage”).

Consultation with extension personnel at the research design stage will give an indication of which level of recommendation the researchers should attempt to develop. For example, it may be unrealistic for a poorly trained and staffed extension service to communicate the third type of recommendation, such as spraying for pests at economic threshold levels. In such cases a research team may be better advised to concentrate on simpler methods, such as spraying at fixed calendar intervals.

Testing of Technology

The testing phase of cropping systems research usually involves three types of trials (for details of implementation procedures see Zandstra and others 1981): cropping pattern trials, superimposed trials, and researcher-managed trials.

Cropping patterns that have undergone the design process are tested in farmers’ fields for evaluation in comparison with existing farmers’ patterns. Under Philippine conditions (where average farm size is about 2 hectares), an area of 1,000 square meters per farm is recommended per pattern. Large test plots are used so that labor and power measurements can be made by the researchers to facilitate cost-and-return analysis for evaluation. Large test plots also expose the farmers to a sufficiently broad application of the new technology to arouse interest and some feedback on the pattern and management practices employed.

Plot sizes larger than 1,000 square meters may be used if the technical change is not highly radical or risky. However, where national research programs have limited funds to conduct such trials, the researcher should probably opt for the smallest area that permits realistic measurement of labor and power and, at the same time, exposes the farmers to the new technology.

The IRRI farming systems program does not advocate use of guarantees against crop failure or poor yield. Such a policy is designed to strengthen the farmers’ interest and managerial commitment so that he considers the crop his own and not the researcher’s. The usual incentive is to provide the farmer with material inputs for a test pattern, but the farmer is required to provide the labor for the various cultural operations. In return the farmer may keep all produce from the test pattern area, after appropriate measurements are taken. Usually the only crop measurement taken is grain yield, through randomly sampled crop cuts.

Superimposed trials are undertaken on the same fields as the cropping pattern tests; that is, treatments are superimposed on the cropping pattern trials. The essential feature of these trials is that, once the designed treatments are applied, all other factors are held constant for both the trial and the field where it is superimposed. Trials may be replicated across fields (that is, one replicate per field or farm). Preferrably, however, the treatments should be replicated at least twice. In comparison with researcher-managed trials, superimposed trials usually have fewer treatment levels and fewer replicates. Because this type of trial is smaller and relatively easier to manage, it can be established on a large number of fields across the research site. In this way the sensitivity of technology performance across different fields can be determined.

Researcher-managed trials are small plot trials replicated within a farmer’s fields and managed entirely by researchers. In this type of trial, the researcher is essentially using the physical and biological environment of the farmer’s fields to evaluate a number of treatment effects. Analysis and interpretation of researcher-managed trials follow those procedures established for research stations (Zandstra and others 1981).
Design and testing continue throughout the site research. New cropping patterns and management levels are designed on the basis of previous years' results of cropping pattern trials, superimposed trials, researcher-managed trials, research station findings, and various monitoring and evaluation surveys. At IRRI cropping systems sites, farmers' meetings are called to obtain feedback on the proposed technology to be tested. The limitations of farmer participation in design and testing of cropping patterns is recognized because the farmer is to a large extent "protected" by his relatively limited exposure to the technology and by the leverage of free inputs. Without such leverage, it may be difficult to encourage farmers to test promising but unfamiliar innovations. Furthermore, in the event of crop failure, a relatively large exposure to a technical innovation may be disastrous to the credibility of the researchers.

With some limitations, a close interaction of the researcher and the farmer, with the knowledge and support of the extension worker, during the stages of technology design and testing in FSR is a clear improvement over the more limited and one-directional "research to extension to farmer" model being employed in many national programs. However, the willingness and ability of researchers to identify and incorporate farmers' perceived goals in the technology design process remain questionable. Reorientation of researchers' attitudes to their client farmers is a necessary prerequisite to a truly collaborative, continuing, and thus more effective researcher-farmer relationship.

The role of extension staff increases significantly following initial testing of farming systems technology at the research site. Evaluation of technology performance, development of interim recommendations for wider testing ("multilocation testing"), and the actual multilocation testing and verification trials require a substantial contribution from the extension service. The methodology for technology verification beyond the immediate area of the research site is the subject of the next section.

Multilocation Testing for Technology Verification

As mentioned earlier, a primary criterion for selecting a farming systems research site is its representativeness of a much larger target area for development. Promising technology emerges from site research through an iterative process of design and testing. Its promise is measured in terms of its technical and economic performance as well as its social acceptability in comparison with farmers' existing production practices.

Rationale

Quantitative measures of evaluation currently being used remain rather crude approximations. The IRRI cropping systems research methodology has developed and uses evaluation criteria suited to market-oriented farming systems (Zandstra and others 1981). The monetary performance criteria used are the returns above variable costs and the marginal benefit-cost ratio. (Details on the use of these economic parameters of acceptability are discussed in Zandstra and others 1981, pp. 62-68.) However, it is noted that such comparisons are not a substitute for carefully recorded farmers' comments about new technologies. Referring to the testing and evaluation of new cropping patterns, Zandstra and his colleagues observe (p. 62): "Researchers should develop, through frequent interactions with farmers, a clear understanding of the attractive and unattractive aspects of the cropping patterns they test. Quantitative analyses and evaluations of analytical results are, however, a necessary complement to feedback obtained from farmers' responses. They permit documentation and provide an objective base for comparison over different crop years and sites."

For farming systems that are not market-oriented because of inadequate infrastructure and that have subsistence food production as their primary goal, monetary performance criteria are less useful. Other criteria, such as total caloric output per household member, may have greater relevance. The problem of evaluating alternative farming systems for farmers with purely subsistence goals has not been accorded much attention by IRRI to date.
The output of technology testing and evaluation at a research site is a specified set of technical adjustments believed to be superior to practices currently used by farmers in the immediate vicinity of the research site. This hypothesis of the superiority of the specified technology is then tested across the target area. In the IRRI and Rice Farming Systems Network terminology, this stage is called multilocation testing. The terminology may vary in different jurisdictions. In Nepal, for example, the corresponding stage is referred to as preproduction verification trials (Cropping Systems Program, Nepal, 1982).

Multilocation testing is a verification procedure that evaluates farming systems technology, usually generated through site research, at many locations that are thought to be representative of the environment in which the technology was developed. Two prerequisites before the multilocation verification can commence are:

- At the site location and description stage, the potential extrapolation area for recommendations from research at the site should be defined. During site research, this area is likely to become more sharply defined as a result of more intensive physical characterization and increased understanding of crop and cropping pattern performance. This revised potential extrapolation area becomes the testing ground of technology generated at the site.

- The farming systems production technology must be sufficiently superior to that of the farmers to merit its adoption. On the basis of empirical data, two necessary conditions for acceptance of a new cropping pattern have been identified as guidelines: the net return per hectare needs to be at least 30 percent above that for the farmers' current system, and the net return above cash costs must be at least twice the farmers' cash cost.

**Design and Location**

In most cases multilocation trials are cropping pattern trials conducted beyond the immediate environs of the cropping systems site. Plot size is not necessarily the same as that used for cropping pattern testing, since for multilocation testing it is not necessary to repeat estimates of labor inputs. It generally suffices to use labor estimates from the research site. There are advantages, however, in using large plots: they are suitable for use by extension personnel in conducting field days to influence farmers and administrators, and for producing seeds before the pilot production program.

It may be useful to superimpose field trials on multilocation test plots. These trials can be used to examine a small number of factors (say, two or three) that are components of the recommendations. Factors selected for such trials should be those that appear to be most important in influencing cropping pattern performance and that are more likely to be influenced by environmental variation.

If there is environmental variation (for example, in soil texture or hydrology) within the potential extrapolation area, the plots must be located so as to cover all major environment types (that is, the area should be stratified according to the expected performance determinant before the plots are allocated). If multilocation testing is extended to areas with land, soil, and climate different from those of the initial research site, serious consideration must be given to the anticipated adaptability of the production recommendations to the various environments, the expected yield and income margins, and the consequences of failure.

**Management**

As in the case of cropping pattern testing at the research site, the multilocation test plots are located on farmers' fields. In general, farmers should be involved in land preparation, crop maintenance, and weeding, although the research or extension personnel must ensure timely and accurate application of fertilizers and chemicals and, ideally, should supervise harvesting of the crop.

The multilocation test plots and associated superimposed trials may be managed by researchers or by extension workers. Although researchers usually possess better training and experience for this work, it is often impractical for them to implement multilocation testing on a large scale because of their inadequate number and mobility.
An example of research-extension cooperation in implementation can be drawn from Bangladesh. In 1974 the Bangladesh Rice Research Institute (BRRI) commenced cropping systems research in Bhogra village in the BRRI project area near Joydebpur. (For more detailed accounts of research-extension activities in Bangladesh, see chapter 5, by S. M. H. Zaman, and chapter 10, by M. Motlubor Rahman.) The research site was rainfed and considered to be representative of those rainfed areas in the country that were subject to shallow flooding during the monsoon season. Hoque and Hobbs (1981) reported on the research findings at Bhogra for 1975–79. On the basis of these findings, production recommendations were made. The basic features of the new technology were the growing of two modern rice varieties in succession, transplanting rather than direct-seeding the first (aus) crop, and adopting a set of improved crop management practices.

Recognizing the importance of technology verification before widespread recommendations can be given, BRRI commenced multilocation testing of the Bhogra technology in five parts of the country during 1982. This testing was implemented by BRRI with the knowledge and assistance of the Department of Agricultural Extension (DAE) officers and VEWs. Further expansion of multilocation testing took place in 1983 and was planned for 1984 because of successful adaptation of the rainfed cropping pattern being tested. This expansion meant that BRRI no longer had the capacity to implement and supervise the trials in all locations. Thus, the DAE agreed to undertake multilocation testing in accord with the BRRI guidelines. This required little reorganization or additional funding, since DAE already undertook a comprehensive program of demonstrations for the aus and transplanted aman (late) crops, in each case advocating the use of modern varieties. It was largely a matter of training extension workers to undertake multilocation testing in farmers’ fields, and of some reorientation of the existing demonstration programs to emphasize a crop sequence (rather that considering the two seasons separately for programming purposes).

In the Philippines multilocation testing and verification trials of component technology are undertaken by Provincial Technology Verification Teams (PTVTs). In general, a PTVT comprises two agriculture graduates who have received in-service training on FSR procedures. The PTVT members are staff of a national research organization but are responsible directly to the provincial agricultural officer (PAO) of the Ministry of Agriculture. The PAO directs both research and extension activities in the province, and thus it is his responsibility to ensure that an effective interaction between research and extension is maintained. Ideally, this interaction could take place in a technical committee, whose role will be discussed later.

Provided that adequate training is given by researchers, it appears to be most appropriate that the organization responsible for extension should also be responsible for multilocation testing. Such an activity is compatible with the T&V extension approach. Benor, Harrison, and Baxter (1984) regard field trials as a vital feature of extension operations. They advocate that researchers and the extension subject matter specialist (SMS) should provide technical assistance to agricultural extension officers (AEOs) and VEWs, who in their regular work program see that the trials are carried out by farmers in their own fields. Furthermore, if the trial (in this case the multilocation test plot) is successful, the VEW is encouraged to use the plot for demonstration purposes (Benor, Harrison, and Baxter, 1984, p. 47).

Data Collection

Although extension workers should participate directly in multilocation testing, it should be remembered that this testing is still a verification stage. That is, information obtained will help decide the extent to which specified technology can be recommended to the farmers (if at all). When a cropping pattern is being tested, data must be collected about both the cropping pattern itself and the environment in which the crops were grown. These data will be used to:

- Determine the agronomic and economic performance of the cropping pattern
- Characterize the sites where the cropping patterns and associated management practices are being tested, thereby permitting the researcher to relate the performance of cropping patterns to site characteristics (with this information, location-specific recommendations can be formulated).
Formulation of Extension Recommendations

The intensity of data collection will be constrained by the technical and financial capabilities of those undertaking the testing. Within these constraints, selection of site characteristics should be limited to those expected to have a dominant influence on the agronomic and economic performance of the cropping pattern. (A minimum set of data requirements is suggested in appendix A to this chapter.)

Data Analysis

Gross yields provide the measure of agronomic adaptation of the cropping pattern to the physical and biological environment, with production costs and benefits excluded. That is,

\[ Y = f(X_i/F_j/Z_k) \]

where \( Y \) = gross yield; \( X_i \) = the production factors that can be manipulated (for example, plant variety, fertilizer, water management); \( F_j \) = farm-specific parameters (for example, power, tenure); \( Z_k \) = fixed environmental factors (for example, topography, rainfall).

A satisfactory gross yield is a prerequisite for, but not necessarily a guarantee of, economic feasibility. The information gained through analysis of the gross yield should give the researcher insight into the limitation of the technology developed at the site.

Adoption of recommended technology by farmers will depend, among other factors, on the real economic benefits farmers may gain by changing their original pattern and practices to those being tested. It is important that the real economic benefits of using a particular cropping pattern, from the farmers' viewpoint, are measured. Researchers often tend to overestimate the yield that will benefit the farmer (Perrin and others 1976). Shares of the farmers' yield paid to harvesters and landlords are often overlooked, and this omission can lead to errors when the net economic benefits are computed. Where tenants are a significant proportion of the farming community, it may be useful to undertake separate economic analyses for tenants and owner operators; these analyses in turn may lead to different extension recommendations for these groups.

Similar errors can be made in estimating effective crop prices and in estimating the real cost of an input. As a result, the economic analysis of a cropping pattern may provide a biased, optimistic view of performance in reality. With these considerations in mind, partial budgeting is used to determine net economic benefit of the cropping pattern and management being tested:

\[ NEB = f(Y, E_i) \]

where \( NEB \) = net economic benefit; \( Y \) = yield; and \( E_i \) = economic parameter (for example, input costs, output prices).

On the basis of the analysis of net economic benefit (and of analysis of gross yield), it is possible to describe the environmental conditions (economic, physical, biological) under which the tested cropping pattern can be expected to give an acceptable net economic benefit relative to the replacement pattern. This assumes, however, that a study of the total farming system shows that such changes in cropping pattern are more attractive than changes in other farm enterprises. (For a thorough treatment of whole-farm and unit-activity budgeting methods, see Gittinger 1982, chap. 4.)

Special Studies

Some issues that may become important at the production program stage are not always clarified through multilocation testing. For this reason, researchers are encouraged to undertake special studies. The following questions may need to be answered:

- Is the extension service capable of effectively delivering the extension message to the farmers? Is the manpower adequate? Is training required? Will mobility be adequate?
- Are the input suppliers (including seed producers) geared to meet demand for new inputs and increased demand for currently available inputs?
• Can farmers adopt the technology using their own cash resources? Is the traditional credit system capable of meeting demands for credit? Will the technology remain profitable at the interest levels charged? Is institutional credit necessary? Should institutional credit cover all or only part of the production costs?

• What will be the effect of increased production on markets? Will prices fall? How would this affect profit? Is price support available, adequate, necessary, or desirable?

Questions such as these need to be asked throughout the potential target area—through formal or informal surveys with farmers and with government and private support service personnel. This stage is actually a continuation of the description of the target area. A special unit (perhaps a monitoring and evaluation unit or even an independent consultant group) should be assigned the task of obtaining such information before the production program is designed.

Output of Multilocation Testing

The FSR approach, if undertaken according to the guidelines described herein, should be able (after multilocation testing) to provide a statement that includes the following:

• Recommended technology. This is a specified list or sequence of technical instructions that farmers are advised to adopt, subject to the conditions described below.

• Conditions under which technology is recommended. Such conditions fall into three categories:
  - Biophysical conditions (for example, a certain cropping sequence may be recommended only for a particular soil type or landscape position)
  - Social and economic conditions (restrictions on the appropriateness of the recommendations may be made on the basis of farm size, tenure status, family size, number of draft animals, and the like)
  - Institutional conditions (institutional change may be a prerequisite for adoption; for example, farmers may require access to credit, a guaranteed produce price, a well-informed and mobile extension service, and so on). Morris, Gines, and Torres (1983) provide several examples from a cropping systems project in Pangasinan, Philippines, where recommendations were conditional upon government institutional support (see table 12-1).

Provided that extension personnel have participated in the identification of research priorities, in the design and implementation of multilocation testing and verification trials, and in the formulation of recommendations, the above statements will provide a sound basis for an effective crop production program.

