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Shaping the CGIAR's Future

IAEG – Factors Affecting the Adoption and Impact of CGIAR Innovations. A Synthesis of Findings

Attached is a synthesis of findings from the case studies. This is circulated as background to agenda item 7, iv, "Presentation and Adoption of Case Studies" which is scheduled for discussion in parallel session.

The IAEG Chair will report on the results of research conducted in cooperation with the centers. At the conclusion of the discussion, the session chair will summarize the decisions reached.

CGIAR

Factors Affecting the Adoption and Impact of CGIAR Innovations:

A Synthesis of Findings

A report to the Impact Assessment and Evaluation Group (IAEG)

By

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FOREWORD

The IAEG-sponsored project "Factors Affecting the Adoption and Impact of CGIAR Innovations" had its genesis at the CGIAR impact assessment and evaluation workshop held at ISNAR in April 1996. Centers and NARS participants identified case study methodology as potentially one of the more useful evaluation methods for assessing impact which could be used by CGIAR evaluators. The evaluators requested further training in the methodology.

The IAEG received advice that Prof Lee Sechrest from the University of Arizona is credited with developing case study methodology for rigorous and credible impact assessment. The IAEG thus commissioned Prof Sechrest to conduct a workshop (held in February 1997) in the use of case study for impact assessment and for designing potential studies. The workshop was attended by evaluators from seven Centers and a number of NARS. Prof. Sechrest was engaged to provide on-going advice to participating Centers to ensure that appropriate design and rigour was applied to the nine studies that developed at the workshop – a tenth study from ISNAR was already underway and was later included in the project in an attempt to add an institutional aspect to the project.

Nine studies in the project have been completed, or nearly completed, and the results discussed at a synthesis workshop held in Hawaii at the end of June 1998. The workshop was attended by the senior Center investigator from each participating Center and a collaborator from a NARS partner. The workshop initiated an integrated analysis of the findings of the individual case studies. The workshop also discussed a draft paper on technology adoption commissioned as part of the project.

The Arizona group has a background in the social sciences and has worked mainly in sectors other than agriculture. This has brought an external perspective to the question of adoption of agricultural innovations. The points that the report makes about adoption are synthesized from the individual studies. The report is constructed so that each section starts off with an assertion that is then followed by references to the case studies. The references to the case studies should be read as illustrations of the kinds of findings that support these assertions rather than as the assembly of the evidence. The assertions were arrived at after perusal of the case study reports and interactive discussions during and following the workshop in Hawaii.

Some of the important assertions came about not because of any direct evidence but because evidence for the consequences of their absence was so compelling. There is no direct evidence for the proposition that effective promotion of adoption requires a comprehensive and coherent plan to achieve it. But what did become clear is that adoption is a quite uncertain and incomplete process when there is no plan.

An important follow-on from this project is that the CGIAR benefit from the points made by these studies, with an expectation that the probabilities of adoption of CGIAR innovations will improve in the future.

This synthesis report to the IAEG is one of three documents emanating from the project. A project overview was reported to the CGIAR at ICW 1997 and the Executive Summaries of the nine individual case studies are available in a companion volume at ICW this year. There is also a report of the initial familiarisation and planning workshop.

We propose that full accounts of each study will be available on the CGIAR Website and that each study will be independently published. We have also been negotiating for shorter versions of these impact studies and the synthesis to be published in a special edition of a leading Evaluation Journal.

IAEG
October 1998

INTRODUCTION

A series of studies having to do with determining factors associated with the adoption of (CGIAR) agricultural innovations by farmers in developing countries was carried out in 1997-98 under the auspices of the Impact Assessment and Evaluation Group of the Consultative Group for International Agricultural Research. These studies, although among them employing a wide range of methodologies, were planned in such a way as to facilitate a synthesis of their findings with respect to a set of issues of generic interest to the international agricultural research community, particularly to donors who support such research. In effect, each of the separate studies can be regarded as a case study in the adoption of one or more technological innovations, most, but not all of which, were at the farm level.

That the separate projects should be regarded as case studies was planned from the beginning. The methodology was guided by a standard protocol for case study research (Sechrest, Stickle, Stewart, and Sidani, 1996) that had been developed in order to increase the rigor of case studies and their acceptance in the scientific community.

International agricultural research results in many and diverse technological innovations, some that might be considered "hard" technology (e.g., materials) and some that might be considered "soft," (e.g., husbandry practices). These technologies often have their origins in one of the international agricultural research centers, but they emanate more immediately from some organization within the National Agricultural Research Systems (NARS)[i]. They are meant to be disseminated within those systems to individual farmers. At the time the technologies are promoted by agricultural organizations, they all appear to be effective, or at least to have good potential for being so. Yet, the course of adoption of these technologies by farmers uncertain and often very slow. It is important to know why the uptake of innovations is so variable. Technologies that are developed at great cost, and many are quite costly, and not taken up are wasteful of resources, both monetary and human.

Even if innovations are widely adopted, however, they may not have all their intended effects, or they may sometimes have effects that are unintended but harmful. For example, some donors appear to want the research they support specifically to improve the lot of women in developing countries. Adoption of some technology or other might have a generally positive effect on agricultural productivity, but that productivity might be very much to the benefit of men rather than to women and, hence, might not be considered optimal. Or an innovation might be highly attractive but require heavy initial investments that could never be recovered under the circumstances prevailing in some farming areas. As noted, innovations could even be harmful, e.g., if they increased the use of child labor. Innovations may also have harmful effects on environments such as land degradation and deposits of chemical residues.

It should be important, then, for the agricultural research community at all levels, from in the field to the donor organizations, to know how the appropriate adoption of technological innovations can be fostered. The studies reported on here each provide useful perspectives on and information about adoption factors, but they also represent to some extent the unique interests of their authors and the singular characteristics of each of the innovations and the sites in which adoption was studied. The aim of the analysis reported on here is to abstract from the several studies, which, we reiterate, are being treated as case studies, the common elements that can be brought to bear on particular adoption issues. The aim is then by careful analysis and judgment to achieve a synthesis of those elements so as to permit integral, coherent conclusions.

Some of the conclusions will be on firmer ground than others; some will have to be regarded as no more than hypotheses for potential future tests. Generally, however, the synthesis is meant to serve the same purposes as would a more formal and statistically sophisticated meta-analysis of the results of a series of quantitative investigations.

In fact, all the studies involved in this synthesis were to a considerable extent quantitative. Case study methodology is often seen as qualitative and intuitive, but what is distinctive about case studies is their singularity coupled with arguments for their generalizability. The nature of the data collected for the case is not a crucial feature of the case study. These case studies examined the adoption of various types of innovations; the innovations ranged from new hybrid seed varieties to organizational change. For the sake of brevity, the topics and agencies involved in the case studies are summarized in below.

CASE STUDY TOPIC	AIMS	INVESTIGATORS
Improvements in groundnut production technology in Vietnam & India	To achieve understanding of the adoption process and develop strategies to improve the adoption of improved seed, water, soil, and nutrient management practices for groundnut production.	ICRISAT Vietnam and India NARS/NGOS
Improved maize varieties and crop management practices in Ghana	Examine the factors that have influenced the adoption of a complex package including seed of improved maize varieties, fertilizer, and planting practices.	CIMMYT and the local Crops Research Institute
Cassava processing technology in Brazil	To assess the factors influencing the adoption of cassava processing and production technologies.	CIAT EMBRAPA SEC AGRIC CEARA
Innovations in post-production technologies for rice in Philippines and Vietnam	Identify stages in the process of research, development, and transfer of technologies and how improvements in this process can be made.	IRRI PhilRice IRRI-GTZ UAF

Factors influencing awareness and adoption of sorghum varieties in Nigeria	Identify both facilitating and constraining factors that influence the awareness and the adoption of improved sorghum cultivars and develop strategies to enhance it.	ICRISAT India and Nigeria NARS/NGOs
Smallholder dairy technology in Kenya	Understand factors affecting adoption and estimate of impact of intensification of smallholder dairy production.	ILRI KARI Ministry of Agriculture, Ministry of Health

CASE STUDY TOPIC	AIMS	INVESTIGATORS
Crop descriptor lists used by gene banks	Assess adoption of the crop descriptors and their influence on use of genetic resources for maize, coconut, and banana	IPGRI Gene banks
International Musa Testing Program	Assess the efficiency of the IMTP as a link between breeding programs, NARS, and farmers in managing Musa research.	IPGRI INIBAP Musa Breeders
Indicators for Sustainable forest management	Prospective case study of the adoption of the criteria and indicators for sustainable forest management. NOTE: This study is not included in the synthesis.	CIFOR C&I Research Project
Enhancing organizational effectiveness	Analyze the experiences of ISNAR in promoting planning, monitoring, and evaluation and development strategies to improve organizational capacity in Latin America countries.[ii]	ISNAR NARO NARS

In addition to the variety of innovations, the targeted end users for these also varied greatly. Some innovations were destined directly for farmers fields while others aimed to impact the functioning of organizations. The innovations studied in the case studies described below had numerous end users and it is important to understand the flow of information and technologies from the international research Centers to the target beneficiaries, the farmers and their communities. The success of the CGIAR is assessed by the effect the research has on food security, poverty and the environment. The aspect of the CGIAR international research laboratories that makes them especially different from others is that they are reliant on national intermediaries for dissemination, demonstration, adaptation etc of farm-level technologies. The International Agricultural Research Centers (IARCs) provide research technologies to in-country institutions (sometimes referred to as National Agricultural Research Organizations or NAROs) and work with them to develop the production technologies for use by farmers. The IARCs do not have a mandate, however, for interacting directly with farmers. If the performance of NAROs is poor and their links with producers are poor, the IARCs can end up supplying irrelevant technologies because they are not in direct touch with the end users. The critical part of the adoption process for the CGIAR centers then is their relationship with these intermediaries and it is the complexity of the relationships between the multitude of players that is the make or break in the adoption process. It is of distinct interest to know whether the factors that influence changes in behavior of the staff in NAROs are different from those influencing farmers.