Table 12-1. Adoptability of Technology in the Pangasinan Cropping Systems Project, Philippines

<table>
<thead>
<tr>
<th>Technology not needing government assistance to achieve adoption</th>
<th>Technology needing government assistance to achieve adoption</th>
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<tbody>
<tr>
<td>IR36 (a variety of transplanted rice)</td>
<td>Extension focus on increasing the efficiency of insect control methods for mungbeans</td>
</tr>
<tr>
<td>Pagasa (a mungbean variety)</td>
<td>Government extension and marketing agency support for cowpeas and sorghum as alternatives to mungbeans</td>
</tr>
<tr>
<td>Increased frequency of insecticide application on mungbeans</td>
<td>Government credit agency support for a program to purchase equipment to increase tillage capacity</td>
</tr>
<tr>
<td></td>
<td>Government irrigation agency management support to modify system operations for the irrigation of mungbeans and alternative crops</td>
</tr>
</tbody>
</table>

Source: Adapted from Morris, Gines, and Torres (1983).
Design and Implementation of Crop Production Programs

A production program is defined as a strategy or plan that provides for the necessary restructuring and ongoing coordination of support services to facilitate widespread adoption of new technology.

Rationale for an Integrated Production Program

The need for a clearly defined production program as part of an FSR and development methodology is based on the argument that research can rarely identify new technology that will be adopted by, and benefit significant numbers of, small farmers while operating entirely within the farmer’s existing resource capabilities (Zandstra and others 1981). This view conflicts with that of Benor, Harrison, and Baxter (1984, pp. 27–29), who argue that significant production gains can be achieved through teaching farmers to make better use of their available resources. They argue that small farmers can immediately benefit from changes in management practices (such as better land preparation, timely weeding, proper plant spacing) while operating entirely within existing resource constraints. This view may have greatest relevance in newly settled areas, where farmers have not acquired the necessary long-term experience to make the best use of resources in their farming environment. In traditional communities, however, there is strong evidence that farmers are already using their available resources in an efficient manner (Schultz 1964). In such cases the constraints to increased productivity are likely to be reduced or removed only if there are technological breakthroughs (such as new plant varieties), if the farmers’ resource base can be expanded (for example, through increased credit availability or new market opportunities), or both.

A review of FSR undertaken in the Rice Farming Systems Network shows that most technologies presented as alternatives to existing farmer practice require additional resources such as seed (of a new variety), fertilizers, chemicals, sometimes equipment (such as sprayers), and the provision of additional labor. Input supply institutions (either government or private) may need to be established, expanded, or reorganized to meet material input requirements. Where farmers do not have the cash to purchase these inputs, credit facilities may be required to meet this need. To communicate the recommended cropping patterns, the extension service may need to be expanded, reorganized, or upgraded through training. The additional or alternative produce of the recommended technology needs to be marketed at an acceptable price, which may require better transport facilities (roads, vehicles, or both), expanded storage capacity, and possibly government support for price stability. To oversee and coordinate these activities, a suitable management structure is required. Another (often overriding) factor that will affect adoption of the recommended pattern and management practices is the farmer’s willingness to take risk.

Thus, a systems approach to technology transfer in the service of increased agricultural productivity is advocated as an alternative to an approach that emphasizes extension alone. It is recognized, however, that an analysis of a production system may reveal that extension is indeed the weak link. For example, the success of T&V projects in parts of India has been attributed to the improvement of a relatively weak extension service in an otherwise well-developed agricultural sector (Russell 1981). Conversely, the relatively limited impact of T&V extension in other areas could well be attributed to the failure of planners to recognize and include the other essential ingredients for effective technology transfer—appropriate technology, availability of recommended inputs, input purchasing power (that is, credit), suitable marketing systems, and effective program management.

Formulating Recommendations

A key feature in implementing an effective production program is the mechanism for formulating technical recommendations. As noted earlier, a recommendation comprises one or more technical instructions together with a description of the conditions under which the instructions are appropriate.
FSR at the research site leads to an interim recommendation or set of recommendations for further testing and evaluation throughout the proposed target area (that is, multilocation testing). Upon verification and modification (where necessary), the recommendations then form the basis of the production program—at least for the first season of implementation.

The recommendations should first be agreed to by a technical committee comprising research and extension personnel. Ideally, this technical committee should be operational from the early stages of the site research, so that its final recommendations satisfy technical and economic requirements of the researchers and the extension service. Extension personnel may be alienated and ultimately made uncooperative if they are simply given a finished product (or recommendation) to “go out and extend.” Best results are likely to be obtained if the extension personnel have contributed to the formulation of the recommendations and are seen by the agricultural community (farmers, bankers, and so on) to have so contributed.

In addition, the recommendations should be brought to the attention of, and should be endorsed by, a production program management committee. It is particularly important that those responsible for input and credit supply and for marketing be aware of the recommendations.

One case in which input and credit supply needs to be considered is in the packaging of recommended inputs. If a particular input is available, it must be packaged for purchase in quantities proportionate to the farmers’ immediate needs. This is especially important where the recommendations are related to credit package releases. For example, if the recommendation requires the farmer to use one 50-kilogram bag of fertilizer per hectare, and if his loan covers 0.5 hectare, it should be ensured that the farmer can obtain the fertilizer in 25-kilogram lots. In general, it is not feasible to package inputs for the precise need of every farmer. Rather, inputs should be packaged on the basis of the most common requirements of farmers.

Once a production program commences, there is a need to monitor the effectiveness of recommendations. As mentioned earlier, a monitoring and evaluation unit should be an integral part of any production program—to follow the performance of the recommended technology per se as well as to monitor the delivery system designed to facilitate adoption of the recommendation. An agroeconomic approach to monitoring and evaluation is suggested to achieve these dual objectives. It has been used on cropping systems production programs in the Philippines to identify adoption constraints and to modify recommendations accordingly. The procedure consists of the following steps:

- Plots 1,000 square meters in size are established in strategic locations, and the recommended cropping pattern is grown under the supervision of research or extension workers. Such plots follow the guidelines for multilocation testing and provide a measure of the technical adaptation of the recommendations throughout the target area in a given season. The results provide standards against which technology performance on farmers’ fields throughout the target area can be compared.

- Superimposed trials are conducted on farmers’ fields to evaluate components of the recommendations where there is some question about the appropriateness of the recommendation (for example, applying fertilizer at 100 percent, 75 percent, and 50 percent of the recommended rate; applying alternative insecticide treatments as a means of assessing the relative effectiveness of the original recommendation).

- Farmer surveys are conducted to monitor yields and incomes, to identify areas of partial adoption or nonadoption, and to obtain reasons for deviations from the stated recommendations. Such surveys include farm interviews and crop inspection that are supplemented by open-ended interviews with key informants to obtain more in-depth information on farm-household decisionmaking.

- Any institutional constraints reported by the farmer respondents are verified. Key information surveys are also applicable here.

- Regular and frequent reporting by the monitoring and evaluation unit to both the management and technical committees is critical to success. Such reporting should elicit quick responses to problems, including adjustments to production recommendations. The role of the monitoring and evaluation unit in measuring long-term progress of a production program is secondary to that of rapidly providing feedback.
• At a minimum the monitoring and evaluation unit should include an agronomist and an agricultural economist. The agronomist’s role is vital in assessing the nature and extent of the field problems encountered. Ideally, this team should be an autonomous unit reporting directly to program management while operating harmoniously with both research and extension personnel.

A seldom utilized function of monitoring and evaluation is the identification of farmers’ innovations. Such innovations may include development of indigenous technology or the modification of introduced technology. Information from such sources could contribute to the regular process of upgrading and fine-tuning extension messages for farmers.

In South Cotabato, Philippines, farmers were exposed to the use of the aquatic fern, azolla, which, through a symbiotic relationship with blue-green algae, can fix atmospheric nitrogen and thus serve as a green manure for irrigated rice. Earlier efforts were directed to the introduction of a rather complex production system involving significant changes to existing farmers’ practices. Over time, however, this system was modified by farmers to its present form, which requires relatively little adjustment to farmers’ current rice-production practices. Monitoring and evaluation of azolla adoption and adaptation by farmers has made it possible to identify this farmer-modified system, which is now being tested in other parts of the Philippines.

The above procedure recognizes that technology adaptation is a dynamic process. Innovations by researchers and farmers lead to the emergence of technical alternatives to existing recommendations, and these must be tested and evaluated in the field concurrently with the implementation of a production program. Similarly, the environment itself may change. New biotypes of insect pests sometimes emerge that render recommended plant varieties unsuitable (for example, IR36 rice is susceptible to brown plant hopper in South Cotabato, Philippines, and in North Sumatra, Indonesia). Changes in the prices of inputs and outputs may alter the profitability of the recommended technology relative to the alternatives available to farmers (Mehta 1983). For example, a rise in the price ratio of nitrogen fertilizer to rice implies a downward adjustment in the recommended application rate of nitrogen fertilizer to rice.

In Korea rice blast disease is a perennial problem because recommended varieties are frequently susceptible to new races of this fungal disease that are evolving. A highly developed program of field monitoring and varietal testing has been implemented in that country to ensure that appropriate varietal recommendations are provided to farmers.

Thus, recommendations need to be revised regularly in the light of research findings and the results of monitoring and evaluating the performance of currently recommended technology in farmers’ fields. The technical committee responsible for the formulation of recommendations therefore requires representation from research, extension, and monitoring and evaluation personnel. Ideally, such a committee meets before each cropping season to evaluate the results from the previous corresponding season and to formulate appropriate recommendations for the current season.

It may also be necessary for the committee to meet during the season to adjust recommendations in the light of short-term occurrences. In formulating recommendations there is the need to consider fallback strategies that take account of variability within the season. These strategies are particularly relevant to rainfed environments, where a fixed set of recommendations for the crop season cannot always be applied (Mehta 1983). For example, the date of transplanting becomes critical in developing a rice-variety recommendation for a rainfed transplanted aman crop in Bangladesh (Magor 1982). Farmers have limited control over when to transplant because transplanting is largely determined by the date of seeding (and harvesting) of the previous aus crop—which in turn depends on the onset of the monsoon. For early transplanting, modern varieties BR10 and BR11 were recommended by BRRI. After a certain cutoff date, however, BR10 and BR11 were not to be recommended, and it was necessary to recommend the photoperiod-sensitive Nizersail variety or an upland crop grown on residual moisture. Component technology recommendations (fertilizer rates, plant spacing, and the like) must likewise be adjusted.

For traditionally grown varieties, crops, and cropping patterns, strategies to minimize risk through cutoff dates and fallback alternatives are well understood and used by farmers. With the advent of new and unfamiliar varieties, crops, and cropping patterns, however, farmers face difficulties in making decisions
under uncertainty. Without the benefit of long-term experience, it becomes necessary to estimate crop and cropping pattern performance. This can be undertaken with the help of water balance models that use long-term rainfall records, soil measurements, and limited agronomic data from field experiments. Such techniques have been applied to predict crop or cropping pattern performances in rainfed areas of the Philippines (Bolton 1980; Zandstra and others 1982) and Bangladesh (Magor 1982).

The implementation of fortnightly training sessions through the T&V extension system provides a mechanism whereby adjustments to recommendations can be rapidly relayed to farmers. In situations where such action is necessary, the major question is likely to be whether the other production support services (such as input and credit supply) can respond accordingly.

Even with the aid of ongoing adaptive research and effective monitoring and evaluation, a technical committee can at best only approximate what is appropriate for most farmers. Accurate ex ante assessment of a recommendation's adaptation and likely benefit to farmers remains a complex (if not impossible) task. Because of this difficulty, it may be more appropriate if the farmer undertakes the final stage of adaptive research. Since the farmer is vitally aware of his own farm-level socioeconomic constraints and resource capabilities, it appears logical for him to interpret and adapt the extension messages to suit his needs.

Gomez (chapter 8) observes that the biophysical and socioeconomic environment of each farm is unique and thus questions the appropriateness of the widespread recommendation of one or two sets of practices. The implication of this is that extension messages should be framed in such a way as to recognize farm-to-farm and farmer-to-farmer variability. As an example, on-farm adaptive research may show that 70 kilograms of nitrogen per hectare is an optimal application rate for rice. Thus, extension promotes this application as the recommended rate. The farmer, with a sound knowledge of the resources available to him, recognizes variability within his farm—that is, some plots may be more fertile than others, some more flood-prone or drought-prone than others, and so forth. The farmer recognizes this and responds accordingly, but it is unrealistic to expect such action from an extension worker given current ratios of farmers to extension workers.

Similarly, some farmers have skills, resources, and interests that result in their placing relatively greater interest in noncrop enterprises such as livestock, fishing, or cottage industries. Such a farmer must trade off an investment in nitrogen fertilizer against investments in other activities and enterprises of his farm and household. Again, the farmer has a distinct advantage over the extension worker in recognizing these influences.

There is, therefore, a case for devising more flexible recommendations. Instead of a recommendation to apply 70 kilograms of nitrogen per hectare, an extension worker may be better advised to say to the farmer, "Your rice crop will respond with a yield of 15 to 20 kilograms of grain for every kilogram of nitrogen fertilizer applied over the range of 20 to 70 kilograms per hectare." In a similar approach to the problem, Russell (1981) advocates an initial recommendation to apply the minimum of fertilizer needed to obtain a noticeable increase in production. This may then be followed by a series of recommendations leading to gradual increases in yield.

Similarly, where new crops or cropping patterns are developed, it may be better to present farmers with a range of options—alternative crops and cropping patterns requiring different levels of investment, risk, and managerial skill. With a "cafeteria" approach such as this, the farmer can select, test, evaluate, and modify technical options to meet his own needs and capability.

An example of this approach can be drawn from South Cotabato, Philippines. In the late 1970s and early 1980s, farmers there were exposed to several important innovations, including dry seeding of rice, hybrid maize, soybean, and cotton. All these innovations have been promoted by extension at one time or another. Because of the soil type in the rainfed lowlands of that province, all four crops were agronomically feasible alternatives to the more traditionally grown crops—transplanted and wet-seeded (puddled) rice and nonhybrid maize. Observation of farmers' responses to these innovations over the past few years has revealed that the decision to plant a given crop or sequence of crops varies across fields, farms, and seasons depending on a complex array of biophysical and socioeconomic factors. Research has therefore served to increase the number of options available to farmers in that area.
Production Program Design

By following the preceding steps (from selection and description of the target area through to multilocation testing), the probability of formulating a sound pilot production program is increased. A pilot production program is considered an early stage of a production program for the entire target area. With the support of effective monitoring and evaluation, this preliminary stage makes it possible to redesign and finely tune the production program components before widespread implementation commences.

The first step in designing a production program is to form a management committee whose function is to plan, manage, and coordinate the program. Ideally, this committee should be operational from the beginning of site research. The management committee should be multidisciplinary and multi-institutional, representing the various groups who are to be involved in the technology transfer.

The program management committee should be a group of people who have the ability, resources, and power to direct the formulation and implementation of the support structure of a production program. The recommendations formulated by the technical committee must be accepted by the management committee, who by their acceptance take responsibility for providing the additional institutional resources that will enable the target farmers to adopt the recommendations. The management committee may include the following:

- A local political leader, such as a governor, mayor, or parliamentarian, who has the power to direct government (and possibly private) institutions within the project area and who will be the contact for liaison with higher administrative levels in the provincial or national government (such contact and influence may be necessary to bring about the changes in institutional structure necessary to support adoption)
- Representatives of local government authorities responsible for extension, credit, input supply (including irrigation system management), and marketing
- Representatives from the private sector who are responsible for extension, credit, input supply, and marketing
- A farmers' representative
- A researchers' representative

The actual composition of the management committee will vary from country to country and province to province. This committee should meet regularly—monthly, if possible—to ensure smooth implementation of the program. The committee should define the scope of the program and agree on task allocations for participating members and groups. Reporting of activities and problems encountered should be made by each participant at each meeting. This implies the existence of responsive feedback mechanisms within each participating agency or group.

One important feedback mechanism of the management structure is the monitoring and evaluation function. Those responsible for this activity should report their findings to the management committee on a regular basis.

The formulation of a production program is usually the responsibility of a planning body or a leading line agency. Because the participation of many institutions may be necessary for the effective implementation of the production program, endorsement of the program by the management committee is critical. On the basis of experience in the Philippines and elsewhere in Asia, a simplified framework for designing an integrated crop production program has been developed. This procedure recognizes the need for clear specification of the technology, target area, and support service requirements of a production program (see appendix B).

By using rigorous procedures such as those described by Gittinger (1982), it is possible to develop a comprehensive area development project founded on technological change. Because FSR is location-specific, so indeed are the structural requirements for an effective system of technology delivery. Emphasis on a given aspect of the delivery system (be it extension, input supply, credit, or marketing) will depend on
the existing status of these services within the target area and on the nature of the technology to be transferred.

Technology Transfer through FSR and T&V Extension

FSR places heavy emphasis on describing the farm environment before and during the designing and testing of new technologies. An analysis of the physical, biological, and socioeconomic environments reveals a heterogeneous pattern within the rural community. Farmers have different capabilities and interests in responding positively to technical innovations presented to them by agricultural extension. Extension systems, including the T&V system, must recognize this farm-to-farm and farmer-to-farmer variability—just as agricultural research is now doing. T&V extension systems should respond in the following ways.

- Increased reliance should be placed on FSR as a source of technical recommendations since FSR is now firmly established as a component of the national research systems of most countries in South and Southeast Asia. Research stations (including international research centers) play a critical role in supplying FSR projects with technology for field testing and evaluation. Wherever possible, however, subject matter specialists (SMSs) in a T&V system should look to FSR, rather than to research stations alone, when seeking appropriate technology to recommend to farmers. An implication is that SMSs should be trained in systems thinking and in the essentials of FSR. In particular, SMSs should acquire skills and actively participate in multilocation testing and technology verification as described earlier. Indeed, greater understanding of farming systems concepts would be a valuable asset at all levels of an extension service.

- Recommendations should be reformulated to reflect environmental variability and heterogeneity in the farming population. A more flexible approach to specification of recommendations is advocated, to include ranges and options rather than absolute recommendations; greater attention to conditional recommendations (that is, those that are only appropriate under specified environmental conditions); and greater attention to target dates, cutoff dates, and alternative fallback strategies (particularly in rainfed areas).

- Recommendations should be regularly updated in the light of farmers' responses. Monitoring and evaluation should be structured to reveal farmers' innovativeness. This information, in turn, can contribute to an ongoing improvement in the quality of the extension recommendations. Through such a continuous process, farmers become active participants in the design and evaluation of technology.

A major implication of such a response by a T&V extension system is that a technical committee of research, extension, and monitoring and evaluation personnel jointly formulate and update recommendations.

A further implication is that VEWs would no longer be simply carriers of messages (that is, prescribed components or packages of technology). Rather, the village-level worker must become more sensitive to variations within the environment and the farm population and be able to adjust his strategies and messages accordingly. Such sensitivity may require a massive reeducation and training effort to have any noticeable effect.

The preceding discussion suggests that T&V extension must learn from and accommodate FSR. It is equally important, however, that FSR programs recognize that their long-term success (hence survival) depends largely on the extent to which their research output is adopted by farmers. It is therefore critical that FSR programs actively encourage extension personnel to participate in technology development. More specifically, FSR programs could encourage extension personnel to participate in research program review and planning sessions and to offer their comments and criticism.

As a major participant in developing FSR methodology in Asia, IRRI has offered a partial solution to the problem of increasing the impact of T&V extension. An extension of the FSR concept, though not the subject of great attention by IRRI to date, is that the same systems approach can apply to the later stages of technology transfer. The emphasis on production programs—rather, extension programs—illustrates this thinking.
Methodology development is an ongoing activity. In the same way that the T&V system of extension is currently being reviewed and revised in the light of field experience, the FSR methodology is also undergoing review and rethinking. This chapter has shown where IRRI’s priorities lie in such methodological improvement. In summary, these are:

- Increasing the participation of farmers in environmental description and in the design, testing, and evaluation of new technology
- Strengthening procedures for verifying and transferring technology beyond the immediate environs of FSR sites
- Broadening the methodology for better applicability to the total farming system.

While such methodological development continues, IRRI will increasingly support national programs in the adaptation and implementation of the farming systems approach to technology development and transfer. This effort is being undertaken primarily through IRRI’s training and professional advancement programs. Included in these programs are support of graduate research, nondegree training courses at IRRI, and on-the-job training at IRRI and at field research sites in the Philippines. A new dimension to these programs is the current plan to support national programs by offering in-country training courses. The latter plan was devised in recognition of the vast numbers who could benefit from such training and who, for logistic and linguistic reasons, cannot be trained at IRRI.

Finally, it must be recognized that FSR and T&V extension are only part of a much wider global effort to transfer technology to benefit the rural poor. I have attempted here to relate how the two approaches are conceptually compatible, can be methodologically complementary, and can be integrated to accelerate agricultural development. The major remaining constraint to such a merging of objectives and strategies is probably institutional rigidity and isolationism. There must be a commitment at the highest level for institutional barriers to be broken down, thereby facilitating interaction and cooperation among research and extension (and farmers) at all levels. There is now encouraging evidence that institutional change to this effect is taking place in some parts of South and Southeast Asia.

Appendix A. Data Requirements for Multilocation Testing

The list that follows is not regarded as a comprehensive checklist for FSR. It serves only as an indication of those factors likely to be important in determining the performance and acceptability of technology beyond the research site villages.

Crop and cropping patterns:
- Planting and harvest dates
- Yield (through crop cut)
- Pest and disease outbreaks, weed or rodent problems, grazing animals, and the like
- Any deviation from the specified recommendations.

Physical environment:
- Rainfall (weekly totals; ideally, one rain gauge per plot or cluster of plots)
- Temperature (daily maximum and minimum—this is necessary only for locations where temperature is considered an important yield constraint, directly or indirectly; data from a reliable nearby meteorological station should be used when possible)
- Soil texture, pH, and any other easily distinguishable soil features (composite soil samples should be collected from each site; if soil factors other than those readily measured at the site are thought to be important, these soils samples will be available for analysis)
- Occurrence of damaging weather, such as strong winds and hail (dates and type and extent of damage should be recorded)
• Hydrology and land form (bunded or unbunded; position in toposequence—high, intermediate, or low; flooding or drought occurrence; for irrigated patterns, record any deviation from the recommendations; for upland patterns, record approximate slope and evidence of past or present soil erosion).

Economic environment:
• Cost of labor in the immediate area (note any differences for the various labor operations involved)
• Local input prices (obtained from the most likely supplier to farmers in the immediate area)
• Any other economic factors that apparently deviate from the situation at the cropping systems site (for example, tenancy arrangements, labor arrangements, transport costs, interest rates)
• Yield, input, and sales data from patterns where the farmers' traditional (replacement) pattern is different from that at the original research site (to permit an economic analysis).

The farmer:
• Obtain feedback from the participant farmer (his and his neighbors' views on the technical and economic aspects of the technology)
• Information about the farm family and household (available labor resources, off-farm employment, sex division of basic tasks, and the like)
• Information on farmer preferences with regard to crop and noncrop enterprises.

Appendix B. Simplified Framework for Design of an Integrated Crop Production Program

1. Specify the technology in the way it will be communicated to extension personnel, who will in turn communicate this to farmers. As mentioned earlier, this is the role of the technical committee.

2. Specify the target area for the pilot production program and the production program. Specify the number of farmers and the anticipated areal coverage of the program up to the production program target. This should not be considered restrictive, since both the technology and the targets can (and probably will) be modified from time to time on the basis of monitoring and evaluation results.

3. Specify the support service requirements for all stages of the production program.
   a. Management structure. An organizational framework should be specified to show the line of management responsibility and the means of interaction and coordination among the program participants. Committees and their functions should be stated (including membership of such committees and schedules of activity).
   b. Extension. Indicate when and where additional staff may be required and any relocation, training, or transport that will be needed. Where the T&V extension system is used, an appropriate schedule of training sessions and farm visits must be established.
   c. Credit. Specify credit needs, if any (total capital need, timing, number of farmers, locations). Describe the mechanism for loan application, approval, release, repayment. Specify eligibility requirements for loan release. Indicate how the loans are structured (allocated amount for seed, fertilizer, chemicals, and the like).
   d. Input supply. Compute the input needs per farmer and for the whole program area. Specify suppliers of the inputs and the quantities that each supplier would be required to make available. Because timing of input application is usually critical, a mechanism and time frame should be established for importation, allocation to suppliers, storage, and release to farmers.
   e. Marketing. Estimate volumes, timing of produce going to various market outlets, transport and storage requirements. Specify any need for price support.
   f. Monitoring and evaluation capability. Specify the required personnel, transport, and other sup-
ports (such as calculators). Establish a mechanism and schedule for interview, interpretation, and reporting.

4. Compute the costs of all the preceding support service requirements. The costs included should reflect additional resource allocations associated with delivering the technology to the target area. Such allocations include:

- Extra extension staff (recruitment, salaries)
- Transport for extension staff
- Training courses
- Capital, seed fund, guarantee fund, and the like for credit
- Additional bank staff
- Storage facilities for inputs and outputs
- Monitoring and evaluation staff (recruitment, salaries)
- Management costs (honorariums, travel).

(This chapter considers only financial costs and does not address the issue of the real cost to the economy if inputs and outputs were valued at their economic prices.)

5. Compute the additional net returns obtained by farmers adopting the technology (that is, the net return of the introduced cropping pattern less the net return of the pattern being replaced).

6. Estimate the (local) net benefit of the production program on a yearly basis through to full implementation of the production program. These data are valuable in evaluating resource allocations made by government to support implementation of crop production programs. This estimate would need to be revised throughout implementation.

7. On the basis of steps 3 and 4, draw up a memorandum of agreement among all the bodies involved in program implementation and management. Such an agreement would specify the duties and obligations of all signatories.

References


The Joint Formulation of Extension Messages by Research and Extension Staff in Indonesia

Salmon Padmanagara

This paper looks at agricultural extension from a practical point of view and shows how it is implemented and how it works amid the ever changing conditions of agricultural development in Indonesia.

Extension and research services in Indonesia had their beginning at the turn of the century. The subsequent changes in the principles, policies, organizational arrangements, and programs and in the qualification of personnel have paralleled the political, economic, and educational development of the country. Further changes should be expected. Agricultural extension, in principle, should always adapt itself to prevailing conditions and situations, although its basic philosophy—which stresses educating the farmer and his family so that they will be able to improve themselves—remains unchanged.

The basic features of Indonesia's current policy of agricultural extension are:

- Farmers are the equals of extension agents; hence the need for intimate farmer-agent cooperation.
- Extension programs are an integral part of the overall agricultural development programs; hence the need for close functional linkages among agencies.
- Extension is a cooperative effort of the national and provincial governments; hence practical administrative linkages are needed, as well as a historical structure down to the district, village, and farmer level.
- Emphasis is placed on extending new technologies to farmers to increase their productivity and on adapting them to suit different agroecological zones and types of farmer.
- A unified extension service based on a whole farm approach is needed to coordinate the advice currently being given by the four directorates of food crops, estate crops, livestock, and fisheries.

On the research side, there are three important tasks:

- Developing and producing new technologies
- Ensuring a continuous flow of the results to those responsible for their application
- Making available the existing knowledge, skills, and technologies to those who need them and are interested in them.

The first task is generally taken for granted, even by the poorest farmer. It is worth mentioning, however, that the ivory tower image a research institution enjoys in the public mind sometimes affects the behavior of the research personnel.

The second task, which has a direct bearing on the topic of this paper, can become (and often is) a problem if rules and procedures are followed too rigidly, conservative attitudes are too strong, and functional relationships among different institutions are not developed properly. Researchers are often frustrated when they do not know to whom and how to deliver the results of their work, particularly where the extension service is not well developed, as has been the case in Indonesia until recently, especially in the outer islands.

The third task will continue to be very important for farmers, at least for the time span of Indonesia's next two development plans. To improve farming and increase production at present, it is often sufficient to extend the existing new technologies, many of which have not yet been widely adopted.
Existing Constraints

The principal constraints on existing Indonesian research and extension services are:

- A long-standing paternalistic approach to extension with messages conceived and delivered in a top-down fashion, so that often they are not well adapted to differences in agroecological zones, socioeconomic factors, and varying resource levels of farmers
- A lack of feedback from farmers and inadequate analysis of the rates at which current recommendations are being adopted
- Poor farmer participation, despite the existence for many years of active farmer groups
- Difficulties in combining national agricultural targets with the needs of farmers at the grass-roots level
- A fragmented approach to extension because of a complex institutional structure
- Complex farm systems, which usually involve tree (estate) and food crops, livestock, and fisheries
- Weak linkages with research, and the ineffectiveness of the new cadre of subject matter specialists that forms the main link between research and extension services.

The Legacy of a Feudal Top-Down Approach

For many years, agricultural extension in Indonesia was implemented in a paternal fashion typical of the colonial or feudal relationship between ruler and the ruled. Until recently, the basic philosophy was that the government should do everything for the people. Everything should be left for the government to decide, to organize, to implement, and to finance. It was not for the people to decide what was best for them. Thus the extension agent decided what was needed by the farmers, what was to be taught, and how it should be done. The farmers were expected to follow without question the programs developed for them. It was assumed that farmers were too backward, too uneducated, and too simple-minded to make decisions on their own. Most regretfully, this perception still persists in varying degrees in certain circles.

This does not mean that no advances were made. On the contrary, much was achieved with the existing and available technologies and expertise, especially in the production of certain crops and in fisheries. The top-down policy seemed suitable for the conditions prevailing in earlier times, and agricultural extension tended to be limited to better farmers. However, the all-important goal of helping (teaching) the farmers to stand on their own feet, which is crucial for the acceleration of agricultural development, was more or less neglected.

In contrast, helping people to help themselves characterizes the agricultural extension policy, which recognizes the farmers' rights of self-determination. Underlying this new approach is the Indonesian philosophy of pancasila, according to which farmers, extensionists, and researchers are all regarded as equals. In addition, farmers exposed to modern ways of living are now better educated and better informed than in the past. Consequently their demands cover a wider range of needs and services. They want to be equal with other citizens in society and treated accordingly.

Farmer Feedback and the Monitoring of Adoption Rates

To be effective and efficient, agricultural extension cannot afford to ignore the signs of the times. It should smoothly and expertly adapt to current conditions and situations; hence the importance of agent-farmer cooperation. If anything, the extension agent and the farmer should regard each other as comrades in arms in the battle for development.

Such cooperation cannot take place unless agents understand farmers' needs. As a result, Indonesia has
begun to train farmers to express their wants, bring forward their problems, and represent their fellow farmers in dialogues with extension agents. Most important, farmers are also being trained to assume responsibilities in the implementation of extension programs. This training helps to set the stage for more effective farmer participation, which is crucial for the development of strong and active farmers' groups.

It is obvious that extension messages should be identified and formulated in consultation with those who need and will bear the consequences of those messages, that is, the farmers. Indonesia is therefore making a conscious effort to solicit feedback from farmers and to use this information to revise its extension programs. The emphasis on cropping systems research over the last decade, for example, has made both researchers and extension staff more aware of farmers' problems and has helped them focus on appropriate solutions in the design of on-farm adaptive trials and of extension programs. (See chapter 7, by Suryatna Effendi, for more details of Indonesia's experience in this regard.)

Closely related to the feedback problem in Indonesia's system has been the lack of attention given to monitoring adoption rates. Every season the response of different types of farmer to recommendations should be monitored to see if they are adopted completely, in part, or not at all, and whether the response is sustained. We are now encouraging village-level workers and subject matter specialists to carry out this type of monitoring, and a special score sheet has been designed for this purpose.

In areas where the score sheet system has not yet been introduced, we have to rely on general indicators such as the changes in fertilizer use. Over the past decade, for example, fertilizer consumption in Indonesia has increased from 0.5 million to 3 million tons, an increase in use especially for rice. However, we still have much more to learn about who does and who does not adopt a recommended input or technology, and why. Thus it is essential that monitoring be formally integrated into our system and that it be used in the revision of both research and extension programs.

Role of Farmer Groups

In trying to secure stronger farmer participation, Indonesia is fortunate in having well-developed farmer groups, especially on Java. In the past these groups played a passive role, merely receiving information that was passed down to them, but now they debate each recommendation and decide on its suitability for their particular village situation, market, soil, or seasonal conditions. They also keep a record of promises made to them by research and extension workers, and in this way are building bottom-up monitoring and accountability into the system.

Today farmer groups elect their contact farmers, whereas previously whoever happened to be the village leader filled this role. Now contact farmers represent each level of farmers, after being evaluated in terms of their land, labor, capital, and managerial ability. All the farmer groups in a district elect representatives to serve on committees that plan programs at that level. A similar procedure takes place at the provincial level. Finally these groups elect andalan, or farmer representatives, who serve on committees at the national level.

Paralleling the extensionist's contact farmer are the satellite farmers used by research staff for their adaptive trials or on-farm laboratory studies. Satellite farmers may or may not be contact farmers. In its training activities the Agency for Agricultural Education, Training, and Extension (AAETE) uses such farmers to help demonstrate trials and improved recommendations to junior staff. Using farmers themselves as trainers helps to dispel the common feeling that farmers are backward and that government personnel are somehow superior, and reinforces the doctrine of pancasila (or equality).

National Targets versus Farmers' Needs

Agricultural development programs, which are an integral part of Indonesia's overall development program, are the main official source of agricultural extension programs. Another important source, however, is the farmers themselves, and, for that matter, the rural communities, their needs, and demands.
The question is how to generate smoothly and effectively realistic agricultural extension programs from two such sources, which often have very different goals.

The extension programs are shaped by the identification and formulation of messages for specific target groups. These messages and recommendations—the information to be taught—should overcome or remedy the basic problems hampering further development. If programs are to be more realistic, they must be based as close as possible to the field level. That is why operational extension programs in Indonesia are developed at the rural extension center as a cooperative planning exercise by extension agents and contact farmers, who take into consideration national and regional interests as well as the wishes and preparedness of the farmers. Those involved in planning extension programs must also take note of the general condition and situation of the farming community, prices and related policies, and the availability of techniques, technologies, and the necessary inputs including credit. The technical capabilities of extension agents and the level of farmers’ skills are also important considerations.