The intermediaries, the NAROs, are diverse in many respects, including in their relationships with end-users of technologies. Very few, if any, NAROs are likely to have resources that are adequate to the full range of activities that might be expected of them, and they undoubtedly differ in the aims and competencies of their staffs. Moreover, the end-users with whom the intermediaries relate are similarly diverse, ranging from uneducated peasant farmers to sophisticated agriculturalists. Local situations vary widely, and the politics of food production, poverty, and social change are enormously complex. An enormously wide range of variables need to be taken into account in the development of adoption strategies.

Obviously, it would have been highly desirable to have obtained information on the role of institutions and organizations in fostering adoption of innovations, and original plans for these studies provided for observations at that level. In the end, however, resource constraints made it impossible to collect data on NARO involvement in the adoption process, and most of what can be concluded here is at best inferential. That study remains to be done.

Adoption is a complex, multi-level process

Adoption of agricultural innovations may in some few instances be a simple, straightforward process. For example, adoption of a plant variety that is resistant to a disease but otherwise not different from its predecessor should not pose any difficulties beyond distribution of the material. Models required to describe the dissemination and adoption process under such circumstances should not require any particular complexity. In fact, however, most innovations, and certainly most of those studied in the projects reported on here were complex and need accounting for at different levels and from the perspectives of multiple organizations and actors.

> As shown in the Ghana case study, even a seemingly simple decision to apply fertilizer is complicated because the use of fertilizer requires analyses and planning in order to carry out the fertilization program correctly. Some farmers did not maintain the use of fertilizer for that reason.

Innovations do not necessarily come neatly packaged and ready to be used in the field. They often require adaptation and adjustment, field-testing and correction before they can be expected to be adopted on a widespread basis. Innovations are often not one-dimensional; they actually may constitute systems of inter-related parts that are meant to be adopted as a whole. The parts of a system may consist of materials, of acts to be undertaken, and even of schedules of acts organized by time and space. Adaptation of the innovation may result in only part(s) of the system being taken up, e.g., as might be represented by the use of a new plant cultivar but not with full implementation of procedures specified for planting and cultivating.

The process of adoption may also occur through time with active participation and feedback from early adopters to the promoters, or even the originators, of the innovation. That will be more likely for some innovations than for others. It would be more likely, for example, for innovations that lend themselves to trial and error “tinkering,” and that do not necessarily require high levels of technical knowledge and skill. Modifying plant cultivars, for example, is usually a slow process that requires the specialized knowledge and skills of plant breeders, some of whom, of course, may themselves be farmers. Modifying a planting arrangement or schedule may require no knowledge beyond that already possessed by farmers, and feedback on its acceptability and perhaps even efficiency can be gained in fairly short periods of time.

The development, testing, and promoting of agricultural innovations requires several levels and types of activities that are not likely to exist within any one organization. Plant breeders or soil chemists, for example, may have relatively little direct contact with extension agents and farmers and may have only limited knowledge of local factors that may determine whether a farmer will adopt an innovation. Conversely, extension agents who work with farmers may have limited channels of communication back up the innovation chain as they acquire critical knowledge about what is going on in the fields. Agricultural research and innovation appears sometimes to suffer from a disconnect between the enterprises that devise innovative materials and practices and the enterprises that should be promoting them in the field. There is a seam in what should be a seamless process. Scientists in research centers should be developing innovations that, when ready for release flow naturally out into the field, into the hands of organizations with the capabilities of and interests in promoting their further testing, development, and adoption. Those same organizations should also be in a position to receive feedback on performance of the innovations in the field and further needs for innovation, and that information should flow just as naturally back to the research centers.

THE ADOPTION STUDIES

Adoption of New Technologies for Groundnut in India and Vietnam: Assessment Using Focus Group and On-Farm Surveys

Purpose of the study

Efforts are being made to improve the technology for groundnut production in both India and Vietnam. The technology encompasses the use of improved cultivars, better water use, proper soil conditioning and planting practices, and nutrient management practices. The aim of the study was to improve understanding of the adoption process and the factors that facilitate and impede the adoption of improved farming technology by taking advantage of the opportunity to compare and contrast the experience in two quite different countries.

Methodology

Data for the study were collected in a series of focus groups, each involving from 9 to 15 farmers, carried out in each country and in subsequent on-farm surveys. The surveys involve multi-stage stratified random samples of villages and of farmer-respondents within them. A total of 355 farmers in Maharastra state in India and 230 farmers from six districts of Vietnam participated in the survey.

Findings

In both countries farmers were selective in adopting the total GPT "package," taking up those parts that seemed to suit their needs, that were most readily affordable, and that were least disruptive with other practices. In India those farmers who adopted the recommended planting scheme, called raised-bed and furrow were far more likely to adopt an ICRISAT groundnut variety (65% to less than 10%). In Vietnam improved groundnut varieties are beginning to replace the local variety, although limitations have been found for the suitability of improved varieties in some areas. Other components of the GPT such as seed dressing are being taken up gradually (40% in India), but other soil and water management practices are at much earlier stages in the adoption process. Adoption of components of GPT is evident in Vietnam, including increased use of an improved fertilizer and some decline in use of pesticides. Data from India indicate a reasonably good internal rate of return on investments in GPT, with most of the benefits accruing to producers (farmers). In both countries, infrastructure problems proved to be limiting factors in adoption, particularly poor seed availability and, in India, lack of assistance in developing capability for raised-bed and furrow planting. Moreover, in Vietnam many farmers were not aware of the improved production package, and a very large proportion lacked capital and faced high labor costs.

Implications for adoption

Systematic and comprehensive planning for adoption is needed so that provision can be made for all the supportive services and other arrangements that are required in order to maximize the options available to farmers. In some places that planning will need to include improved communication channels. Seed availability is critical, but all other components of a complex system must be made readily available. It is equally critical that improved varieties have the characteristics required for local climate and soil conditions and that meet the needs and expectations of the producers. Better methods need to be devised of taking into account the needs and wishes of farmers in the development of GPT because it is unlikely that research and technical personnel and centers can both anticipate and keep in focus all the many requirements.

The Ghana Grains Development Project: A Case Study In Farm-Level Technology Adoption

Purpose of the study

This study examined factors associated with the adoption of three improved maize production technologies developed through the GGDP: (a) improved germplasm, (b) fertilizer recommendations, and (c) planting configuration recommendations. Although these three technologies were by no means the only ones developed by the GGDP, they were among the most important. The overall purpose of the Project was to develop and diffuse improved technology for maize and grain legumes.

Methodology

Data on the adoption of the GGDP-generated maize technologies were collected through a national survey of maize growers carried out between November 1997 and March 1998. A three-stage, clustered, randomized procedure was used to select a representative sample of 420 maize farmers. These farmers were questioned at length about their maize production, consumption, and marketing practices; their preferences for different maize varietal characteristics; and their knowledge of and access to improved inputs, such as seed and fertilizer (for additional details about the survey, see Morris ***et al.***, 1998).

Findings

Adoption of GGDP-generated maize technologies has been extensive. During 1997, over one-half of the sample farmers (54%) planted MVs on at least one of their maize fields, and a similar proportion (53%) implemented the plant configuration recommendations. The rate of fertilizer use on maize was lower, however, as less than one-quarter of the sample farmers (21%) reported having applied fertilizer to their maize fields. These findings provide clear evidence that the GGDP-generated maize technologies have diffused widely. In 1997, two-thirds of all Ghanaian maize farmers used at least one of the three improved technologies – by any measure an impressive number, especially considering that maize in Ghana is grown mostly by small-scale farmers living in isolated communities.