Since agricultural extension, research, and other service agencies have been in existence for quite some time, identifying and formulating extension messages should not be seen as starting from zero. A wealth of statistics, information, experiments, and relevant data is available to extension program planners. What they need to do is streamline the planning process, synchronize functions, and strengthen the roles of the various government officials and farmers concerned.

Indonesia has already taken steps in this direction. For example, specialized training programs are now organized for research workers, extension agents, technical officers, and farmers (that is, contact farmers or key farmers). An important aspect of this training is attitude development. Training methodologies are designed and implemented to ensure that operational programs are closely connected with technical subject matter and actual field conditions. As already mentioned, satellite farmers participate directly in field laboratories organized for these purposes.

Complex Institutional Structure

The approach to extension in Indonesia cannot be fully understood without some knowledge of the complex institutional structure that lies behind it. Over the past decade research has been reorganized under one institution, the Agency for Agricultural Research and Development (AARD), but no parallel structure has yet emerged for extension. Each directorate has its own extension service: for food crops, animal husbandry, estate crops, and fisheries. The national Agency for Agricultural Education, Training and Extension largely oversees the educational and training activities, primarily at the national level and in some of the provinces where it has established Agricultural In-Service Training Centers, but it is not yet present in all provinces. The DGFCFA (the Directorate General for Food Crops Administration) has the largest number of field personnel, but, like most field-level personnel, they are recruited and paid under the BIMAS (Bimbingan Masal or Mass Guidance) program. Furthermore, although the DGFCFA’s extension department oversees extension activities, its crop production department actually plans and supervises the adaptive trials, the purpose of which is to derive location-specific extension recommendations. These trials are not necessarily conducted in close collaboration with AARD, which has its own network of adaptive and on-farm trials.

A similar situation exists in the estate sector, where the directorate for estate crops has an extension department, while semi-autonomous agencies implement much of the tree crop program and again may have their own extension staff. They look to BALITTRI, the estate crop arm of AARD, for research support. Animal husbandry and fisheries have smaller but parallel services, and as yet there are only weak links to coordinate them. AAETE does not have the same status or authority as AARD to oversee all extension activities.

There is no question that the existing structural and functional division in the organization is responsible for operational inefficiency and budgetary anomalies. At the field level it is difficult to integrate the extension function for all crops in a system dominated by an infrastructure tailored to food crops. There has
been a mismatch between the demand for trained extension staff and AAETE's ability to meet that demand. The effectiveness of Agricultural Information Centers under AAETE has been impaired by the structural separation between the producers and disseminators of information and the users. The linkage between research and extension has also been weakened by the splintered extension apparatus. The support of extension activities by different line agency budgets causes local bottlenecks in the availability of funds and conflicts between individuals in positions with different structural and functional line responsibilities. The adverse effects of the institutional deficiencies inherent in Indonesia's extension system are being amplified and aggravated now that the system is expanding into new locations and is increasing its emphasis on dryland farming and on multicrop coverage. Indonesia is therefore amending its organizational structure to remedy these defects and improve coordination at all levels.

As a first step, it has made AAETE responsible for coordinating extension at the national level; the office of the provincial head of agriculture, who is also provincial chairman of the BIMAS program, provides coordination at the provincial level. A parallel institution is now being established at the district level. AAETE has also taken over from the DGFCA the responsibility for implementing the World Bank-assisted national agricultural extension program (NAEP).

The Need for a Whole Farm Approach

AARD has conducted some cropping systems work (see chapter 7) in several agroecological zones of both Java and the outer islands that has been particularly useful in settling transmigrants, but much more remains to be done. Most farmers in Indonesia (except those in predominantly irrigated rice areas) have complex farming systems consisting of annual food and perennial tree crops, livestock, and often fish ponds. This means that a farmer could be receiving advice from four different extension services that have little or no coordination. AARD through its Center for Agricultural Research Programming (CARP) is therefore developing a farming system approach that considers the whole farm, while national extension policy is giving more attention to the development of a unified extension service.

A critical question facing extension is how to cope with the vastly increased flow of specialized technical information in this multicrop environment. Because of the limited contacts between farmers and subject matter specialists, complicated technical and agroeconomic information will have to filter through the lowest layer of the extension system (that of the penyluhan pertanian lapangan, or PPL, which is the equivalent of the village extension worker), but whether the system can handle this task is as yet unknown. One serious complicating factor is the virtual absence of low-risk, superior technical packages for individual nonrice, especially dryland, crops and for multicrop farming systems. Another problem is the inadequate supply of inputs and poor marketing systems for crops in most dryland farming areas. The acid test will be whether Indonesia's new extension system can effectively utilize the vast staff resources in the face of the lagging research results and general infrastructure development and at the same time build and sustain farmers' interest.

A unified extension system has been considered a desirable goal ever since the early 1970s. Now that the AAETE has been given a mandate to oversee extension coordination, it has to work with the four directorates of food crops, estates, livestock, and fisheries and the provincial authorities to make this a reality. Through the Project Implementation Unit of the National Agricultural Extension Program (NAEP) the AAETE will provide coordination at the national level, while the provincial and district offices will do so at their own levels. The provincial head of agriculture has a deputy for training, extension, and technical development who will be the day-to-day coordinator of the activities of the four directorates, AAETE's Provincial Agricultural Information Center, and the BIMAS program; the district head may need a deputy to do the same. The basic effort to improve coordination is, however, being initiated at the level of the rural extension center.

The four directorates are now pooling their staff at the rural extension centers, and the most qualified PPM (penyluhan pertanian media, an agricultural officer who programs the work for five to ten or more PPLs or village-level workers) is put in charge and coordinates an integrated program of all four services (or
as many as are present) for delivery to farmers. Although livestock staff will continue to deliver livestock messages, estate and food crop staff will be aware of their activities and may disseminate the simpler messages, and vice versa, and call on the requisite specialist when problems arise. Thus, for the first time, the service is becoming unified at the grass-roots level, and a program is being drawn up to deal with the important elements of the farm system in the zone, whether related to food crops, estate crops, livestock, or fisheries.

It is encouraging to see this unity developing even in the remote outer islands. For instance, the district of Minahasa in North Sulawesi has drawn up a phased program to increase the number of PPLs from each directorate at rural extension centers in line with the dominant enterprises in the farm system. In addition, PPLs from the regreening program under forestry (which is in a separate ministry) are being unified at the centers. The method currently used for programming the work of the PPLs from estates, fisheries, forestry, and livestock is to arrange their visits to farmers’ groups in parallel with the PPL for food crops. They often interface with subgroups specializing in the particular enterprise within the farmers’ groups, but there are also some separate farmers’ groups. In South Sulawesi, a recent provincial workshop attended by about 200 participants concluded that there is little difficulty in unifying extension for livestock, fisheries, and food crops, but that greater problems exist for estates, where PPLs have varying functions and extension working areas are often quite different from those for food crops. We are confident, however, that these problems can be overcome with ingenuity, time, and patience.

With respect to the links between research and extension, the research community and staff in the extension services are generally aware of the need for such linkages. Interaction is taking place, but it is difficult to determine actual practices on a systemwide basis and to assess their effectiveness. Extension service subject matter specialists are supposed to be the prime channel of communication between research and extension, but their attention has been diverted to other matters. AAETE staff also have contact with research staff during with the preparation of extension materials, but such contacts are often infrequent, not systematic, and sometimes superficial.

Heavy reliance on informal contacts in the past has led to an uneven exchange of information, depending on individual initiatives and the physical proximity of extension staff to research facilities. More recently, some joint activities have been organized, such as formal monthly meetings at research institutes, joint field programs, and farm-level research trials and experiments. Heavier involvement of research staff in extension training is also contemplated. At present, however, shortages of staff, inadequate residential facilities in some locations, poor transportation, and a lack of travel funds are serious constraints. Extension-oriented dissemination of research results directly by the research institutes is also expected to increase. Thus, even though the linkages have been inadequate, there are indications that they are strengthening. These improvements notwithstanding, much additional effort will be needed to create an institutional framework and operational procedures conducive to an effective two-way transmission of information between research and extension in Indonesia.

The Consultation Framework

Various kinds of meetings at all levels of administration are organized to develop a personal and intimate relationship between research staff and all the bodies concerned with extension, to develop an appreciation of each other’s tasks and duties, to exchange views and consult each other, and to share new developments of importance to all. The identification and formulation of extension messages are part of the activities of these meetings.

The following meetings are held at the national level:

- Consultative forum between officials and contact farmers
- Consultative meetings for extension directors
- Subject matter meetings attended by extension directors, technical directors, and research directors
• Coordination meetings for the purpose of developing and monitoring extension programs
• BIMAS meetings chaired by the minister to identify and solve problems in the implementation of various production programs.

At these meetings, extension programs are broadly defined and outlined as an integral part of the agenda. They are further developed into extension packages for the various subsectors in seminars and workshops. Agricultural extension coordination forums and consultative forums of officials and contact farmers are also organized at the provincial and the district levels. National extension program guidelines and broad targets prepared by the Planning Division of the Ministry of Agriculture are modified as they go down the chain and are synchronized with specific regional production programs that are built up from rural extension centers and the district level. The main interface is initiated at the centers, but the major exchange with research staff takes place at the district and provincial levels.

Some Concluding Comments

Indonesia's greatest success story with respect to developing effective extension messages and increasing farmer productivity has been in irrigated rice production. Good collaboration has been achieved between research scientists and personnel of the crop production and extension division of the DGFCA. A move has subsequently been initiated to improve recommendations for the secondary food crops (maize, cassava, groundnuts, soya beans, and mungbeans). In early 1983 four teams consisting of agronomists and agro-economists from AARD, DGFCA crop production, and DGFCA extension and a specialist from each of four international centers (CIMMYT, maize; CIAT, cassava; AVRDC, soya and mungbeans; ICRISAT, groundnuts) visited provinces where the crop was considered important and reviewed existing recommendations, the status of crop production and potential markets, and the priorities for future research and extension programs. These topics were discussed at a preliminary workshop held in Jogjakarta, the outcome of which has been improved recommendations for each province concerned. Such joint field tours by research, crop production, and extension staff that emphasize in-depth discussions with farmers need to be carried out every season, and their reports together with the results of adaptive trials and the monitoring of adoption rates in the previous season, should be available at meetings to draw up revised programs.

This is just a beginning. A much more complex activity is now under way in the effort to institute the whole farm approach. Cropping systems research initiated by the Center for Research in Food Crops is now to include estate crops, fisheries, livestock, and forestry, so that it will become farm systems research. This type of research is being undertaken at Sembawa, Sumatra, at the smallholder Rubber Research Institute, where rubber is the main cash crop, but is being researched together with food crops and livestock enterprises in whole farm systems. Similar farming systems research is being carried out in other ecological zones and has important implications for the development of improved extension messages.

The multicrop and farm enterprise approach in extension must be effectively coordinated at all levels. The AAETE is now responsible for this task at the national level under the chairmanship of the minister himself, and provincial and district officers will carry out this function at their own levels. The important interface, however, is at the grass-roots level of the rural extension centers, where a unified extension service is being developed to deal with farmer groups and their representatives. It will take time to develop an effective service, especially as the cadre of subject matter specialists and their relationships with research centers need strengthening. A potentially effective strategy has been marked out, however, and attitudes are being changed through orientation courses designed to develop a more egalitarian participatory approach based on the Pancasila doctrine instead of the former top-down approach.

In the meantime, research agents, extension specialists, technical officers, and master contact farmers at the various administrative levels have decided on the specific extension messages. Field days, which are also organized at the experiment stations, universities, and regional in-service training centers, are themselves important events in the process by which research and extension technicians and farmers jointly identify and formulate extension messages. This joint exercise is further strengthened by research workers' visits to
farming communities, by farmers' visits to the experiment station, and, most important, by on-farm experiments.

I am convinced, and the results in Indonesia bear this out, that the broader base, as described here, will produce more practical, relevant, and effective extension messages and more appropriate problem-oriented adaptive research. Furthermore, it will accelerate the development of human behavior more conducive to better implementation of agricultural development programs.
Pakistan is predominantly an agricultural country. About three-fourths of the population live in villages, and more than half of the rural labor force is engaged in the agricultural sector. The agricultural sector supplies the bulk of raw material for most of the industries, and a major share of foreign exchange is earned through the export of farm produce.

The government is making concerted efforts to increase agricultural production by exploring the maximum potential possible with efficient utilization of resources. Comparison of crop yields with other countries (table 14-1) indicates the possibilities of further increases in productivity if better management techniques are adopted.

Provincial as well as federal research institutions, universities, and government agencies are doing continuous agricultural research to further this goal. The production technology developed has shown positive results, and yields on government and contact farmers' farms are much higher than the national average.

Adaptive Research and Extension

The yield gap shows that there is a dire need for the transfer of production technology to common farmers if they are to benefit from this technology. The reasons for low yields under common practices and conditions need to be identified, and the validity of the improved production technology within different agroclimatic zones and under the conditions of individual farmers needs to be determined. For the proper dissemination of the improved production technology, a linkage between research and extension is needed. Such coordination was developed in Pakistan with the introduction of the Adaptive Research Program under the training and visit (T&V) project, the Punjab Extension and Agricultural Development Project, assisted by the World Bank.

Adaptive research in Punjab is intended to modify results of applied research for conditions in different agroclimatic zones and to fill gaps between research findings and farmers' achievements. These modified results are disseminated to farmers through extension staff; researchable problems of the farmers are collected; and solutions are worked out at the local level. The problems identified are also passed on to different research institutes for further research when such referral is thought necessary.

Different constraints to yield increases that were encountered by individual farmers in various agroclimatic zones were determined, and solutions were worked out. The causes for low productivity may be attributed to many factors, but the weak agricultural extension services were identified as one of the most important factors, for the following reasons:

- Lack of sufficient staff and the high number of farm families to be served by agricultural officers and field assistants
- Availability of few mobile facilities for agricultural officers and field assistants
- Obsolete knowledge of extension personnel—most agricultural officers were recruited after graduation from the agricultural universities, and they were seldom offered adequate in-service training to acquaint them with the latest production technology
- Inadequate training facilities—there were only two institutes for training field assistants, at Sargodha and Rahim Yar Khan; the institutes trained field assistants by imparting a two-year di-
ploma course of study; once qualified and posted in the department, field assistants had absolutely no in-service arrangement to refresh their knowledge.

- Inadequate residential accommodations for extension personnel, which affected staff punctuality and efficiency
- Inadequate coverage of extension—because of various socioeconomic factors, the activities of the extension agents were confined to contacts with the influential and large zamindars (landlords); thus a majority of the farming community remained technically unattended.

The Punjab Extension and Agricultural Development Project was started to strengthen the agricultural extension services. Motorcycles were provided to all the village-level field workers so they would have easy access to the farmers. New houses were constructed and provided for all field staff to ensure the full-time presence of staff among the farmers and to increase staff efficiency. The main objectives of the project are:

- To increase the efficiency and effectiveness of the extension program by reorganizing and strengthening the present setup
- To introduce a strict accountability system for field staff through the T&V system
- To increase the efficiency of extension workers through the provision of transport, residential facilities, and necessary audiovisual aids
- To strengthen the in-service training of field staff by introducing regular training programs
- To provide more opportunities for technical field staff to receive training in the advanced extension methodology
- To establish adaptive research for filling the known gap between research findings and farmers' achievements under specific local requirements.

If the linkage between research and extension for the dissemination of agricultural technology to common farmers is to be effective, problems faced by individual farmers must be identified and solutions found. The modus operandi of adaptive research in Punjab is outlined in detail in the following sections.

### Identification of Farmers' Production Problems

Problems are identified by the field staff in agricultural extension and by the specialists in adaptive research. At the first tier is the field assistant, who has direct contact with the farmers. He meets farmers in his jurisdiction every fortnight on scheduled dates. The field assistant identifies local as well as individual problems when he meets farmers for the transfer of technology. The agricultural officer, assistant director of agriculture, and the deputy director of agriculture check the effectiveness of the technology conveyed to the farmers by the field assistants during meetings with the farmers and staff members. These meetings with individual farmers help identify and collect production problems related to the farmers' socioeconomic conditions, farming system, and farming conditions.

### Table 14-1. Comparison of Yields of Major Crops in Pakistan and Selected Countries (kilograms per hectare)

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pakistan</td>
<td>1,316</td>
<td>Pakistan</td>
<td>312</td>
<td>Pakistan</td>
<td>1,251</td>
<td>Pakistan</td>
<td>36,600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>United States</td>
<td>2,128</td>
<td>United States</td>
<td>583</td>
<td>United States</td>
<td>5,691</td>
<td>United States</td>
<td>79,201</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turkey</td>
<td>1,774</td>
<td>Turkey</td>
<td>740</td>
<td>Turkey</td>
<td>2,181</td>
<td>Cuba</td>
<td>45,968</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>1,477</td>
<td>Egypt</td>
<td>681</td>
<td>Italy</td>
<td>6,568</td>
<td>India</td>
<td>53,383</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mexico</td>
<td>3,483</td>
<td>Mexico</td>
<td>915</td>
<td>Mexico</td>
<td>1,359</td>
<td>Egypt</td>
<td>83,014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>France</td>
<td>5,057</td>
<td>Iran</td>
<td>563</td>
<td>Yugoslavia</td>
<td>4,252</td>
<td>Mauritania</td>
<td>73,443</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the beginning of every fortnight, meetings of the District Agricultural Coordination Committee—which is headed by the deputy director of agriculture and is made up of senior subject matter specialists, senior training officers, subject matter specialists, and the assistant directors of agriculture—are held to discuss the farmers' problems. Meetings of experts from the agricultural research institutions and the agricultural university with extension and adaptive research staff are also convened regularly at the start of kharif and rabi seasons to discuss farmers' problems identified during the previous season. These meetings are usually held at provincial headquarters, and a circular is distributed to notify all concerned. Sometimes the meetings are held at one of the adaptive research farms so that all participants will have a chance to witness adaptive research activities and to observe field conditions. The venue of the meeting is changed from provincial headquarters to an adaptive research farm when a majority of the participants desire the change. These meetings are well attended and are being conducted successfully in Pakistan.

The purpose of the adaptive research program is to solve local problems and to confirm the existing research recommendations. Modifications and adjustments in recommendations are made in view of the local agroclimatic conditions. Joint meetings are well attended by experts from the university and research institutes and by all senior extension staff.

In one such meeting, the deputy director of agriculture posted in an area of rice tracts pointed out that the recommendation to apply the first irrigation to the wheat crop twenty-one days after germination was not being accepted by the farmers of his district. A survey was designed by adaptive research staff and was conducted by extension field staff through meetings with individual farmers to ascertain the real situation. It was found that a majority of the farmers were rejecting the research message. Experiments were conducted in applying the first irrigation to wheat at intervals of seven, fourteen, twenty-one, twenty-eight, and thirty-five days after germination. Replication trials were arranged on adaptive research farms and farmers' fields for wheat sown after rice and for wheat sown in fallow fields. It was found that application of the first irrigation twenty-eight days after germination gave higher yield when wheat was sown after rice. First irrigation given to wheat fourteen days after germination in fallow fields, however, registered better results.

The recommendations were modified in the light of the results of field trials conducted on farmers' fields as well as on adaptive research farms, and farmers were advised to apply the first irrigation to wheat planted after rice at an interval of twenty-eight days after germination. Economic analysis given in tables 14-2 and 14-3 indicates that if farmers sow wheat after rice they can increase their yield by about 11 percent without

<table>
<thead>
<tr>
<th>Irrigation after germination</th>
<th>Total expenditure per acre (rupees)</th>
<th>Yield per acre (kilograms)</th>
<th>Increase or decrease in yield per acre (kilograms)</th>
<th>Gross income per acre (rupees)</th>
<th>Net income per acre (rupees)</th>
<th>Percentage increase or decrease in net income from modified practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 days</td>
<td>1,126.63</td>
<td>1,653.87</td>
<td>-221.91</td>
<td>2,398.12</td>
<td>1,271.49</td>
<td>-18.13</td>
</tr>
<tr>
<td>14 days</td>
<td>1,131.89</td>
<td>1,682.86</td>
<td>-192.92</td>
<td>1,440.17</td>
<td>1,308.28</td>
<td>15.76</td>
</tr>
<tr>
<td>21 days*</td>
<td>1,166.86</td>
<td>1,875.78</td>
<td>-</td>
<td>2,719.89</td>
<td>1,533.03</td>
<td>-</td>
</tr>
<tr>
<td>28 days**</td>
<td>1,207.69</td>
<td>2,101.07</td>
<td>225.28</td>
<td>3,046.55</td>
<td>1,838.86</td>
<td>18.40</td>
</tr>
<tr>
<td>35 days</td>
<td>1,172.97</td>
<td>1,909.51</td>
<td>33.73</td>
<td>2,768.79</td>
<td>1,595.82</td>
<td>2.76</td>
</tr>
</tbody>
</table>

* Recommended practice.
** Recommended modification of previous message.
— Not applicable.

a. Includes cost of seed, fertilizer, land rent, seedbed preparation, irrigation, and all other inputs and expenditures for harvesting and threshing.
b. This high expenditure reflects the increase in threshing expenses because of the larger yield; in Punjab a threshing charge is paid that is equivalent to 12.5 percent of the value of the grain produced.

Source: Directorate of Agriculture (Adaptive Research), Punjab.
**Table 14-3. Economic Effects of Various Intervals for First Irrigation on the Yield of Wheat Sown in Fallow Fields, Sheikhupura, 1981-82**

<table>
<thead>
<tr>
<th>Irrigation after germination</th>
<th>Total expenditure per acre (rupees)</th>
<th>Yield per acre (kilograms)</th>
<th>Increase or decrease in yield per acre (kilograms)</th>
<th>Gross income per acre (rupees)</th>
<th>Net income per acre (rupees)</th>
<th>Percentage increase or decrease in net income from modified practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 days</td>
<td>1,139.96</td>
<td>1,727.39</td>
<td>149.06</td>
<td>2,504.72</td>
<td>1,364.76</td>
<td>16.09</td>
</tr>
<tr>
<td>14 days**</td>
<td>1,182.33</td>
<td>1,961.14</td>
<td>382.81</td>
<td>2,843.66</td>
<td>1,661.33</td>
<td>41.31</td>
</tr>
<tr>
<td>21 days*</td>
<td>1,112.94</td>
<td>1,578.33</td>
<td>—</td>
<td>2,228.58</td>
<td>1,175.64</td>
<td>—</td>
</tr>
<tr>
<td>28 days</td>
<td>1,088.23</td>
<td>1,442.08</td>
<td>—136.25</td>
<td>2,091.02</td>
<td>1,002.79</td>
<td>14.70</td>
</tr>
<tr>
<td>35 days</td>
<td>1,068.32</td>
<td>1,332.14</td>
<td>—246.19</td>
<td>1,931.60</td>
<td>863.28</td>
<td>—26.57</td>
</tr>
</tbody>
</table>

* Recommended practice.
** Recommended modification of previous message.
— Not applicable.
a. Includes cost of seed, fertilizer, land rent, seedbed preparation, irrigation, and all other inputs and expenditures for harvesting and threshing.
b. This high expenditure reflects the increase in threshing expenses because of the larger yield; in Punjab a threshing charge is paid that is equivalent to 12.5 percent of the value of the grain produced.
Source: Directorate of Agriculture (Adaptive Research), Punjab.

any additional material input, solely by adjusting their irrigation pattern. The net income of the farmers will increase by an estimated 18.4 percent with adoption of this practice.

In a similar meeting at district headquarters, extension staff pointed out that farmers were not adopting departmental recommendations for applying zinc sulphate to paddy fields in some areas of the district of Sheikhupura. As a result, they were getting low paddy yields per acre. To demonstrate and evaluate the effectiveness of zinc sulphate application for rice, trials were conducted on adaptive research farms and farmers’ fields. The experiments included different methods of zinc application. The yield data and the computed economic analysis of the experiments given in tables 14-4 and 14-5 revealed that, among the

**Table 14-4. Economic Effects of Different Methods of Zinc Application on Rice, Sheikhupura, 1980-81**

<table>
<thead>
<tr>
<th>Method</th>
<th>Total expenditure per acre (rupees)</th>
<th>Additional expenditure per acre (rupees)</th>
<th>Yield per acre (kilograms)</th>
<th>Increase in yield per acre (kilograms)</th>
<th>Gross income per acre (rupees)</th>
<th>Additional income per acre (rupees)</th>
<th>Cost-benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1,818.05</td>
<td>—</td>
<td>2,967.80</td>
<td>—</td>
<td>3,635.55</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ZnSO(_4) application of 5 kilogram per acre Root dipping of seedlings in 2% Zn0 suspension</td>
<td>1,879.32</td>
<td>61.27</td>
<td>3,267.95</td>
<td>300.15</td>
<td>4,003.24</td>
<td>367.69</td>
<td>1:6.00</td>
</tr>
<tr>
<td>Foliar spray with 2% Zn0 suspension</td>
<td>1,867.50</td>
<td>49.45</td>
<td>3,128.00</td>
<td>160.20</td>
<td>3,831.80</td>
<td>196.25</td>
<td>1:3.97</td>
</tr>
<tr>
<td></td>
<td>1,891.92</td>
<td>73.87</td>
<td>3,082.47</td>
<td>114.67</td>
<td>3,776.02</td>
<td>140.47</td>
<td>1:1.90</td>
</tr>
</tbody>
</table>

— Not applicable.
a. Includes cost of seed, fertilizer, land rent, seedbed preparation, irrigation, and all other inputs and expenditures for harvesting and threshing.
b. The additional expenditure is due to the cost of zinc application and to the increase in threshing expenses because of the larger yield.
Source: Directorate of Agriculture (Adaptive Research), Punjab.
various methods, application of 5 kilograms of zinc sulphate per acre, ten days after transplanting the seedlings, produced the highest yield per acre with the maximum cost-benefit ratio.

The experiments further showed that severe zinc deficiency was noticed mainly in Ferozepur and in some parts of Sheikhupura and Nankana Sahib, subdistricts in which rice is grown in the same area constantly year after year. Other parts of the latter two subdistricts, where rice is not sown continuously, showed little response to zinc sulphate application. Departmental recommendations were therefore modified accordingly, and extension agents were asked to advise farmers to use zinc sulphate only in areas where rice is always planted.

Apart from the meetings described above, the adaptive research staff also identify farmers' problems as follows.

*Convening Direct Meetings with Farmers*

Farmers' days are held at adaptive research farms, where the farmers get a chance to see the latest technology being demonstrated. The number of farmers attending has ranged from 25 to 100 depending on the accessibility of the demonstration site. In such meetings the adaptive research staff have the opportunity to conduct discussions of production problems being faced by farmers. The problems elicited are sent for solution to the research staff concerned.

*Laying out Trials on Farmers' Fields*

Field trials are laid out for verification of improved technology on farmers' fields; trial plots are spread throughout the district in such a way that all agroclimatic areas and field conditions are represented.

Adaptive research staff come in direct contact with the farmers and their farming conditions while setting up the verification field trials and subsequently recording data from the trials. This process also helps in the identification of local problems.

*Conducting Surveys*

Surveys were designed by adaptive research staff and were conducted by extension staff in an effort to understand the extent and locality of the problems indicated by staff members in the various meetings.

*Generation of Technology*

Under the Punjab Extension and Agricultural Development Project, the adaptive research staff are responsible for providing effective and appropriate agricultural technology to the extension agents and, subsequently, to the farmers. The goal of adaptive research is to modify and adjust the results of applied research and to fill the gaps between research findings and the farmers' achievements under specific local conditions. It is imperative that, to disseminate research findings and techniques in an adoptable form to the farmers, an integrated and comprehensive adaptive research program be implemented.

Five adaptive research farms, one in each district (Sheikhupura, Jhelum, Sargodha, Vehari, and Rahimyak Khan) and representing the various agroclimatic conditions in the Punjab, have been established. Four senior subject matter specialists, one each for agronomy, plant protection, agricultural engineering and farm management, and farm economics have been posted at these centers, except at Jhelum, where there are only two senior subject matter specialists, one for agronomy and the other for agricultural engineering. Each senior subject matter specialist is assisted by one assistant research officer. The senior subject matter specialist (agronomy) is designated principal subject matter specialist and is in charge of the adaptive research farm.
The director of agriculture (adaptive research) is the financial and administrative executive of this program and is directly responsible to the director-general of agriculture (extension). He works in cooperation with the director of agriculture (extension), deputy directors of agriculture, and other staff of the project. He has a small team at headquarters consisting of one agricultural economist, one research officer, and two agricultural officers (technical). He maintains liaison with the Pakistan Agricultural Research Council, the Ayub Agricultural Research Institute at Faisalabad, the University of Agriculture at Faisalabad, the Pakistan Central Cotton Committee, and other institutes.

Under this program, research findings are verified and quantified according to the different prevailing agroclimatic conditions. Trials for verification of proven technology are laid out on farmers' fields in such a way that all agroclimatic zones and farming conditions are represented. Data are analyzed and the results quantified according to similar farming conditions.

The adaptive research farms and on-farm field trials with the contact farmers are a pivot of the research-extension system. Data from these trials are collected at the centers, and the modified results are made available to the extension service and common farmers through training materials and by demonstration plots. The farmers are given a series of recommendations for increasing production, starting with low-cost technology. The success of the T&V system of agricultural extension depends on the generation and dissemination of appropriate technical messages that are acceptable to the farmers. These messages are tailored to the present levels of skill and resources of farmers in each agroclimatic zone.

For example, during trials in the farmers' fields it was discovered that a high percentage of weeds in the wheat crop was the main cause of low yield. A shortage of labor for manual weeding was also observed as a constraint to effective weed control. Trials were conducted using different herbicides in comparison with mechanical and hand-weeding practices to demonstrate and evaluate the effectiveness of different herbicides for this purpose. A weed count was taken at appropriate intervals to see the effectiveness of various herbicides on different kinds of weeds. Economic analysis of the experiments (as given in tables 14-6 through 14-9) was conducted, and it was established that the benefit obtained from chemical weed control is directly related to the extent of damage from local weeds and to the different crop rotations in practice. The most severe damage was in areas having a crop rotation of rice-wheat-rice-wheat.

Table 14-5. Economic Effects of Different Methods of Zinc Application Where Rice Is Not Grown Constantly, Sheikhupura, 1980–81

<table>
<thead>
<tr>
<th>Method</th>
<th>Total expenditure per acre&lt;sup&gt;a&lt;/sup&gt; (rupees)</th>
<th>Additional expenditure per acre&lt;sup&gt;a&lt;/sup&gt; (rupees)</th>
<th>Yield per acre (kilograms)</th>
<th>Increase in yield per acre (kilograms)</th>
<th>Gross income per acre (rupees)</th>
<th>Additional income per acre (rupees)</th>
<th>Cost-benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1,805.33</td>
<td>—</td>
<td>2,760.80</td>
<td>3,381.98</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ZnSO&lt;sub&gt;4&lt;/sub&gt; application of 5 kilograms per acre</td>
<td>1,847.08</td>
<td>41.75</td>
<td>2,815.80</td>
<td>55.00</td>
<td>3,491.98</td>
<td>67.38</td>
<td>1:1.61</td>
</tr>
<tr>
<td>Root dipping of seedlings in 2% ZnO suspension</td>
<td>1,843.98</td>
<td>37.65</td>
<td>2,810.45</td>
<td>49.65</td>
<td>3,442.80</td>
<td>60.82</td>
<td>1:1.61</td>
</tr>
<tr>
<td>Foliar spray with 2% ZnO suspension</td>
<td>1,869.61</td>
<td>64.28</td>
<td>2,795.75</td>
<td>34.95</td>
<td>3,424.79</td>
<td>42.81</td>
<td>1:0.67</td>
</tr>
</tbody>
</table>

— Not applicable.

<sup>a</sup> Includes cost of seed, fertilizer, land rent, seedbed preparation, irrigation, and all other inputs and expenditures for harvesting and threshing.

<sup>b</sup> The additional expenditure is due to the cost of zinc application and to the increase in threshing expenses because of the larger yield.

Source: Directorate of Agriculture (Adaptive Research), Punjab.
Table 14-6. Economic Effects of Various Methods of Weed Control in Wheat with a High Percentage of Weeds, Sheikhupura, 1982–83

<table>
<thead>
<tr>
<th>Method</th>
<th>Total expenditure per acre (rupees)</th>
<th>Additional expenditure per acre (rupees)</th>
<th>Yield per acre (kilograms)</th>
<th>Increase in yield per acre (kilograms)</th>
<th>Gross income per acre (rupees)</th>
<th>Additional income per acre (rupees)</th>
<th>Cost-benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Weeding</td>
<td>1,191.00</td>
<td>—</td>
<td>1,219.05</td>
<td>—</td>
<td>1,950.48</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dicuran MA (60 WP)</td>
<td>1,498.38</td>
<td>307.38</td>
<td>1,885.95</td>
<td>666.90</td>
<td>3,017.52</td>
<td>1,067.04</td>
<td>1:3.47</td>
</tr>
<tr>
<td>Banvel (40.6 EC)</td>
<td>1,249.49</td>
<td>58.49</td>
<td>1,269.00</td>
<td>49.95</td>
<td>2,030.40</td>
<td>79.92</td>
<td>1:1.37</td>
</tr>
<tr>
<td>Tribunil (70 WP)</td>
<td>1,500.69</td>
<td>309.69</td>
<td>1,957.50</td>
<td>738.45</td>
<td>3,132.00</td>
<td>1,139.52</td>
<td>1:3.68</td>
</tr>
<tr>
<td>Dosanex (80 WP)</td>
<td>1,512.90</td>
<td>321.90</td>
<td>2,123.55</td>
<td>904.50</td>
<td>3,397.68</td>
<td>1,447.20</td>
<td>1:4.50</td>
</tr>
<tr>
<td>Bar harrowing</td>
<td>1,230.45</td>
<td>39.45</td>
<td>1,266.30</td>
<td>47.25</td>
<td>2,026.08</td>
<td>75.60</td>
<td>1:1.92</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>1,572.69</td>
<td>381.69</td>
<td>2,227.50</td>
<td>1,008.45</td>
<td>3,164.00</td>
<td>1,613.52</td>
<td>1:4.22</td>
</tr>
</tbody>
</table>

— Not applicable.

a. Includes cost of seed, fertilizer, land rent, seedbed preparation, irrigation, and all other inputs and expenditures for harvesting and threshing.

b. The additional expenditure includes extra charges for weeding by different means and for threshing of additional wheat produced.