The survey showed that the adoption has been influenced by three sets of factors: (1) characteristics of the technology, (2) characteristics of the farming environment, and (3) characteristics of the farmer. Complexity and riskiness of the technology are important in determining adoption, but the technology must be determined by farmers to be profitable. Adoption will also depend on the particular agro-ecological zone in which any farmer lives, and variations between zones may make adoptions more or less suitable in particular cases. Farmers are more likely to adopt innovations if they already have resources that are required for investment and if they are better educated and informed.

Implications for adoption

If complex innovations can be introduced in the most effective ways, adoption can probably be enhanced. Divisible innovations will be better adopted, issues of risk and economic benefit need to be addressed, and resources required must be given consideration. Adoption cannot be expected to be even over geo-ecological zones, and variations in innovation programs should be provided for. New technologies stand a better chance of being adopted if they are compatible with current farming practices.

CIAT´s Integrated Cassava Research and Development (ICRD) Strategy: A Case Study on Adoption and Impact in Northeast Brazil

Purpose of the study

This study was of the adoption of new cassava post harvest production technology in the northeast of Brazil in the state of Ceara. Cassava farmers in Ceara have low incomes and little capital, along with a difficult growing environment. The technology of chipping and sun drying cassava has the advantage of linking small farmers to dynamic growth markets that offer them the opportunity to increase their incomes, and the technology is quite suitable to village conditions in developing countries as evidenced by its widespread use in northern Thailand over the last three decades. Nevertheless, this innovation is relatively complex in that its use requires collective action by farmers as well as the entry into a new market.

Methodology

This study employed a case study approach to address some key issues in adoption among rural people in low-income countries. The aim was to provide thick description of the process from the points of view of various actors utilizing a range of data and information sources. A variety of data sources are used in this case study including both primary and secondary quantitative and qualitative data. An important source of quantitative data is the project monitoring and evaluation system that was implemented as part of the original project. Focus groups were conducted with cassava producers and processors in communities selected on a stratified basis to be representative of the range of communities and processing facilities involved. In addition, special interviews were conducted with women who participated in the project.

Findings

In terms of the number of plants established, about 200 by 1996, the cassava chipping and drying plant adoption process was highly successful. To some extent, however, the rater of establishing such plants was excessive since farmer groups could not be adequately screened for their suitability for involvement in such plants, and the resources they required could not be provided in a timely fashion. Production of dried cassava was uneven, too, having been quite adversely affected by a serious drought in 1993.

Communities that developed chipping/drying plants and operated them successfully had good motives in low prices for cassava farinha and good support for the practice from institutions that provided training as well as a solid base of information from other communities that had previously established such plants. Less successful communities appear sometimes to have been dominated by a small group of interested farmers and influenced to some extent by local politics. Moreover, the successful adopting communities tended to have had participatory experience in developing the cassava chipping and drying industry. Some adopting communities had already been at least partially organized for agricultural production activities. In only a few communities was the availability of credit made as a specific point influencing adoption.

The industry did improve incomes in the area in which it was established, although the drought had a highly unfavorable effect. The economic benefits were particularly important to women and to farmers with only very small plots of land. On the other hand, the farmers did seem to perceive some limit on the income they could expect, and they did not greatly increase overall cassava production.

Implications for adoption

Cassava farming involves an integration of production, processing and commercialization activities around the cassava crop at community level, and institutions in charge of technical assistance activities for cassava farmers can not and should not work exclusively in any of these three activities, in isolation from the others. Farmers can obtain important economic and social benefits from cooperative ventures to adopt productive technologies. Participation by the farmers and communities who will be involved in the innovation is likely to be beneficial, but so is support from appropriate agricultural organizations. Careful planning for the adoption of the technology is likely to be required when the innovation is capital intensive and must be soundly based in favorable economic expectations.

CGIAR and NARS Post-Production Innovations in The Philippines and Vietnam

Purpose of the study

Farmers in Southeast Asia increasingly need a wider choice of labor-saving technologies to help them cope with growing labor shortages and higher labor costs. The project, ***Agricultural Engineering in Evolutionary Systems (AEES)***, was set up in 1995 to help make public-sector agricultural engineering more effective at filling a gap left in the private sector in the Philippines and Vietnam. The present study focused on the introduction of two technologies—the Stripper Gatherer (SG) harvester to the Philippines and a very low cost grain dryer, the SRR dryer, to Vietnam. These technologies were chosen because they are relatively new, which made it easier to study the initial adoption process. Both technologies—although limited in adoption to date—are ultimately likely to be widely adopted in the respective countries. The discussion here emphasizes the SG harvester.

The methodology employed in this study was that of the classical case study, with close observations of events and processes as they occurred, interviews with various persons involved, and examination, where necessary and desirable of documents.

In 1994, the German government, through Deutsche Gesellschaft für Zusammenarbeit GmbH (GTZ), funded PhilRice to assume responsibility for evaluation and local adaptation of the SG harvester in the Philippines, as well as to provide industrial extension. Unfortunately, neither IRRI nor PhilRice were able to bring the fabrication quality of the large manufacturer up to standard. As a result of this and machine mobility problems in sticky and soft mud, sales were initially disappointing.

In 1995, PhilRice was successful in including the SG harvester in a government machinery promotion program that all 12 Regions in the Philippines with demonstration units and provided soft loans for cooperatives to buy the technology. The program encouraged a number of manufacturers, through the promise of government orders, to begin building the machine. By 1996, thirteen manufacturers had built at least one stripper-harvester.

Efforts to promote the SG harvester were marred by sometimes poorly planned, ineffective demonstrations and impeded by a variety of other difficulties such as the threat of labor problems stemming from partial displacement of field workers who were, nonetheless, essential under some conditions in which the SG harvester could not function. The machine was also expensive in relation to the use that could be made of it by many individual farmers.

IRRI carried out research to solve the most evident problem with the technology—poor mobility in soft and sticky field conditions. Two critical requirements were to reduce machine weight while maintaining strength and durability and to improve the wheel design. An innovative manufacturer tackled the first aspect in 1996 when he developed a version of the Mark II stripper-harvester that was 25% lighter. IRRI collaborated with another manufacturer to develop an improved wheel. In 1998, IRRI released drawings of the Mark III stripper-harvester, based on these two developments.

In 1996, PhilRice began developing a smaller, cheaper, and lighter version of the stripper-harvester called the Lite stripper-harvester (LSH), but indications are that the LSH will need to go through several more design iterations before farmers see it as a "perfected" technology.

The work produced two key insights. First, manufacturers and farmers often modify or adapt a technology to meet their needs. Second, once farmers and manufacturers know enough about the technology to make sensible modifications and select the ones that better meet their needs, the technology development process becomes self-perpetuating and leads to wider adoption—without the need for further intervention by the public-sector. To be more effective in adding to farmers' choices of appropriate technology, the public sector must introduce new technology in an evolutionary, participatory process, rather than a top-down one. In other words, instead of dividing the research, development, adaptation, and adoption (RDAA) process into separate, sequential tasks with different stakeholders responsible for each, the public sector should be more of a catalyst or facilitator for the whole process.

Findings from the case studies suggest that research institutes should:

- Adopt fewer hierarchical organizational structures to allow more flexibility and responsiveness to evolving situations;
- Have more flexible mandates that allow research teams to be involved in the initial adoption of a new technology;
- Develop innovations that motivate researchers to work to solve farmers' problems;
- Acknowledge that the innovations of first-adopter farmers and manufacturers are often essential before widespread adoption will take place for complex technologies and/or those being introduced into complex systems;
- Plan projects to allow time and resources to be put into working in partnership with manufacturers and first-adopter users to capture these innovations;
- Take into account that the time necessary for working in partnership will be proportional to the complexity of the technology and the system into which it will be introduced;
- Give much more priority to monitoring, evaluation, and feedback during the course of the project.

Participatory approaches—methods that involve stakeholders early on in the R&D and transfer processes—will create a synthesis between researcher and farmer knowledge that will better solve farmers' real problems.

Factors Influencing Awareness and Adoption of Sorghum Varieties in Nigeria

Purpose of study

The ICRISAT program in Nigeria was to develop and disseminate improved sorghum varieties and hybrids that would be adapted to the agro-ecological zone, have high yields, be resistant to biotic stresses, and suitable as food to the local farmers. Two varieties that demonstrated good performance in on-farm trials were released and promoted for adoption. The present study was to determine the level of adoption achieved and the factors associated with the decisions of farmers to use the new varieties. The primary approach to enhancing adoption was a series of on-farm adaptive research efforts publicized by radio and television.

Methodology

Focus group meetings were used to identify issues and to help in the selection of villages and farmers for a subsequent adoption survey. Ultimately, more than 200 farmers in 27 randomly selected villages representing different agro-ecological zones were surveyed. Data were collected through structured interviews so as to obtain information concerning farmers' perceptions of the attributes of the new cultivars and the personal characteristics and resources of the respondents.

Findings of the study

Awareness of the cultivars in the villages in which they had been introduced was high, the main sources of information being research staff and agents of the brewing companies offering to buy the grain, and subsequent farmer-to-farmer contacts. Extension agents had very little part in disseminating the technology. Many villages do not have extension agents to assist them.

Adoption has been low in the dry savanna zone but better in both the two zones with higher rainfall. Both of those zones also benefit from proximity to the market facilities provided by the brewing industry, making sorghum valuable as a cash crop. An important factor limiting adoption is that seed availability is not dependable. Adoption has been more extensive among large-scale farmers in the wet zones because they have the capital to invest in seeds. The rate of adoption of sorghum varieties has probably also been reduced by the fact that during the time of their development, the subsidy on fertilizer, that had resulted in rapid adoption of new maize varieties, was eliminated. Farmers were dissatisfied with the yield of the new cultivars in the absence of fertilizer.

Implications for adoption

More intensive efforts at making farmers aware of the new culitvars and in showing them how to grow them are needed. A major NGO that might have been helpful is leaving Nigeria in 1998, and other organizations need to be poised to take over. In particular, assistance might be sought from the brewing industry. If adoption is to succeed, however, a seed multiplication program will have to be planned and carried out; that will require explicit responsibility for initial coordination and a strategy for transferring responsibility to local farmers' groups. Access to credit to support both seed and fertilizer purchases will also be required.

Farmers also need assurance of markets for their sorghum grains, and that requires stability in the brewing industry, which is by no means certain. As yet there is insufficient awareness of alternative uses for sorghum, and that should also be part of the overall strategy for promoting adoption. Some segments of the Nigerian farm population have expressed concern about growing grains for the production of alcoholic beverage, and Muslims do constitute the majority of sorghum producers. From that standpoint, alternative uses are doubly important.

That a comprehensive strategy for facilitating adoption is required is further supported by observations about the inadequacies of dependable supplies of other inputs required for good agricultural production. Very few villages have good access to inputs such as fertilizers, seed dressing chemicals, water pumps and spare parts, and so on. Moreover, it is likely that farmers who have begun to adopt new varieties could benefit from further information about improved practices for plant husbandry such as planting practices and fertilizer management.

Smallholder Dairy Technology in Coastal Kenya: An Adoption and Impact Study

Purpose of the study

Adoption of dairy technologies can have a positive impact on the welfare of smallholder farmers and promote agricultural development. The objectives of this study were to examine the factors influencing adoption of three related dairy technologies in coastal Kenya, and, secondarily, to assess the impacts of dairy adoption on household income, employment generation, and nutritional status of pre-school children. Although three technologies were involved, they actually constitute a system in which the parts are closely dependent upon each other.

Methodology

For this study of the adoption and impact of the three dairy technologies (crossbred dairy cattle; cultivation of the fodder grass Napier (***Pennisetum purpureum);*** and the infection-and-treatment method of immunisation against East Coast fever or ECF), three separate surveys of farm households were conducted in three districts of Coast Province. The project compiled an inventory of 750 households with dairy cows in the three districts comprising the study area. The ***Adoption Survey*** queried 75 dairy adopters (owners of at least one grade or crossbred (G/C) dairy animal) and 125 non-adopters, using a stratified random sampling frame. An ***Impact Survey*** followed the same sampling procedure with 200 households not contacted during the adoption survey being interviewed. Indicators of nutritional status for pre-school children were collected for 112 children in these 200 households. Finally the ***Detailed Survey*** consisted of semi-structured interviews with 29 farm households randomly selected from the households participating in the impact survey. Of the 29 households, 15 had previous experience with G/C dairy cattle and 14 had no experience with more intensive dairying.

Findings

The three districts combined comprise a bit over 125,000 households, and a bit more than 700 have adopted the dairy-farming technology. The most important sources of information about the benefits of G/C cattle ownership were extension agents, demonstrations, and other households owning G/C cattle. The primary reason for acquiring G/C cattle was to have milk for sale so as to increase cash income. Adoption of G/C cattle was, as expected, negatively related to suitable alternative agricultural uses for land and positively related to size of household, a proxy for labor available. Lack of money to purchase a G/C animal was frequently mentioned as a reason for nonadoption, and farmers owning such animals tended to have higher off-farm incomes. Reasons for not having G/C cattle, aside from cost, included concerns about loss of the animals to disease and potential difficulties in selling milk, the latter reflecting primarily lack of information. Adoption of the production of fodder grass had the same general predictors as for ownership of cattle. Concern about loss of an animal to disease was the most frequently cited risk involved in becoming involved in dairy farming, but increased workload and changes in household routine were also mentioned. Adoption of the third element of the dairy technology, immunization of G/C cattle against local diseases was not widespread, in large part because of lack of logistical and institutional arrangements for that step. Some farmers who had become dairy-farmers abandoned that enterprise, most typically because of the death of an animal that they could not afford to replace. Some others, however, abandoned the cultivation of fodder grass because of the extra work required and the disruption of other practices. Entering into dairy farming was perceived as increasing both family consumption and sale of milk with few reports of negative changes such as increased workloads or need for hiring of labor. Increased income from milk sales was substantial.

Implications for adoption

Technologies that can be divided are likely to be in the process of adoption, and that can be either an advantage, e.g., in promoting adoption, or a disadvantage if partial adoption tends to make failure more likely. Dissemination of needed information to guide decision-making is critical and likely to be difficult in settings in which the potential audience is dispersed and only a small part of the larger population. If adoption is to be promoted successfully, plans must be made and implemented to provide the logistical and administrative support required for innovative practices. It may take many years to determine whether adoption of innovations should be regarded as successful, and unless some goals are specified, it may never be possible to make that judgement.

Case Study on the Adoption of IPGRI's Crop Descriptor List

Purpose of the study

IPGRI has produced Descriptor Lists for more than 80 crops and a preliminary impact assessment study was conducted in 1996. However, information on perceptions of their quality and their impact when used as guidelines for germplasm documentation was incomplete. Little is known on how widely they are adopted and on the decisions of priorities. The study sought to evaluate the extent of adoption of the IPGRI Descriptors and examine the factors affecting adoption in order to help increase their impact on the conservation and use of plant genetic resources. The study concentrates on qualitative aspects of the use of the Descriptors and focuses on banana, coconut and maize, selected for the diversity in cases that they present, eg. in terms of type of crops, economic importance, geographic distribution and use of the germplasm, and networking activities.

Methodology

Data were collected from existing sources such as archives, reports and other documented feedback received over time from collaborators and users of the IPGRI Descriptors. New information came from various sources including interviews with individuals and groups of users and questionnaires. The major source of information was an extensive questionnaire sent to the germplasm collection managers for each of the crops selected. Questionnaires investigated the reasons for requesting copies of IPGRI Descriptors and the use being made of them. Interviews were conducted with staff from institutions that collaborated in the development of the banana and the coconut Descriptors and with IPGRI staff. A focus group discussion was held with 10 genebank curators of the major ***Musa*** collections around the world.

Findings

The challenge in developing crop Descriptor lists is to ensure that the final result can rely on broad support or consensus by the majority of intended users. Thus, each step in the development of Descriptors is done in consultation with the staff responsible for the activity within IPGRI thematic and regional groups, with genebank documentation staff, and with crop experts. A decision to revise a Descriptor list is taken using the same consultative approach and has been carried out, on average, 10 years after first publication. Revisions represent clear improvement according to the feedback received but should preferably be undertaken at shorter intervals.

The IPGRI Descriptors are very well known by the plant genetic resources community, especially the target users: genebank curators, crop specialists and plant breeders, and users consider the IPGRI Descriptors in general to be "very useful" for a series of activities. The majority of the germplasm collection managers surveyed maintain a documentation system/database for their accessions. The main reasons for adopting the IPGRI Descriptors are because they meet their needs for germplasm documentation and/or because they are the only Descriptor lists available for the crop of interest. The majority of collection managers for the three crops studied select from the lists only the most useful Descriptors for their specific needs and modify or adapt the Descriptors. Some use the complete list while others use the lists only as a reference or guidelines for documentation. The IPGRI Descriptors are adapted either because the characters observed cannot be described adequately using the IPGRI Descriptors, some institutes already have their own documentation systems, and/or there are no Descriptors for the characters they consider important. Users would also like the Descriptors in languages other than English, French and Spanish.

Most of the adopters experienced some limitations in using the IPGRI Descriptors, including lack of financial resources and human resources to undertake the work, a lack of training and expertise available in documentation, and a lack of a documentation system. Other problems include use of the recommended colour charts, scoring certain Descriptors, the length of the list, difficulties with terminology, selection of Decriptors states and the language of publication.