Source: Directorate of Agriculture (Adaptive Research), Punjab.

All the herbicides tested gave an economic return, and control of weeds varied between 43 and 91 percent in areas with a high percentage of weeds. Weed control in such areas increased yield by as much as 82 percent. Use of herbicides was contraindicated in areas with few weeds because there it does not give an economic return. Other means of weed control should be used in areas having fewer than thirty weed plants per square meter. Farmers in cotton-growing areas were advised to control weeds in wheat fields manually or by using bar harrowing; farmers in rice-growing tracts with large numbers of weeds were asked to apply herbicides. It also was determined that the extent of damage further depends on the type of weed flora in a particular area, and research in this respect is going on at adaptive research farms.

Table 14-7. Effectiveness of Various Methods of Weed Control in Wheat with a High Percentage of Weeds, Sheikhupura, 1982–83

<table>
<thead>
<tr>
<th>Method</th>
<th>Application per acre before application</th>
<th>Two weeks after application</th>
<th>Six weeks after application</th>
<th>Near harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>No weeding</td>
<td>—</td>
<td>170.0</td>
<td>181.5</td>
<td>—</td>
</tr>
<tr>
<td>Dicuran MA (60 WP)</td>
<td>1 kilogram before application</td>
<td>161.0</td>
<td>23.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Banvel (40.6 EC)</td>
<td>250 milliliters before application</td>
<td>180.8</td>
<td>98.6</td>
<td>99.0</td>
</tr>
<tr>
<td>Tribunil (70 WP)</td>
<td>700 grams before application</td>
<td>155.0</td>
<td>17.0</td>
<td>22.6</td>
</tr>
<tr>
<td>Dosanex (80 WP)</td>
<td>700 grams before application</td>
<td>196.3</td>
<td>14.0</td>
<td>17.8</td>
</tr>
<tr>
<td>Bar harrowing</td>
<td>Twice before application</td>
<td>174.6</td>
<td>81.7</td>
<td>92.0</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>Twice before application</td>
<td>188.0</td>
<td>20.0</td>
<td>21.5</td>
</tr>
</tbody>
</table>

— Not applicable.

Source: Directorate of Agriculture (Adaptive Research), Punjab.
Table 14-8. Economic Effects of Selected Methods of Weed Control in Wheat with Few Weeds, Sheikhupura, 1981–82

<table>
<thead>
<tr>
<th>Method</th>
<th>Total expenditure per acre(^a) (rupees)</th>
<th>Additional expenditure per acre(^a) (rupees)</th>
<th>Yield per acre (kilograms)</th>
<th>Increase in yield per acre (kilograms)</th>
<th>Gross income per acre (rupees)</th>
<th>Additional income per acre (rupees)</th>
<th>Cost-benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Weeding</td>
<td>1,090.29</td>
<td>—</td>
<td>1,453.335</td>
<td>—</td>
<td>2,107.33</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dicuran MA (60 WP)</td>
<td>1,265.44</td>
<td>176.15</td>
<td>1,520.375</td>
<td>67.04</td>
<td>2,204.54</td>
<td>97.21</td>
<td>1:0.55</td>
</tr>
<tr>
<td>Banvel (40.6 EC)</td>
<td>1,144.95</td>
<td>54.66</td>
<td>1,176.825</td>
<td>23.49</td>
<td>2,141.40</td>
<td>34.07</td>
<td>1:0.62</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>1,263.53</td>
<td>173.24</td>
<td>1,526.415</td>
<td>73.08</td>
<td>2,213.38</td>
<td>106.05</td>
<td>1:0.61</td>
</tr>
</tbody>
</table>

— Not applicable.

\(^a\) Includes cost of seed, fertilizer, land rent, seedbed preparation, irrigation, and all other inputs and expenditures for harvesting and threshing.
\(^b\) The additional expenditure includes extra charges for weeding by different means and for threshing of additional wheat produced.

Source: Directorate of Agriculture (Adaptive Research), Punjab.

Formulation of Training Messages

Keeping in mind the prevailing crop season and weather conditions, the adaptive research specialists prepare fortnightly technical extension messages to be conveyed to the farmers through the extension agents. The message draft is thoroughly discussed in the District Agricultural Coordination Committee meetings held before the commencement of the fortnight. After it is final, the message is printed up by the senior training officer. The senior training officer organizes fortnightly training programs at different training centers on specified dates. The printed material is distributed among the field staff and explained by the trainers—the senior subject matter specialists, senior training officer, and subject matter specialists.

A close watch is kept on, and persuasion directed toward, acceptance of training messages, and modifications are made in the case of a sudden change in weather or the outbreak of any havoc (such as the appearance of plant pests or blight). For example, training messages were modified because heavy rains occurred in cotton-growing areas five days into the first fortnight of July 1983. The previous training message did not include the concept of drainage but instead asked farmers to apply irrigation water. The research-extension system has responded quickly to such sudden changes because the senior subject matter specialists and the senior training officer are always closely attuned to the agroclimatic situation.

Implementation and Maintenance of the T&V System and the Flow of New Research Messages

Each field assistant is supposed to assist 500 to 700 farm families in his jurisdiction by having direct dealings with the contact farmers selected among them. The ratio of agricultural officers and field assistants in Punjab is one to seven. The field assistant concentrates his activities among the contact farmers, who are expected to invite neighboring farmers to their fields whenever the field assistant visits. The agricultural officer supervises six to seven field assistants, the assistant director of agriculture seven to eight agricultural officers, and the deputy director of agriculture three to four assistant directors of agriculture, depending on the number of tehsils (subdistricts) in a district.

Training messages—prepared by the senior subject matter specialists of adaptive research and finalized in meetings of the District Agricultural Coordination Committee—are imparted to the field assistants and agricultural officers on one entire day during the four days of each fortnight set aside for this purpose. This is
when the field assistants are taught what is to be recommended to and demonstrated for the contact farmers in the following two weeks. During the training session the field assistants tell the supervisors about the problems encountered by the farmers during the previous two weeks. If answers for the problems are not readily available, the trainers arrange to visit the villages and farmers concerned, and the problem is taken up by the senior subject matter specialists of adaptive research for definite solution.

For example, the attack of rice hispa (leaf miner) during the kharif season of 1983 was reported by the field assistants during training sessions. Rice hispa is not a common insect pest in rice tracts and normally does not appear in Pakistan; therefore the training message did not include appropriate remedial measures. Field visits were arranged at once, and appropriate measures were suggested to farmers.

A second fortnightly training opportunity is taken with the agricultural officers. This is a more informal session, held in the agricultural officers' circle with his field assistants, in which primarily operational problems are discussed. Routine reporting by the field assistants is made through diaries. The agricultural officer notes the visits made and observations and questions recorded by the field assistant. The agricultural officer makes spot checks in the field assistant's circle to ascertain whether he is following his prescribed schedule. The agricultural officer spends one day a fortnight with each of the field assistants, arranging his visits in such a manner that he meets a different group of farmers on each occasion, thereby getting to know all of them. Similarly, the assistant director of agriculture and deputy director of agriculture also check the effectiveness of the program's functioning on prescribed dates.

Conclusions

A linkage between agricultural research and extension was effected in Punjab with the establishment of the adaptive research program under the Punjab Extension and Agricultural Development Project, financed by the World Bank. Two years were taken in arranging the project and in recruiting staff. This research-extension linkage has been quite successful in solving farmers' production problems and has been a means to increase agricultural production in Punjab. Adaptive research has been able to identify and compile farmers' problems, and solutions to these problems have been worked out.

The main elements of this success, and significant findings obtained through the research-extension linkage, have been the following:

- Adaptive research has been able to bring research and extension staff closer together.
- Up-to-date technology has started flowing from the research institutes to farmers.
- Farmers' production problems have been identified and compiled, and feedback to research has started.

<table>
<thead>
<tr>
<th>Method</th>
<th>Application per acre</th>
<th>Weeds per square meter before application</th>
<th>Two weeks after application</th>
<th>Weeds per square meter</th>
<th>Percentage control</th>
<th>Six weeks after application</th>
<th>Weeds per square meter</th>
<th>Percentage control</th>
<th>Near harvest</th>
<th>Weeds per square meter</th>
<th>Percentage control</th>
</tr>
</thead>
<tbody>
<tr>
<td>No weeding</td>
<td>—</td>
<td>21.2</td>
<td>25.2</td>
<td>—</td>
<td>27.5</td>
<td>—</td>
<td>34.5</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dicuran MA (60 WP)</td>
<td>1 kilogram</td>
<td>19.8</td>
<td>0.2</td>
<td>98.99</td>
<td>0.4</td>
<td>97.98</td>
<td>6.7</td>
<td>66.16</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Banvel (40.6 EC)</td>
<td>250 milliliters</td>
<td>21.3</td>
<td>8.8</td>
<td>58.68</td>
<td>10.7</td>
<td>49.76</td>
<td>12.1</td>
<td>43.19</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>—</td>
<td>22.5</td>
<td>1.0</td>
<td>95.45</td>
<td>2.10</td>
<td>90.66</td>
<td>3.6</td>
<td>84.00</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

— Not applicable.

Source: Directorate of Agriculture (Adaptive Research), Punjab.
• Research results have been modified for local agroclimatic conditions and have been disseminated to farmers, thus helping to increase production. For example, a modification in the pattern of first irrigation of wheat suggested by adaptive research staff will result in an estimated increase of 11 percent in wheat that is sown after rice in an estimated area of 10 lac, or approximately 405,000 hectares in Punjab (1 lac = 100,000 acres; 1 hectare = approximately 2.47 acres). Other research indicated that zinc sulphate should be recommended only for areas planted with rice year after year.

• Farmers in Punjab are now motivated to use herbicide for weed control in rice tracts because it increases yield. The problem of labor shortage for manual weeding has thus been solved through the use of herbicides because such use gives better economic return. (Herbicides should not, however, be used in areas with few weeds where an economic return is not forthcoming—for example, in cotton tracts in Punjab.)

• Herbicide use that varies with agroclimatic conditions and crop rotation will result in the judicious application of herbicide, and unnecessary waste of agrochemical resources will be avoided.

• The agricultural research-extension system in Punjab has responded immediately to sudden changes in weather and to other emergencies, such as the sudden appearance of plant pests.

• The adoption rate among farmers is much higher for training messages that have been modified in the light of such sudden changes in agroclimatic conditions.

These gains from the linkage of adaptive research and extension have been impressive. Nevertheless, the research-extension system in Punjab needs strengthening to meet the needs of all farmers, particularly of smallholders, in the province. Such efforts are under way.
Farmer-Centered Extension to Increase Adoption of New Technology: Experience in Northern Thailand

Peter W. C. Hoare

Linkages between agricultural research and extension are usually considered in the context of generating new agricultural technology at research centers for dissemination through the training and visit (T&V) extension system to the farming community. But as Cernea, Coulter, and Russell (1983) noted, research and extension need to better identify farmers' priority problems in order to develop more appropriate technical recommendations. This in turn requires more sociological and communications research to develop new techniques that can be incorporated into the existing T&V management organization.

This chapter presents a preliminary study of the application of extension research to the problem of the suitability of the T&V system in rainfed agricultural areas. Some of the special problems for extension in upland, rainfed areas are the diversity of agricultural production systems and of social institutions in such areas and the limitations of institutional agricultural research knowledge. The highlands of northern Thailand present these special agricultural and socioeconomic problems.

The Department of Agricultural Extension (DAE) in Thailand provides extension services to farmers in the irrigated lowlands and in part of the uplands of northern Thailand. Other line departments, such as the Department of Land Development, have a limited number of extension staff to support project implementation in specific areas. Sixty percent of the area above 500 meters in altitude, however, is not serviced by village extension workers (VEWs) of the DAE. This area is the home of the majority of the estimated 500,000 tribal hill people, of diverse ethnicity, and of northern Thai tea farmers. Some of the highland communities have been established for over 150 years.

Rural development services to these hill communities are channeled through a multiservice agency, the Hilltribe Development and Welfare Division of the Public Welfare Department (PWD). At the village level, development services are provided by a team which at full strength comprises a social worker who is usually the team leader, an agricultural extension worker (vocational school graduate), a paramedic, and a teacher's aide.

On the average, one of these teams serves about 150 households in four to five upland or highland villages in remote areas. Apart from the difficulty of providing development services to remote and inaccessible villages, there are also problems of cross-cultural communication because most VEWs are Tai,¹ and each group of hill people has its own language and social institutions.

The Farmer-Centered Extension Method

From 1978 to 1980 I tested farmer-centered extension methods with village-level development teams of the PWD in the highlands of northern Thailand (Hoare 1985). The extension techniques had evolved during more than two decades of Australian experience in rainfed agricultural development in the

¹ The term “Tai” is used for any group speaking a Tai (or Daic) language, whereas Thai is used in the text to refer to the country of Thailand.
It is appropriate at this point to introduce the concepts on which farmer-centered extension methods are based and to trace their origin in the social sciences.

Farmer-centered extension methods are based on principles of rural sociology, group dynamics, and adult education. In their work on changing agricultural practices in rural communities in the Pacific Basin, the late Joan Tully observed that the social structure of rural communities in both developed and developing countries is characterized by reference groups. The membership of these groups is built around a lifetime of face-to-face interactions and kinship patterns within rural communities.

An extensive pattern of life-long associations exists in the group. This means that in the group there has been much face-to-face interaction over a long period of time. This can be called a permanent group since interaction between the majority of members is life-long. The face-to-face interaction is promoted by an extensive kinship pattern. In addition to this interpersonal association within the group, there is a long history of group action to attain group goals. (Tully 1981, p. 80)

The commonly held values, beliefs, and attitudes become the basis of group norms, and there are accepted ways of behaving within these reference groups. Group members who refuse to conform to the group norms become deviants and lose their influence within the reference group (Tully 1981, p. 80). For example, if one of the group adopts new agricultural technology without the tacit consent or the consensus of the reference group, his behavior may be seen by other group members as deviating from accepted group norms, and he may lose his influence in the community. In the T&V system new agricultural technology is communicated by contact farmers (CF’s) who have been selected by VEWs. The VEWs, however, are not members of these community reference groups. Although VEWs use simplified sociometric techniques to select CFs in Thailand, the CFs are probably regarded as deviants by their reference groups because of their close association with the VEW and their receptiveness to new technology. The new technology communicated by the CF may therefore not be adopted by other members of the reference group.

A research group at the Thai Khadi Research Institute at Thammast University has questioned the ability of the CF to carry out his expected role in the Thai cultural setting.

Expectation that the leaders must be the patrons giving assistance to their clients calls into question the Department of Agricultural Extension concept contact farmers, which is based on selected farmers who will assist in spreading the new practices to most farmers in the area quickly.

The researchers went on to detail the social status and financial assistance expected of leaders, who “are expected not only to come from a higher social level, but also to be a patron assuming expenses for others, which cannot be expected from a poor or average farmer” (Heim, Rabidhadana, Pinthong 1980, p. 3). Suschasupa, Comudon, and Wongsprasert (1983) also questioned the applicability of the CF concept in highland communities in northern Thailand, which practice shifting cultivation and have widely dispersed fields.

Principles of group dynamics can be applied in rural communities to elicit the collaboration of reference groups as a positive force for development programs. The problem census is one technique that can be applied effectively by VEWs after a short period of in-service training, even if they are relative strangers to the community. The problem census may be used to initiate agricultural development programs that are based on the consensus of the community and do not violate group norms; to overcome cross-cultural and other communication barriers between the rural bureaucracy and farmers; to reveal attitudes of farmers; and to initiate a process that can lead to group adoption of new technology. The method of conducting a village problem census has been described by Tully (1981, p. 81) and Crouch (1984, p. 16).