The surveys showed that the main reasons for not adopting (about one third of the germplasm collection curators) the IPGRI Descriptors is either because the respondents had already documented their collections before the descriptors were published or because they simply did not know about or have access to the IPGRI Descriptor publication. Only in a few cases were the Descriptors unsuitable for their purpose and/or not available in the first language of the user. A very small proportion of non-adopters find that the IPGRI Descriptors are not compatible with the documentation system already in place.

Regular reviews seem to be essential to keep up with users' needs. While about half of the respondents felt that the IPGRI Descriptors could be improved in one way or another, the proportion of respondents who felt improvements were necessary was much lower for the recently reviewed Descriptor lists, confirming that revisions are effective. Some suggestions are made in the report to improve future Descriptors and reduce the cost of production, making more efficient use of available resources.

The IPGRI Descriptors illustrate well the importance of involving the target beneficiaries in developing such innovations to ensure suitability for users and of obtaining regular feedback to ensure that a high level of usefulness is maintained. This enables the credit for the success of the IPGRI Descriptors to be attributed to all partners. IPGRI Descriptors are most of all used because they meet the needs of the users and most users are able to modify the list and select only the most relevant Descriptors for their specific needs.

The major limitations in using IPGRI Descriptors relate to the lack of financial and human resources to undertake documentation activities, lack of training and expertise in documentation and lack of documentation systems. The feedback indicating lack of awareness of the Descriptors highlights the need for regular monitoring of potential users and to find out exactly why potential users do not know about the IPGRI Descriptors so that their distribution can be better targeted.

International Musa Testing Program of INIBAP – IMTP

Purpose of the study

This study was aimed at assessing the effectiveness of the IMTP as a system for providing Musa (banana and plantain) breeding programs with information on the performance of their new varieties under a range of environmental conditions and varying pest and disease pressures, while at the same time allowing National Agricultural Research Systems (NARS) early access to improved varieties. The study looks critically at the motivation underlying the participation of the various partners in the program. It also attempts to examine the links that must be in place for new varieties developed by breeding programs to be adopted by small holders. The study also describes the constraints that have been identified as affecting the operation of IMTP and documents how the program has evolved in response to the changing needs of participants.

Methodology

The case study used a variety of complementary approaches, gathering new information by questionnaire, interview and focus group discussion. The precise target groups for the study were the IMTP trial site managers and the people involved in further evaluating the IMTP varieties released as a result of Phase I, that is, the National Evaluation Program (NEP) managers. The present case study uses the “illustrative” approach, as defined by Sechrest et al. (1996). This approach describes in detail a process or series of events in order to obtain a clear understanding of the cause and effect relationships involved.

Information for the study was obtained mainly from two questionnaires: one aimed at the 20 IMTP trial site managers of the IMTP Phase II, and a second at the 50 institutes that had, between 1993 and 1996, requested the hybrids recommended from IMTP Phase I for further evaluation; i.e. the NEPs.

Findings

The most important reasons for participating in the IMTP were to acquire improved Musa germplasm and to respond to farmers’ needs for varieties with improved performance. The IMTP allows NARS to evaluate the material under their own conditions and make appropriate recommendation for farmers in their respective region. Another important reason to participate in the IMTP especially mentioned by NARS was to establish links with other researchers from International/Regional Agriculture Research Centres and other Advanced Research Institutes (53%). The opportunity to influence future strategies of Musa breeding programs was also cited as an important reason for participating (40%). For breeding programs donating germplasm, the most important reason for participating was to get international publicity for their best hybrids and to get them evaluated as widely as possible.

Trial site managers reported some problems during their participation in the IMTP. The most serious limitation was difficulty in multiplying sufficient planting material to establish trials. Difficulties in collecting evaluation data, often due to lack of personnel, the presence of off-types in material received, and delays in receiving germplasm were also important factors affecting participation. Other difficulties were caused by lack of information on the management of the varieties being evaluated and the poor suitability of the varieties for local conditions and tastes.

Participants in the IMTP feel that breeding programs have a “very good” understanding of

NARS' needs in terms of disease resistance and yield improvement whereas their understanding for pest resistance, fruit flavour, post-harvest characteristics, growth habit, type and uses, and drought resistance have been rated less favorably.

The link between the IMTP and farmers will depend on the specific mandate of the institutes carrying out the evaluation i.e. international, regional or national. The involvement of farmers in the NEPs provides a mechanism for feedback to the breeding programs through the NARS, of information on the potential acceptability and performance of the varieties tested.

Implications for adoption

The study highlights the importance for effective participation of involving target beneficiaries at the project planning and developing stages. An overall plan that provides for requirements at every level and step of the testing and production is needed and should be monitored for implementation in order to assure that consideration is given to all elements, including multiplication of plant material for distribution. Close cooperation between NARS and the IMTP is necessary because the NARS provide the link between the testing program and the farmers.

Assessment of Organizational Impacts: Progress report on an ISNAR evaluation in Latin America

Purpose of the study

This study is an evaluation of the organizational impacts of an ISNAR project, "Strengthening the Management of Agricultural Research in Latin America and the Caribbean." The project, which began in 1992 and is still being implemented, aims to strengthen the management of agricultural research by promoting and establishing planning, monitoring and evaluation (PM&E) systems in agricultural research organizations. The PM&E project had its origin in a request from Latin American agricultural research leaders for assistance in improving strategic planning and research management in their organizations. Declining funding for agricultural research and increasing demands for accountability and enhanced organizational performance made improvements in PM&E essential.

Methodology

Based on participatory planning, three complementary project components were developed:

- Training of professionals in PM&E and in the strategic management of change
- Preparation, publication and dissemination of reference and training materials on PM&E
- Strategies for promoting and institutionalizing integrated PM&E systems in four Pilot Cases

This study of organizational impacts is being carried out by ISNAR as part of a larger effort to develop frameworks and methods which international and national organizations can use to assess their organizational capacity and performance, and their direct impacts on client organizations as opposed to indirect, downstream impacts on end users. The organizational assessment framework used contains four main "organizational dimensions":

Organizational environment - the external environmental in which the organization operates.
Organizational motivation - internal factors that influence the direction of the organization and the motivation of its members.
Organizational capacity - internal resources and systems that bear directly on organizational functions and performance.
Organizational performance - the organization's accomplishments in relation to its objectives.

The framework views an organization's performance as a function of its external environment, motivation, and capacity. It recognizes that a capacity-building project may have direct effects on a client organization's environment, motivation and capacity; but only indirectly on its performance. Performance, viewed as a function of the other three dimensions, is under the control of the organization itself, not of the ISNAR project.

Four complimentary studies were undertaken to identify and assess the impacts of the PM&E project on client NAROs.

- A study of patterns and trends in PM&E drawn from case studies of nine agricultural research organizations in LAC.
- An assessment of the impacts of project training on participating individuals and organizations.
- An assessment of the impacts of project publications on participating individuals and organizations.
- Self assessments of organizational change in the Pilot Cases.

Results

Results to date suggest that the nature and extent of organizational changes brought about by the PM&E project seem to depend upon the intensity of interaction between the project team and the organization in question. The impact of project publications is greater if they are used in training. Both of these are leveraged into still greater organizational impacts in the Pilot Cases, where project staff interact frequently with key decision makers. The principal effects of information and training tend to be reported at the individual level. In the Pilot Cases, where there is a formal commitment to support organizational change, there are also substantial changes in the organization. There are many sources of change in the environment of NAROs. The PM&E project is only one of these, but one which comes at a particularly opportune time. NAROs are currently challenged by external as well as internal forces, and their leaders are generally receptive to ideas that will promote good performance and sustainability.

The profile of respondents to the information and training surveys indicates that the project is reaching and involving appropriate NARO personnel – those well-placed to disseminate ideas for change. The PM&E project has enriched the material and human resources available to NAROs in the region, providing them with relevant assistance in their capacity building efforts. Participating NAROs have become more effectively linked with their national equivalents in other countries and are able to exchange and draw upon each others' experience and expertise. The information and training developed by the project is relevant, as indicated by its intense use. A valuable group of highly motivated and competent trainers has been established in the region.

Implications for adoption

Many organizations, including NAROs, do not have clear-cut performance objectives – clearly identified results for which they believe they should be held accountable. Planning for results requires that NAROs reflect on the meaning of "good performance" and define it in measurable terms. The PM&E project has promoted the identification of relevant goals and objectives and the development of action plans to achieve them. It has encouraged participating organizations to move towards managing for results. The articulation of performance goals will make it easier in the future for the NAROs to gauge their performance and also for ISNAR to determine its contributions to NARS capacity and performance.

The conceptual framework adopted for the impact evaluation has shown a number of useful features. It is comprehensive, covering all aspects of the organizations whose capacities are in the process of being strengthened by ISNAR. It has face validity and is intuitively satisfying to organizational managers and staff. It is adaptive in that it can accommodate new considerations as they emerge. The four dimensions of the framework are capable of being operationalized and customized to suit any given organization.

MODELS FOR ADOPTION

Adoption of innovative agricultural technologies has been a topic of widespread and longstanding interest, and several different approaches to understanding adoption have been explored. These approaches may be considered in a general way to constitute models of adoption. It is not the purpose of the present study to contribute specifically to the embellishment of any model, nor does this work depend upon propositions derived from any particular model. Our hope was to determine whether by "on the ground," close up studies of individual instances of efforts to foster the adoption of specific innovations, carried out in different places and under different circumstances, it might be possible to achieve some understanding beyond that currently realized.

In fact, the current models of adoption do not seem to afford the rich texture of concept and prescribed action that is likely to be required to achieve efficient and effective dissemination and adoption of agricultural innovations. Existing models are generally narrow in scope. Often to the point of appearing one dimensional in their views. Some are probably reasonably descriptive of the way in which adoption proceeds, but they are sparse in implications for how to make the process in any way more dependable.

Although it is by no means a straightforward matter to identify adoption models and to distinguish them from each other—they do overlap to some extent—the most salient models appear to us to be:

1. ***The diffusion, or communications, model*** (Rogers and Shoemaker, 1971; Rogers, 1995) delineates five stages of the innovation-diffusion process from initial awareness of the innovation, through persuasion, decision, and implementation, to confirmation, the point at which the adopter questions and affirms or rejects the wisdom of his or her decision.
2. ***The technology transfer model*** is a "top down" model that supposes that innovations are created by scientists and then transferred down a chain of intermediaries to their end users.
3. ***The agricultural extension model*** may not be a separate model but only a mechanism by which technology transfer takes place. It is, in any case, the prototype for dissemination of innovations in agriculture.

The foregoing might all be considered "classical" models in that they have been around for a long time and are well known and established. In addition, there are models that are more contemporary:

4. ***The structural/institutional model*** (SIM) (e.g., Brown 1981; Shaw, 1985) addresses the influence of systems factors, and in particular, structural and institutional factors, on adoption.
5. ***Participatory Action Research*** is not so much a model of adoption as a strategy for enhancing the probability of adoption. Traditional models of adoption, as noted, typically rely on a linear, or "top-down" progression from development to adoption of an innovation. In contrast, participatory research involves targeted users in all phases of the research, from the conceptualization of the problem through testing possible solutions, to adaptation to local conditions, and final dissemination.

In addition, there are economic models, there are a number of recent and comprehensive reviews (eg. Feder, Just, & Zilberman, 1985);

6. The ***individual household behavior model*** examines the decision-making process characterizing choice of components of packages of adoption over time.
7. ***Aggregate models*** have traditionally been patterned after epidemiology and were constructed to fit logistic models. Adoption and diffusion can be viewed as

analogous to the spread of disease, based on exposure to information and other users of the innovation.

The foregoing economic models appear to be more nearly descriptive of the process of adoption of innovations rather than as prescriptions actually followed in promoting adoptions.

It is possible, perhaps even likely, that no one "model" of adoption can capture the complexities of the adoption process, particularly if, as we will argue, it is the maintenance of innovations that is of primary interest. The foregoing models seem particularly limited from a pragmatic standpoint: how can farmers be induced to adopt effective agricultural innovations and maintain them over time? The adoption-maintenance process is multi-faceted, longitudinal, and population-based. None of the models seems that complex.

Is failure of adoption of innovations a problem?

It seems widely, although perhaps not universally, accepted that slow and uncertain adoption of agricultural innovations is a problem. Certainly it is a source of disappointment to sponsors. Whether that disappointment is justified is difficult, perhaps impossible, to say. A major reason is that no one knows what the rate of adoptions of innovations ought to be. One would look in vain for an introduction of an agricultural innovation accompanied by a statement of what would be regarded as a successful rate of adoption or what the ultimate level of adoption should be. If two years after its introduction a new plant cultivar is being grown by 5 percent of farmers in an agricultural region, that might seem disappointing; on the other hand, it might be regarded as a considerable triumph. Until one knows what the goals are for adoption, one cannot very well decide whether adoption rates are satisfactory.

Moreover, the extent to which apparently low rates of adoption are regarded as a problem probably depends on the perspective of the person or group involved. Some scientists might think it their role simply to create new materials on a regular and continuing basis, with those materials being made available to be adopted or not according to the judgments and interests of the prospective adopters. From another perspective, farmers are often thought to know best where their interests lie, and if they do not adopt some innovation, that is very often for the best. The book Farmers First (Chambers, Pacey, and Thrupp, 1989) provides many instances of productive nullification by farmers of the recommendations of agricultural scientists and other experts. More recent critics have been strongly negative toward what are seen as "top-down" approaches that suppose that scientists and extension agents know best and that failures of innovations to be adopted are somehow a failure on the part of farmers (Bauer, Hoffman, and Keller, 1998; Rolling and Groot, 1998). The failure of innovations to be adopted may, in some views, be taken as a failure of the agriculture establishment, including scientists, to take farmers into the innovative process as full partners.

Some current thinking about adoption takes the view that adoption is not something that should be "expected" in a top-down fashion is that the "success" of innovations is not to be judged in terms of the extent of their adoption (Bauer, Hoffman, and Keller, 1998)) since that implies that they "should" have been adopted. In what we might term the "paradox of adoption," however, those same critics, in supporting the case for their "farmer first" approach to adoption of innovations point to the higher rates of adoption achieved by their approach. Presumably the success of agricultural innovations must be evaluated in some way, and the extent of their adoption seems an inevitable choice as an index. Evaluation of innovations should, however, be judged in terms of overall performance rather than on a case-by-case basis. Not every new plant cultivar needs to be adopted widely, or even at all, but if over a period of time very few cultivars developed within a research center are ever adopted, then one might question the success of the overall program.

Donors, by contrast, may, understandably, believe that their support is being wasted if it does not lead to immediate and high rates of adoption of a large proportion of all innovations produced in centers they support. It is an important task of the research centers to demonstrate to donors that their programs are successful in an overall way, and that is a task that can probably be carried out most effectively only in partnership with NARS, which are the interface with the farmer-users.

Is research on adoption being adopted?

A great deal appears to be known about how to promote adoptions of innovations. The research is voluminous, and many findings appear to have been replicated numerous times. Questions about adoption seem usually to be formulated in terms of "What are the factors that lead farmers to adopt innovations?" with the implied question "Why don't farmers adopt innovations as they should?" An equally good question, however, might be "What are the factors that promoters of adoption could employ in order to increase rate of adoption?" with the implicit question "Why don't promoters of adoption use the knowledge we have about how to bring about adoption of innovations?" That question must be qualified by noting that the problem is not that those engaged in promoting innovations do things that are not sensible, let alone wrong, but that the knowledge they bring to bear on the problems is not systematized and developed into effective, strategic plans.

A central thesis of this paper is that the promotion of adoption of agricultural innovations is not approached systematically as a critical requirement of an agricultural research system. To a great extent promotion of adoption seems an afterthought or as a task of no great consequence or difficulty. Planning for adoption promotion activities is not extensive, goals are not established, and resources devoted to the task are almost always quite limited. The problems may not lie with recalcitrant farmers but with agricultural agencies that are not sufficiently attentive to what is known about promoting adoptions.

Why, in hindsight, do agricultural agencies appear to put inadequate resources into promotion? One explanation is that promotion activities for a new technology need to be planned in advance. At the time planning for promotion is carried out the innovation in question is competing for promotion resources with other technologies which may appear equally or even more promising. It is only in hindsight, after the competition has dropped by the wayside, that it might appear that inadequate resources were put into the promotion of the successful technology. In other words it can be hard to spot winners in advance. While we would agree with this, we argue that this should not be used as an excuse. Rather it argues for an "evaluation culture" called for the Chairman of the CGIAR at ICW 1997. It argues for better project monitoring and evaluation to enable winners to be spotted earlier, within a project framework which places higher emphasis on promotion and feedback. Evaluation and monitoring per se may do little to improve the linkage between usefulness and adoption of an innovation. That improvement surely lies in better identification of problems and constraints, along with adequate systems analysis. Promotion and feedback, then, should be consequents of a satisfactory evaluation program.

Where does responsibility for promoting adoption lie?

The question of who should be charged with promoting adoption of innovation is by no means an incidental one. As we will argue, the process of promoting adoptions is complex and difficult. In involves a commitment of both personnel and material resources that may not be as easily achieved in some settings as in others. In fact, we believe that if adoption is to be pursued with any deliberateness and vigor, it probably requires specifying responsibilities and resources for accomplishing them.