The problem census is a structured meeting at which all participants have the opportunity to contribute to the identification of agricultural problems (or other problems, such as health) and the assignment of priority to these problems by the rural community. At the meeting the village people divide themselves into small groups, ideally consisting of four to six persons. After a group recorder has been selected, the VEW gives the frame of reference for discussion. This may be a broad question such as “What are your main agricultural problems?” This is appropriate for a new VEW starting work in an upland village with
diversified farming systems. In a lowland irrigated area where the VEW has to implement a specific project—for example, an irrigated rice intensification project—it may be a narrow question such as “What are your main problems with paddy rice?” After about forty minutes of group discussion the group reporter or another person selected by the group reports the specific findings of the group to the meeting. I have been involved in more than sixty such meetings, many in villages where there are few literate people, and in no case did a group list fewer than four points in forty minutes of discussion. Where there are a large number of illiterate adults schoolchildren can act as recorders.

There will be some repetition of points recorded by the different groups, and the next step is for those present at the meeting to rank the points raised in order of priority. The whole process of conducting a problem census and ranking the problems takes about two hours and can involve large numbers of people (Crouch 1984, p. 27). The number of people involved and the subsequent steps taken to clarify the problems and to generate alternative solutions were noted by Napier and Gershenfeld (1981, p. 362):

Problem solving is a multidimensional process. It is quite possible to involve large numbers of people (fifty, one hundred, five hundred, or more) during the problem identification, diagnostic (clarification) and ideational (generating alternatives) phases. As suggested earlier, people feel quite differently about the solution they have to live with if they have been given a fair opportunity to participate and are aware of all the factors underlying an issue.

The steps in the problem-solving approach to agricultural development have been detailed by Lamrock (1966) in the Papua New Guinea extension manual and by Tully (1973). After the problem census one or more follow-up meetings will be required, and data will have to be assembled on the inputs and expected outputs of the various alternative solutions for agricultural development. In-service training sessions with the participation of the relevant subject matter specialists (SMSs) prepare the VEWs best for the subsequent meetings with village people. This preparation with the SMSs and the subsequent village meetings are highly structured situations in which the principles of production economics are applied through the consensus budgeting technique. The consensus budget is simply a gross margin analysis, compiled with the participation of everyone in the meeting. The SMS may be the expert on chemical inputs and expected yields, but often does not know much about labor inputs. The VEW and the farmers are usually most knowledgeable about labor inputs. Tully (1981, p. 82) observed that the whole group argues every budget figure. The VEW needs thorough preparation for the follow-up meetings in order to cope with a variety of solutions that may be proposed by the farmers. “The fact is that there are few problems that are closed and not open to a variety of creative solutions. It is the job of problem solving to help draw out the best alternatives and to break down artificial barriers, including those that psychologically bound the problem” (Napier and Gershenfeld 1981, p. 363).

Within a short time the VEW and the farming community will develop their skills on gross margin analysis and partial budgeting and begin to consider the whole farm picture involving the present utilization of farm household resources. An understanding of the family labor budget will be necessary when considering the range of alternative farm enterprises that could result in increased farm income. According to Brown (1979, p. 70), the collation of this data in representative farm models is one of the most important tasks in planning agricultural development:

The preparation of models is perhaps the most important feature in planning agricultural projects. Each model embodies the assumptions about the productive capacity of the farms it represents. The data for each model are arranged in the form of the various budgets discussed in earlier chapters. The budget for land shows what and how much can be produced; the labor budget shows whether family labor will be adequate for the production program and what additional labor might be hired; the budget for physical resources indicates the inputs required for the project.

Once the alternative development plans have been considered within the budgeting framework of production economics, the VEW and the farming community can develop a joint plan of action. If project or government inputs are available, these inputs will need to be carefully phased to coincide with periods when farm labor is available.
The supporting programs to train VEWs and farmers in the new technology can then be planned to fit within the normal T&V system training schedule. These training programs follow the same principles of adult education used in the problem census and consensus budgeting techniques. The farmer has a lifetime of experience, possibly within that one locality, which the younger VEW cannot duplicate. The VEW needs to recognize this experience, and the farmers need to be aware of this recognition, otherwise communication will cease and the extension work will be ineffective with that farmers' group.

To a child, experience is something that happens to him; to an adult, his experience is who he is. So in any situation in which an adult's experience is being devalued or ignored, the adult perceives this as not rejecting just his experience, but rejecting him as a person. Andragogues convey their respect for people by making use of their experience as a resource for learning. (Knowles 1979, p. 56)

In summary, the farmer-centered extension method (FACE) is based on principles of rural sociology, group dynamics, and adult education. It is necessary to develop the skills of VEWs not only in agricultural technology but also in the behavioral sciences, production economics, and adult education. These basic skills can be imparted to VEWs during fortnightly in-service training (Hoare 1980).

Compatibility with the T&V System

The T&V system of agricultural extension is now being implemented through World Bank loans in forty countries in Asia, Africa, Latin America, and Europe (Benor, Harrison, and Baxter 1984). However, it was emphasized at the First Asian Workshop on the T&V system in Chiang Mai in 1981 that T&V is a set of management principles rather than a new extension system (Cerner, Coulter, and Russell 1983).

FACE is a set of extension techniques based on scientific principles, which can be applied to develop agricultural extension programs either within the T&V organizational system or independently. In the foregoing discussion it was shown how the FACE methods could be fitted within the regular schedule of visits and training for VEWs.

Explicit reference was made to the T&V system, during the project preparation for the Highland Agricultural and Social Development (HASD) Project, but the project areas were outside the area of concentration for the DAE National Extension Project and the T&V system. The FACE method is being applied in a "promotional phase" within the HASD project until the DAE develops the capability to service the more remote upland areas in northern Thailand.

Developing the Extension Program

During project preparation for the Thai highlands subproject, three farm models representative of the area's farming systems were identified by the Food and Agriculture Organization (FAO)/World Bank preparation team (FAO/World Bank 1978): model A, subsistence farming and shifting cultivation; model B, opium growing; and model C, growing pickled tea ("miang"). A major objective of the project is to intensify agricultural production and to reduce farm size. The Royal Forest Department would then reclaim for afforestation lands to which the hill people have no legal title. This reduction in farm area would be compensated by the development of small-scale irrigation and rainfed terracing for food and tree crops. Arabica coffee was identified by the project preparation team as the tree crop to be promoted throughout the project area. The economic analysis was based on the adoption of coffee cultivation by most of the households in the project area (0.16 hectare per household).

In the first year of project implementation, a problem census was conducted in a tea-growing village in the project area, and the farming enterprises of each household in the village were analyzed. This study was done as a training assignment by the author with a team of seven agricultural graduates who had been newly recruited to provide technical and extension training assistance to VEWs implementing the HASD Project. The findings of this study were that the development model proposed (0.16 hectare of Arabica coffee per
household) was unlikely to be adopted by farming systems represented by model C. In a small area already
planted to Arabica coffee productivity was low because of poor root development and coffee rust; labor
resources in most households were insufficient to establish and maintain 0.16 hectare of coffee; and the
availability of land was limited by prior tenure and unsuitable soils (Hoare 1980). The average slope of the
existing tea gardens was between 55 and 70 percent on granite-derived soils, and terracing was identified as
a key recommendation (or impact point) for the adoption process.

However, budgeting procedures for project implementation had already been established on the basis of
project preparation documents, without reference to the reality in the field. Coffee seedlings were
produced at the Key Village Centers for the households in the tea-growing villages. The institutional basis
for project monitoring was the number of coffee seedlings produced in the nurseries, and this criterion
showed that the target for coffee cultivation was being achieved. In reality, however, there was minimal
adoption of the recommendations, in particular terrace construction. During the inception study to prepare
for Australian technical assistance and to aid the Thai government with project implementation, it was
found that few of the expected benefits of the project were reaching the farmers in the project area (ADAB

After the PWD accepted FACE as the extension strategy to be used in the HASD project, there was a
need to develop better communication between the VEWs and senior project management. This was
achieved through an annual budget-planning workshop attended by VEWs and senior management four
months before the commencement of the fiscal year. They attempted to tailor the project to the agricultural
development programs, which had their origin in problem census meetings in the rural communities, to the
ability of the existing staff to implement these programs, and to project objectives, with the assistance of the
Australian advisory team and the U.K. Overseas Development Administration coffee specialist.

In the tea-growing villages, gross margin analyses were compiled in the village meetings to compare the
expected inputs and outputs for their existing extensive “miang” tea system with those for Arabica coffee
and for intensive terraced tea. These analyses required about five hours per village to complete, and the
farmers participated in every step and supplied the data on labor. The results showed that Arabica coffee
should be the most profitable tree crop over a ten-year period, with the breakeven point at five. However,
the farmers chose the intensive terraced tea, even though the breakeven point was about year eight. The
rationale was that tea required a lower investment by the farmers, and their past experience indicated that
prospects for coffee were uncertain. The annual planning workshop offered a way for VEWs to include
support for planting material and fencing materials in the budget for fiscal 1982-83, and the adoption of the
recommended cultural practices for terraced tea convinced management to include tea as a component of
the agricultural development project in fiscal 1983-84. One difference between the smallholder tea project
and the other tree crop components was that terracing for tea was a cost to the farmer and required more
“sweat equity” (labor inputs).

Impact of Farmer-Centered Extension

For this preliminary assessment of the impact of farmer-centered extension, the “zone of concentration”
chosen was the extent to which the impact points made by the VEWs were adopted. This is only one of the
three zones of concentration defined by Cernea and Tepping (1977) and by Slade and Feder (1981). In
farmer-centered extension the VEW visits were replaced, during the development of the extension
program, by meetings (for problem census and consensus budgeting), which in some villages led to group
adoption of the new technology (see table 15-1, 1983-84 adoption figures for tea terracing for the villages of
Pahlo, Pang Mai, and Pang Tadt). This represented efficient utilization of extension resources.

The first harvest of tea leaf would not be for another four years, so the yield measurement was replaced
by an assessment of how well the recommended package of thirteen practices in the establishment year for
tea were adopted by the smallholder farmers. The Raming tea plantation, the best commercial standard in
the area, was used for comparison (Cernea and Tepping 1977, p. 19, 20; Slade and Feder 1982, p. 4).
Again, the key impact point in the adoption of new technology for highland tree crops is terracing, both to conform with government policy on soil conservation on steep slopes and to increase farm labor productivity when harvesting begins. The adoption of terracing by farmers after the introduction of the farmer-centered extension methods is shown in table 15-1.

The before-project baseline in 1979 for adoption of terracing technology was zero. The baseline for the first two years of the project was less than 1 percent (only five households had constructed intermittent terraces by hand hoe).

After the change to farmer-centered extension methods, the adoption rates for terracing for tea increased to 8 percent and 32 percent of households in fiscal 1982-83 and 1983-84, respectively. Factors

Table 15-1. Farmer's Adoption of Terracing for Rainfed Highland Tree Crops in Eighteen Villages in Northern Thailand, 1982-84
(number of households)

<table>
<thead>
<tr>
<th>Villages covered by VEW</th>
<th>Households per village</th>
<th>Households adopting terracing for tea</th>
<th>Households adopting terracing for fruit trees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1982-83</td>
<td>1983-84</td>
</tr>
<tr>
<td>VEW 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huey Tad†</td>
<td>48</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>Pang Geud</td>
<td>22</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Pang Viang Dong</td>
<td>28</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Pang Iad</td>
<td>21</td>
<td>—</td>
<td>15</td>
</tr>
<tr>
<td>Pang Hok</td>
<td>23</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Subtotal</td>
<td>142</td>
<td>10</td>
<td>58</td>
</tr>
<tr>
<td>VEW 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pang Ma-O'</td>
<td>30</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Pang Klang</td>
<td>20</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Pang Mai</td>
<td>8</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>Pang Nai</td>
<td>14</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Pang Hea Hia</td>
<td>12</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Pang Pong</td>
<td>12</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Chom Pu</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pang Huai Gang</td>
<td>24</td>
<td>—</td>
<td>6</td>
</tr>
<tr>
<td>Pang Sam Sop</td>
<td>12</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Subtotal</td>
<td>132</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>VEW 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pah Lo†</td>
<td>13</td>
<td>—</td>
<td>13</td>
</tr>
<tr>
<td>Pang Mai</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Pang Tad†</td>
<td>9</td>
<td>—</td>
<td>9</td>
</tr>
<tr>
<td>Pang Mae Mae</td>
<td>52</td>
<td>—</td>
<td>12</td>
</tr>
<tr>
<td>Pang Mae Sai</td>
<td>29</td>
<td>—</td>
<td>10</td>
</tr>
<tr>
<td>Subtotal</td>
<td>112</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>Total</td>
<td>386</td>
<td>32</td>
<td>125</td>
</tr>
<tr>
<td>Total adopting (percent)</td>
<td>100</td>
<td>8</td>
<td>32</td>
</tr>
</tbody>
</table>

Note: The eighteen villages selected were in the three VEWs' area of responsibility for extension activities and were the highland tea-growing villages inhabited by northern Thai that were included in farm model C by the project preparation team. The two exceptions are the Lahu hilltribe villages denoted by note d. The sample covered more than 80 percent of all tea villages and the VEW areas where the majority of the population were tea growers.

a. The "sweat equity" provided by the farmers for terrace construction by hand hoe, holing, fencing, planting, and weeding of the tree crops was linked to free government inputs of fencing materials and planting material. These government inputs are being reduced in fiscal 1984-85 and 1985-86 by the establishment of village nurseries with voluntary labor and the use of local materials for fencing.

b. The 1983-84 (fiscal year) figures include those farmers who first adopted the new terracing technology in 1982-83. More than 90 percent of those farmers who terraced for tree crops in 1982-83 also terraced in 1983-84, but in many cases their choice of tree crop changed within the span of only one year.

c. The village in which the VEW was based.

d. Lahu hill-tribe villages.
other than the extension method contributed to increased adoption of the new technology (for example, the projects’s improved management of the phasing of government inputs to match the availability of farm labor). However, many of these external factors were related to the better knowledge of the existing system gained through application of the farmer-centered extension method.

The rapid adoption of terracing technology in the project area and the linkage with new technology on tea establishment and maintenance are surprising when considered in historical perspective. Except for improvements in transportation, there have been few technical innovations in this industry in northern Thailand during this century. Previously tea was planted by dibbling seed into forested areas (Keen 1972).

The farmers' sweat equity for the terraced tea in worker days per hectare were: 10 to 120 for clearing vegetation, 72 to 130 for terracing, 20 to 72 for digging holes, 20 to 24 for planting, and 50 to 240 for weeding.

In some villages there was a change in the preferred tree crop from tea to pomello within one year (see Pang Klang and Pang Nai in table 15-1). The reason was the lower labor input required for weeding pomello (160 trees per hectare) as compared with tea (6,250 trees per hectare) when the farmers were fully employed picking tea leaves, and the perceived higher gross returns. This changeability is of considerable importance for project preparation and implementation, which needs to be flexible. Such flexibility is inherent to farmer-centered methods during project implementation.

**Direction of Future Research**

Only one of the farm models—model C, covering less than 10 percent of the project population—has been discussed in this preliminary study. But a similar pattern of increased adoption is emerging where farmer-centered extension methods have been applied to other project components such as small-scale irrigated terrace development and irrigated rice yield increase (Hoare and Wells 1984).

This study has shown that, for upland and highland rainfed areas in northern Thailand, agricultural development programs that are not farmer-centered may result in inefficient use of limited public resources and low rates of adoption of a new technology by farmers. As a result of the application of farmer-centered extension strategies, combined with supporting training programs and improved project management to ensure that government-assisted inputs are received when farm labor is available, the flow of project benefits to farmers markedly increased within one year. It is suggested that alternative models be sought during project preparation and project implementation in upland rainfed areas of the region, since the minimal adoption by farmers of terracing for tree crops before 1982 was due in part to deficiencies in project preparation. One such model involving extension and rural communities in project identification and planning in a sample of villages from the proposed project area was described by Hoare (1984, p. 37). These farmer-centered models would involve VEWs, SMSs, and the rural communities in project identification and planning.

**References**


SECTION V

Overview
Although this volume focuses on agricultural research and extension linkages mainly in Asia, as did the Denpasar workshop at which the authors refined their arguments, the issues discussed and the solutions suggested apply, to a greater or lesser extent, to other developing countries outside Asia. Extension and research practitioners, planners, and students elsewhere may find here much that is relevant to their particular circumstances.

The previous sections of this volume clearly indicate that a broad consensus exists within the Asian research and extension communities on at least four major points.

First, to develop genuinely substantive linkages between agricultural research and extension, there must be increased emphasis on on-farm research, with special attention to feedback from extension staff and farmers. Such feedback is essential to complement more conventional programs of experimentation in agricultural research stations, which in the past have been confined to individual crops and livestock and have taken too little account of the economic, social, and cultural conditions of the people. Without the support and understanding of the people who do the farming, the recommendations of such programs cannot and will not be applied.