The studies underlying this report were carried out by seven of the international agricultural research centers. Their involvement came about because they were in a position from the standpoint of personnel and logistics to do the research required with a modest infusion of financial support. We do not mean to imply by this report or the work that led up to it that we believe that the international centers should have responsibility for promoting adoption of innovations, even if they do initially produce the innovations. The centers do not have staff and other resources to devote to promoting adoptions, and the general orientation of the centers toward more basic science is probably not conducive to the intensive field work that would be required to promote adoptions of innovations. The direct clients of the Centers are the NARS. That does not, however, absolve the Centers of any responsibility for determining that the innovations on which they work would ultimately be useful, which means that they should have prospects for being acceptable in the field, a point to which this report will return.

Another thesis of this paper will be that if adoption is to be greatly enhanced, let alone maximized, responsibility for promoting it must be explicit. Adoption at an optimal level is unlikely to be attained if the processes that lead to it are left to the diverse and haphazard forces that buffet the agricultural enterprise. The establishment of clear lines of responsibility and authority, coupled with commitment of resources adequate to the task of introducing and promoting innovations, is an innovation that should be tried.

SYNTHESIS OF FINDINGS CONCERNING ADOPTION OF AGRICULTURAL TECHNOLOGIES

The issues discussed here emerged from consideration of the complex findings represented by the diverse individual studies, reflections on them and discussions of them with the investigators, and the nature of the extant literature on dissemination and adoption of technological innovations across a variety of fields. The conclusions presented here are syntheses at both empirical and conceptual levels. Their acceptance as conclusions should take into account the generally rigorous nature of the science represented by the individual projects, the fact that they represent the synthesis of multiple and diverse research settings, methods, and problems, and, finally, by their analytic and conceptual coherence.

Bringing about successful adoption of innovations requires a strategy

If one conclusion emerges clearly from the nine cases with which we have to deal, it is that if adoption of innovations is to be maximized, adoption must be deliberately planned for. It cannot be imagined that adoption of even an excellent innovation will be widespread without the development of a comprehensive strategy to bring it about. We are not suggesting that innovation can never occur without active intervention, but if it is supposed that an innovation is so compelling that adoption will be widespread and immediate, that should be noted as a basis for a decision not to intervene, and appropriate monitoring should be carried out. That may be a sufficient plan, but it should be planned for.

As noted, the adoption process is complex, and for all but the simplest of innovations, multiple things have to happen, and they often must happen in a particular sequence and with attention to timing that can be critical. The SGH case study showed that in the early stages of adoption, technologies can evolve quickly (the generalizability of this finding is supported by the other five case studies carried out by the IRRI project) through manufacturer and user innovation. The ISNAR experience with promoting project management and evaluation (PM&E) innovations showed the NAROs that adopted the innovations making major changes and adaptations. Therefore planning for initial adoption, particularly of technology that lends itself to user modification, should allow for research to be integrated into promotion. This integration allows for the capture in subsequent iterations of the technology of these “learning by doing” and “learning by using” gains (Rosenberg, 1982). The SGH and PM&E case study suggests that it is only once this fusion of user and scientific knowledge is obtained that real, sustainable and widespread adoption takes place.

By a strategy, we mean a plan that begins with a careful specification of just what the technology is that is to be adopted and a goal, or set of goals, indicating what would be regarded as satisfactory progress at particular points in time and what would ultimately be considered a successful conclusion. So far as could be determined, of the innovations involved in our studies, only the SGH was fielded with any particular schedule for accomplishing steps in the adoption process. Even in that case, however, the plans tended to be for specific parts of the process, e.g. for evaluation and local adaptation, but not for R&D or promotion. None of the case studies found any particular schedule for accomplishing steps in the adoption process, and certainly for no innovation was there a clearly established longer term goal such as that 50 percent of farmers would have adopted or that the innovation would be applied to a certain number of hectares of farmland. Such benchmarks and goals are necessary to guide a program designed to bring about adoption for they indicate when and where efforts should be made to advance the program and when it should be supplanted by some alternative. Virtually no major government or private initiatives are undertaken in these times without specification of goals, what it is that is to be achieved, and a time table of some sort for those achievements.

Examination of the actual levels of adoption of innovations achieved in the cases reported on here may not impress one as remarkable, and in some instances outside observers might well regard the innovation process as a failure. Those judgments would probably be unwarranted, however, given that no particular goals, or even expectations, were ever expressed, or at least were not so far as we can tell.

> The total sales of the Stripper Gatherer Harvester (SGH) in the Philippines had not gone beyond 115 by the time the study of that innovation was completed, but that level might have been good given the time it takes most CG technologies to be locally adapted and made available to farmers. On the other hand, it might also have been unsatisfactory; no goals having been set, it is hard to say.
>
> In Ghana, 54 percent of farmers surveyed had planted a modern variety of maize, and that may or may not seem a satisfactory outcome. Few specific goals were ever set for adoption of any of the innovations so nothing more than an impression of success or failure can be reached.[ii]

The need for an explicit plan for bringing about adoption is, of course, not a novel idea. The Transfer of Technology and Extension models of adoption both recognize the requirement that specific mechanisms to bring about adoption are required. Indeed, most of the innovations studied in the CGIAR projects involved some level of explicit planning for adoption. What was not the case, however, was that planning was systematic, comprehensive, and effective. In most cases, planning appeared to have depended upon assumptions that a series of desirable events would take place rather than a deliberate determination that they would do so.

> The adoption of small holder dairy farming in Kenya required not simply a shift in breed of cattle used but also the building of appropriate sheds, the planting of a particular kind of forage, finding a market for the milk, and so on.

Even apparently simpler innovations such as adoption of a new plant cultivar (India, Vietnam, Ghana, Nigeria) required that new cultivars and methods of planting and tending them be demonstrated, that seeds be made available, that fertilizer sources be identified and arrangements made for its purchase, and a variety of other arrangements be made.

Successful implementation of a strategy requires specific allocation of responsibility

An effective plan for adoption requires an agent[iii] specifically responsible for the adoption process. That agent should have knowledge of the overall plan, have the resources to monitor its implementation, and the charge to intervene in an appropriate way if the plan seems to be failing. If everybody is in charge of adoption, then nobody is in charge.

> In Vietnam, where the Oil Plant Institute is responsible in an explicit way for adoption of the Groundnut Production Technology, adoption has been reasonably successful.
>
> By contrast, the lines of responsibility in India were much less clear, and adoption was also much less likely. Although NARSs[iv] were generally responsible for promoting adoption of each of the innovations, the responsibility was, we think, diffuse rather than definite and specific.

Most of the adoption programs, to the extent that they could be called that, were not guided by any sort of a formal, written plan of action. Adoption activities were simply expected to take place, and adoptions were simply expected to occur.

> The SGH in the Philippines was an exception, but as already discussed, the government promotion campaign was rather "top-down" and did not easily allow for the capture of manufacturer and farmer innovation.

In fact, the steps required for successful adoption of any given innovation were never provided for in any organized and dependable manner. Adoption appeared to be generally more successful, however, where such provisions were more nearly in place, as in the adoption of Groundnut Production Technology (GPT) in Vietnam, or in individual cases in which the several steps could be accomplished with the resources available to the farmer, as in adoption of dairy farming in Kenya by farmers with more personal resources to invest.

Inputs must be accounted for.

One of the largest constraints to adoption noted in several of these case studies was the lack of necessary inputs such as seeds, germplasm, or skills. A strategic plan should account for all the input required for adoption and specify exactly how each element of the required structure or material would be produced. Failure to provide for continuing sources of supply of seeds, fertilizer, and so on was also a factor limiting maintenance of innovations once adopted and in slowing their further spread beyond the initial adopters. It is not necessarily the case that any one mechanism for meeting those needs must be designated, simply that a mechanism be noted. For example, it might be that under some circumstances it would be plausible that needs of late adopters for seeds could be met by purchasing or borrowing seeds from early adopters, so that no central seed supply would be required. But if that is what those promoting adoption have in mind, it should be spelled out in the plan.

The complexity of influencing adoption of innovations needs to be recognized.

It is obvious that the taking up of innovative technology is a complex matter, but the justification for the reminder lies in the widespread failure to engage in complex strategies to accomplish the task. None of the innovations involved in the studies on which this report is based was promoted with a comprehensive, multifaceted, and strong program that gave full recognition to the difficulty of the task.

> Where promotion campaigns were carried out, for example with the stripper harvester in the Philippines, they tended to focus too heavily on promotion and not have adequate mechanisms for gathering feedback and injecting it back into research.

Because of the way that research and promotion are often separated organizationally, it has proved difficult in practice for research teams to remain integrated with promotion over time. Thus opportunities for creating a synthesis of local and scientific knowledge may have been missed.