Second, to be effective this increased emphasis must be accompanied by greater interdisciplinary collaboration among researchers and between researchers, farmers, and extension staff working in the field. A basic principle of the training and visit (T&V) approach is the participation in on-farm research of extensionists—whether they work at the village or district level as subject matter specialists—and of the managers of research units at all levels.

Third, it follows then that all agricultural institutions, policies, and procedures must be more responsive to the interests and needs of all farmers, particularly to the vast majority who are small farmers, and at the same time they must be responsive to national economic development goals. These two requirements can be mutually supportive.

Fourth, management of the linking processes is of the essence. Whether of research or extension, it must be alert, dynamic, and responsive to local and national needs. Above all, management must be aware of the interdependence that surely exists between the farming population, the staff of the extension system, and the researchers who support them and who depend to a large extent on farmers and extension staff for guidance as to what needs to be done.

These four major points involve a much wider range of specific issues of varying importance in different country and agroecological situations. Some key specific but common issues on which it is possible to generalize are:

- The role of farming systems research (FSR) and diagnostic surveys in improving the identification of the problems faced by farmers in their search for enhanced productivity
- The role of subject matter specialists and the development of their competence
- The relevance of monitoring adoption rates, with particular reference to the phenomenon of partial adoption
- The development of farmer participation at all stages so as to promote continuous back and forth communication in the system
- The need to take full account of technical, economic, sociocultural, farm management, and institutional and policy considerations in the design and implementation of both research and extension programs.
These issues were selected, from many others, to be considered in some detail because of their pivotal impact on the success or failure of research and extension programs. The pages that follow draw heavily on the contributions included in this volume and the debate from which the volume was generated.

The Role of Farming Systems Research

The ultimate objective of farming systems research (FSR), indeed that of any adaptive agricultural research that seeks to generate new technologies, is to increase farm and farmer productivity and thereby farm and farmer income. Because production problems are manifold in any farming system, wherever it is practiced, they must be ranked not only according to the extent to which they constrain productivity in the particular system, but also according to their potential for solution. A judgment should then be made on the basis of these two criteria for the allocation of resources for addressing them. Production problems can be ranked realistically only by a systematic approach. The first step is to develop and subsequently to apply a methodology for determining and defining the problems as they affect the farmer and his farming system. While farming systems research can mean different things to different people, if it is to be relevant it must generate findings that, when applied, will result in increased productivity on, and increased income from, the farm.

Such findings depend at the outset on an accurate assessment of the problems to be investigated. In other words, before any agrotechnical research is contemplated, the farming systems extant in a particular ecological and socioeconomic situation must be identified. A diagnosis must be made of their characteristics, of the relations between the key factors that shape them, and of the constraints that prevent them from optimizing their potential benefits.

Such diagnostic surveys must be concerned not only with technical considerations but also, and often more importantly, with the impact of sociocultural and economic factors on the system as practiced at the farm level. It follows then that a multidisciplinary approach, comprising agronomic and possibly animal production research skills together with the skills of a socially oriented farm economist, is essential if the survey is to be meaningful. The farm economist in particular must investigate and evaluate how and why the farmer makes decisions to allocate his land, labor, and other resources to different crops, livestock, and off-farm activities; and how, by his management of the major factors of production in the ecological and economic environments of his holding, he satisfies his family's priorities. In this regard, a correct perception of the sociology of the farm family is imperative, and analysis of the sociological as well as the economic characteristics of the farm unit must be part and parcel of FSR studies.

Having established the technical problems and apparently poor technical practices that characterize the system, the team must determine their causes and decide the extent to which they are susceptible to solution. Thereafter, the technical and socioeconomic interventions already developed on research stations must be inventoried, and the possibly relevant technology subsequently tested on farms. Such on-farm trials are carried out with assistance from the extension service and with active participation by the farmers themselves. The primary purpose is to validate the applicability of research station results to farmers' conditions and to feed back to the research station information on the relevance of the technology. Where the technology is not relevant there will be need for minor, or perhaps major, adjustments to meet the conditions of the client farmers in the system. The two-way mechanism thus established effectively links the research system with the farmer via the extension system, so that research can be continuously and adequately responsive to the circumstances on the farm.

Where no apparently relevant technology exists but there are prospects for its development, it is incumbent on researchers to design programs that try to solve the problems identified. The initial investigation will be under the tightly controlled conditions of the research station, and the results will be subsequently verified on farmers' fields as described above.
The Role of Subject Matter Specialists

Much has been written and said about the pivotal role of subject matter specialists in promoting and sustaining research-extension linkages. In many countries, the SMS is seen to be the weak link in the chain binding researchers, extension workers, and farmers in their efforts to increase farm productivity and farmers' incomes. It follows then that efforts to recruit (where needed), train, and develop this cadre of staff deserve a very high priority in all countries. In those with rudimentary linkages between research, extension, and farmers, the SMS is a potential catalyst to bring all parties and their sometimes conflicting interests into a mutually supportive continuum of endeavors. In countries where the linkages have been formed and agriculture and farmers have reached, or are reaching, comparatively advanced levels, the role of the grass-roots extension worker is becoming increasingly specialized, blending into that of the specialists in a subject matter of particular relevance to the farming system in question.

But no matter what level of agriculture is practiced, and no matter how confluent the activities of research and extension workers, there can be no argument that the role of the subject matter specialist in technology testing and in translating and transmitting farmers' assessments of its validity to researchers is, and will remain, vital. It is the SMS who, sometimes with the assistance of researchers and sometimes not, helps extension staff lay out on-farm verification trials on sites deemed suitably representative of the client farming population. It is the SMS who assists and advises extension staff in the conduct of trials, and it is the SMS who collects and collates their results for incorporation into new, refined extension messages or for consideration by researchers in designing additional research programs.

Perhaps equally vital is the role of the SMS in training extension workers in the elements of the technology to be transmitted to farmers. For it is upon these training skills that the accuracy of the extension message and its subsequent delivery to farmers indirectly but ultimately depends. The SMS must interpret research station results, assess their relevance and readiness for on-farm verification trials, and convey such information to field-level extension staff. In addition, the SMS must support extension staff in the field, assess and respond meaningfully to extension agents' interpretations of farmers' problems, and where necessary establish the validity and extent of such problems.

These roles require that the SMS be trained to an appropriate level of general understanding of the farming system(s) in his geographic area of responsibility. He should also have specialized training—ideally with at least a masters' degree—in a relevant area such as agronomy, pest and disease control, or livestock production so that he can truly claim to be and, more important, be seen to be a specialist in his field. Of equal importance, the SMS must be fully competent to train others, for without this capability the SMS cannot effectively transmit his knowledge and specialized skills to those he is employed to support. Knowledge transmission in this context is used in the broadest sense: the SMS must not only transmit new knowledge in the form of impact points and follow-up to extension workers, but he must also convey to research workers, and, if necessary, convince them of the validity of the need for different directions or new programs in their investigations.

As agriculture develops and intensifies, the SMS must also develop his skills and specialization. Just as the field-level extension worker must maintain a higher level of relevant skills and knowledge than that of his farmer clients, the SMS must similarly maintain a higher level of relevant skills and knowledge than that of the extension workers. Further, he must be seen by the research community servicing the extension system to be fully alive to the research needs of extension and equally alive to, and persuasive about, the relevance or inadequacies of the research community's output.

It is unlikely that many countries will be able immediately to deploy an adequate number of SMSs capable of completely fulfilling these demanding roles. But it is imperative that priority be given to recruiting, training, and supporting this cadre of staff. Unless such priority is assigned and sustained,
adequate research-extension linkages cannot be created or maintained, and the integrity of both the extension and research systems is bound to be irrevocably compromised.

Monitoring Adoption Rates

Precise measurement of the impact of extension programs is difficult for a variety of reasons. If impact on production is taken as the criterion, such factors as weather, the timely and adequate supply of inputs, farmer incentives, and the spontaneous adoption of recommended practices fog the measurements of the effects of extension itself. While research on this complex issue proceeds, results are subject to a variety of interpretations and will inevitably vary in different circumstances.

One means of measuring extension impact is to monitor adoption rates, from which production gains can be extrapolated, but such monitoring has other, and arguably more important, benefits. The rate of uptake of recommended practices, in whole or in part, clearly indicates the extent to which the client population perceives them to be relevant. Having established uptake rates, by a survey or other objective means, extension and research managers can then establish whether—and, more important, why—extension recommendations have or have not been successful. Thereafter, and preferably very shortly thereafter, they should identify the relevant factors and take whatever corrective action is appropriate.

Corrective action may be comparatively simple—such as merely fine-tuning an extension recommendation. It may, however, be complicated and difficult if, for example, terms of trade for a particular crop or enterprise change substantially and thereby invalidate a recommendation developed under more favorable circumstances. In such cases it may well be necessary to investigate whether the terms of trade can be returned to their former condition—by government intervention or by anticipated improvements of producer prices in the free market. If such changes are impossible or appear unlikely, there may be a need to undertake and evaluate further diagnostic surveys of the farming system(s) affected and then formulate new recommendations for extension suitably attuned to the conditions encountered by farmers.

The point here is the importance of monitoring and evaluating the effectiveness of both research and extension systems and the need for extension and research managers to act promptly on this information to take the corrective action indicated. Greater use should be made of systems of monitoring and evaluation in both research and extension to strengthen and institutionalize the links between them.

Feedback from monitoring and evaluation enables both managers and policymakers to make rational decisions on the adequacy of particular recommendations. It also helps them determine the appropriateness of the resources devoted to technology development and dissemination, the effectiveness of the dissemination process, and the extent to which resource allocations or other relevant factors require examination and adjustment.

There is general agreement that insufficient attention has been given in the past to adoption rates in particular, and to monitoring and evaluation in general. The behavior of farmers—especially the large proportion who are partial adopters or who flatly reject recommendations—is deserving of careful and continuous study. To be meaningful, such studies must take account of the sociological perspective and view the family farm as the real-life framework within which the technical and economic aspects are analyzed. The results of these studies should be examined to extract lessons for improving the extension and research systems concerned.

Finally, greater efforts are needed to improve sociocultural analyses and ongoing evaluation studies so that partial adoptions can be more intelligently interpreted.

Development of Farmer Participation

There is no question that farmer participation is essential if two-way lines of communication between research and agricultural practice are to be established and maintained. At the present time in most
countries farmers' participation in the identification and subsequent follow-up of production problems is more or less inadequate. Because of the dynamic nature of agricultural production, and therefore of its problems, such participation must perform be an iterative process.

Farmer participation is important at all phases: during the diagnostic phase of farm systems research before the new technology is generated; during the testing of the technology on farms and perhaps even on the research station itself; certainly in the demonstration phase; and in the evaluation of the technology's acceptability, when technical, social, economic, cultural, and institutional constraints are taken into account.

Farmers selected as contacts for extension agents obviously need to be willing and active participants, but they must also represent the main strata within the farming population of the area. Depending on the nature of local social organization and other conditions, such contacts may be either individuals or groups, provided they fulfill the criteria of being both willing and representative of the farming population to which they belong. Nor should it be forgotten that in many countries women play an active role in farming operations and therefore have as much feedback to contribute as the men in all phases of the research and extension process.

Care must be taken to ensure that the participating farmers recognize the importance of their task for the successful implementation of research and extension programs. Their accountability to their constituents should be fostered—for example, by disseminating records of their contributions to meetings with research and extension workers. There is also much to be said for the maintenance of records of problems posed by farmers. This will help farmers draw attention to outstanding issues that continue to require research or extension action and will foster the responsiveness of research and extension workers to these problems.

Throughout this book attention has been drawn to a need that exists even where research and extension systems are operating with a reasonable degree of harmony and that is even more urgent where this desirable state of affairs has yet to be achieved. It is the need for all concerned to recognize that conditions are dynamic and subject to quite rapid change and that systems must be responsive to both internal and external stimuli. In general, this need is nowhere more apparent than when moving from consideration of primarily technical problems of single commodities toward concurrent consideration of the entire farm enterprise and the interaction of its components. At the same time, and almost by definition, focus on the entire farm enterprise calls for significantly increased attention to both economic and sociological aspects in the design and implementation of research and extension systems and their intimate linkages.

This broadening of perspectives calls for recognition of the constraints (funding, manpower, and facilities) on planning and implementation in both research and extension and requires a strict ordering of priorities. Such priorities must take account of national development goals, just as realistic national development goals must take account of what is technically, economically, and socially feasible in the agricultural sector.

Complex policy and administrative steps, often with far-reaching implications outside the agricultural sector, may well be needed to effect even simple procedural and institutional changes. In many countries policies sometimes appear contradictory, as when budget allocations for research or extension tend to be cut despite apparently broad national agreement about the importance of agricultural development. Similarly, there are often administrative difficulties in ensuring that there is no conflict between national goals and local or regional development efforts in executing research and extension strategies.

Although the universities and other relevant centers of learning provide the raw material for both research and extension systems, there is perhaps a need to reevaluate their training of manpower and to revise their curricula to meet changing requirements. There is also a need to integrate research and extension more closely in both the teaching and research spheres. These considerations are particularly valid in the light of questions about the need for and feasibility of giving extension staff a professional cachet similar to that long held and cherished by researchers.

Finally, there are grounds for promoting, at the highest levels of government, a better understanding of the role of extension and research and of their relationships in the formulation of national agricultural policy. Among other things, governments must recognize that universities and other centers of learning
have many more functions than the mere granting of degrees and diplomas and that these functions are of pivotal importance to improving institutional linkages and hence the performance of research and extension in meeting national development goals.

More specifically, the training and visit system of extension must, without sacrificing its basic principles of regularity and the continuum between farmer, extension, and research, take account of different country and regional conditions and evolve to meet changing circumstances. In some countries these changing circumstances are throwing up secondary problems and challenges with which many planners, researchers, and extension managers are grappling. This volume, like the Denpasar workshop, has sought to define the more important of these problems; they have been debated openly from the perspective of different countries and organizations, and ways have been suggested of tackling them. The editors trust that at least some of the broad and deep experience represented at Denpasar has been captured in these pages.
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The most recent World Bank publications are described in the annual spring and fall lists. The latest edition is available free of charge from Publications Sales Unit, Department B, The World Bank, Washington, D.C. 20433, U.S.A.
Although agricultural research and extension have common objectives, the lack of close coordination between them often limits their ability to help farmers effectively and to contribute to agricultural development. This volume reviews and analyzes actual experiences—successes and failures—with linking research and extension in several Asian countries.

Four main themes are addressed: policy and institutional dimensions of building up the linkages between research and extension; the identification of farmers’ most urgent production problems; the generation of improved technology and its on-farm validation; and the joint formulation of extension messages by extension and research staff.

Prominent researchers, policymakers, managers of research and extension services, and social scientists from India, Indonesia, Pakistan, the Philippines, Sri Lanka, Thailand, and elsewhere have contributed to the discussion. They argue that technological know-how can best be incorporated into various farming systems if extension is used to build a continuum between research and its ultimate beneficiary, the farmer. The authors advocate the continuum as a two-way communication process, with each of the three factors reinforcing the work of the other two.

**World Bank Books of Related Interest**

*Agicultural Extension by Training and Visit: The Asian Experience*
edited by Michael M. Cernea, John K. Coulter, and John F. A. Russell

One of the most promising ways of achieving mutually reinforcing and open communication between agricultural researchers and farmers is the training and visit (T&V) system of agricultural extension. Extension managers and evaluators from six Asian countries and six discussants present their analyses. They address farmer adoption of improved technologies, the research-extension interaction, training, system management, and monitoring and evaluation of farmers’ reactions to extension. The valuable, first-hand experience documented here will be of use to agricultural policymakers, project designers, sociologists, extension workers, and agricultural researchers.

*Training and Visit Extension*
Daniel Benor and Michael Baxter

This comprehensive explanation of the organization and operation of the T&V system of agricultural extension was refined from a series of operational notes on the system’s structure and function. Intended mainly for use by extension staff at all levels, agricultural research personnel, trainers, and administrators, it is both a methodological guide and a training resource.

*Putting People First: Sociological Variables in Rural Development*
edited by Michael M. Cernea

This book discusses several culturally sensitive approaches to the preparation, planning, and implementation of rural development projects. It emphasizes the importance of analyzing the social organization of rural populations and their modes of production and provides models for using such analyses in the design of agricultural programs, livestock and forestry development projects, land settlement programs, and similar efforts. Sociological methodologies for operational development activities are also discussed, together with procedures for evaluating the social impact of projects and collecting social data rapidly in the field.

The difficulties encountered when rural development projects do not “put people first” and the various strengths and weaknesses of development interventions are considered, with many examples drawn from World Bank-assisted projects in different countries. The criticism of existing limitations in project preparation is combined with sociological guidelines and practical recommendations on how to increase the involvement of local people in rural development programs and facilitate the creation of grass-roots organizations.

This publication will be of interest to sociologists, economists, social anthropologists, development practitioners, project planners, agriculturalists, foresters, irrigation engineers, and students of social change.