Some agricultural innovations are appropriate for, or even meant for, intermediaries such as marketing agents, sometimes in the role of contractor. Many types of agricultural machinery, including not only the cassava chipping and drying system, but rice harvesters, dryers, and other post-production technology, not only lend themselves to contracting or other forms of shared service but may be intended for that function in the first place. The means by which such innovations may be promoted may need specific research if they are to be understood.

It is difficult to know for certain whether complexities are unrecognized, overlooked, ignored, or bypassed in attempts to get innovations adopted, but in none of the innovations studied in our series did the complexities seem to get the attention they needed. Some specific instances will serve to illustrate the point:

> Arrangements for demonstrating the Stripper Gatherer Harvester (SGH) within the government promotion program in the Philippines were sometimes poorly handled with the result that some demonstrations were highly ineffective.
>
> Seed supplies for sorghum farmers in Nigeria were inadequate, with the result that some farmers stole seed from other farmers' fields.
>
> Potential smallholder dairy farmers in Kenya were sometimes reluctant to invest in crossbred cattle because of uncertainty about their hardiness, lack of veterinary care, and the absence of any plan to protect them against loss if animals died, although their concerns were not always fully justified.

A strategic plan should include provisions to make innovations affordable and profitable to the adopter.

Innovations must be affordable if they are to be widely adopted by farmers. Affordability may come about in several different ways, however. Some innovations may be inherently inexpensive, some may be subsidized fully or in part by outside agencies, and some may be subsidized temporarily by loans to be paid off from increases in productivity. It is important for understanding adoption of any innovation to have some estimate of the expense involved in adoption and a description of how and how well the issue of affordability was managed. Although affordability was almost certainly considered at least implicitly for all the innovations we studied, explicit consideration was not always obvious.

Innovations involving adoption of new cultivars, or even of new crops, may not involve additional expense to the farmer, or at least the expense may be small. In some instances plant material may be distributed free of charge to farmers, e.g., new banana/plantain cultivars were obtained by IMPT organizations and distributed to farmers without any cost to the farmers. On the other hand, some technologies involve considerable, even large, financial outlays.

> The Stripper Gatherer harvester (IRRI) had to be paid for by individual farmers, and the cost to them was quite substantial ($1500 to $2100), amounting to approximately one year's income for a farm worker. For the most part, only relatively wealth farmers could afford to purchase that technology.
>
> Similarly, farmers involved in cooperative groups in Northeast Brazil could not afford the technology for solar drying of cassava chips by themselves because it involved expensive materials such as cement that had to be transported from nearby cities and it required specialized labor to build the structures.

Adoption of a technology may be deemed sufficiently important by an agency, either a government agency or an NGO, that its adoption may be subsidized in full or in part. Although subsidized adoption would appear quite likely to increase adoption, that increase would occur only if the subsidy were large enough to overcome other barriers to adoption. Judgments about the subsidy required may be difficult to make, and resources available to support subsidy may be limited.

The SGH case study found that adoptions were quite limited by cooperatives that were able to acquire the machine on very soft terms through a government program; most adoptions were by individual farmers who paid the full, unsubsidized cost of the machine. (Cooperatives in the Philippines, which often have management difficulties, seem to have general problems in interacting with new technology.)

Both the SG and the cassava chipper/dryer system involved fairly complex and capital expensive innovations, and others that were not so expensive were widely adopted without any direct subsidy, e.g., groundnut cultivars in Vietnam. On the other hand, fertilizer was never adopted widely, or at least not adopted and maintained, in Ghana, in part because the costs, although perhaps not large in absolute terms, were beyond what most farmers were able to, or willing to bear. A sufficient subsidy would have boosted adoption to the extent that it made use of fertilizer profitable for the farmer[v]. Actually, and the point is an important one, fertilizer is not necessarily a simple technology, for it requires complex analyses and planning in order to carry out a fertilization program correctly. Some farmers did not maintain the use of fertilizer for that reason.

One form of subsidy that seems attractive is in the form of loans to farmers that make it possible for them to purchase the innovation and materials associated with it. As with other forms of subsidy, however, loans must be large enough in size and on sufficiently good terms to make them feasible and attractive to farmers.

〈 Although the SGH is relatively fairly expensive ($1540 minimum), more than 50% of sales in the Philippines were to private farmers without any subsidy or loan. When the Department of Agriculture made a limited number of loans available to farmers, however, in only a short time several additional machines were sold, even though the terms of the loans were not overly generous. Indications are that the scheme will boost farmer adoption.[vi]

The use of loans to boost adoption of innovations is not a simple matter, however, as is shown by the experience in Ghana, where loans for the purchase of fertilizer were often defaulted upon when the use of the fertilizer did not prove profitable.

Affordability itself is not a simple matter. It may not be possible, or even desirable, to make all innovations readily affordable to the poorest farmer Economies of scale exist for certain technologies, particularly mechanical technologies such as harvesters, threshers, dryers and rice mills. So long as effective contracting services exist, then poor farmers can often benefit from a new technology by hiring it.

The SGH was originally designed by IRRI primarily as a contractors' machine, the cost of the harvester being large in relation to the economy of rural areas in either the Philippines or Vietnam. The cost of the harvester is, however, similar to that of the axial-flow thresher (also designed by IRRI) used to thresh nearly all the rice grown in the Philippines and Vietnam. Contracting is the way that most farmers in the Philippines and Vietnam gain access to relatively expensive harvesting, threshing, drying, and milling technology.

Access to resources (credit or cash) to obtain innovations is a requirement for their adoption, but those resources may be available to at least some potential adopters. Farmers who adopt the Groundnut Production Technology (GPT) tend to be ones with larger land holdings in part because they are the ones who can most afford it. Likewise with the adoption of modern varieties of maize in Ghana, modern seed varieties, fertilizer, and row planting were all adopted more often by farmers with larger land holdings.[vii] Such findings are, of course, consistent with the SIM model of adoption. Resource limitation on adoption may, as noted, be overcome in some instances by appropriate strategies for inducing adoption.

When asked why they did not engage in smallholder dairying, 8 of the 14 of farmers who were interviewed reported that lack of available cash and credit prevented them from acquiring an animal. The cost of purchasing grade/crossbred cattle in Kenya is fairly steep: one animal costs twice the average monthly income of farmers in the region. Households who had disadopted dairying most frequently reported that they had not replaced their animal (that had died) because they lacked the financial resources to do so. Those who had cattle reported that they purchased the animal with savings and in rare instances, through collective effort or with help from a development project.

It is interesting, however, that in Kenya one of the sources of the cash required for entering dairying was non-farm income. The part of Kenya in which the study was carried out has a substantial tourist industry, and at least some farmers and their families are employed for part of their time in it. That was one of various sources of income that made it possible for some of those farmers to acquire crossbred cows for dairy purposes. The availability to farmers of non-farm income was not so obvious in any of the other areas in which studies were carried out, but the possibility exists in some places that farmers might be encouraged to engage in off-farm income in order to acquire small amounts of capital to permit engaging in better farming practices.

Apart from the direct costs associated with a particular innovation, there are other costs that must be born by user that also weigh in the decision to adopt. For example, if an innovation raises the demand for labor that is expensive or scarce then it is unlikely to be successfully adopted.

High labor costs were noted as factors in the adoption rates of groundnut technology innovations in Vietnam.

The availability of labor was also important in adopting smallholder dairying in Kenya: income from dairying was related to hiring labor outside the family to manage the additional work that owning cattle entailed.

In contrast, labor important in the adoption of row planting and fertilizer was available in Ghana and does not appear to have adversely affected the rate of adoption.

Allowance needs to be made for the fact that adoption of innovations is likely to be impeded if routine, ongoing activities will be disrupted.

Some agricultural innovations require very substantial disruptions in the ways in which farmers adapt to the demands of their culture and environment; other innovations may require little, if any, changes in daily routines.

The SG harvester required a considerable disruption of farmer's usual ways of doing things.

In Vietnam, some farmers had uses for the straw that the harvester precluded, and they followed agricultural practices that would have had to be substantially changed if they used he harvester.

In the Philippines, the main disruption, and it was no small one, was in the alteration of long-established patterns of relationships between farmers and the seasonal labor they required.

Disruption also affects cultural practices. Farmers who decided to join farmer's groups in Brazil to gain access to cassava technology had to learn to do business in a new way. Contrary to more easy-going approaches they used prior to joining, the farmer's groups required that they become more business-oriented. That orientation represented a shift away from an individual focus with each farmer concerned only with his or her own crop, to a communal effort in the context of a broader market.

> The technology itself also shifted the use of cassava from traditional processing into cassava flour into a different product, i.e., dry feed chips for cattle. The ready market for the feed chips overcame any inertia in the direction of flour production.

Problems involving disruptions of routine and cultural practices may be resolved over time through natural processes of social change.
The history of the mechanical reaper, a mechanical harvester introduced by IRRI to the Philippines 10 years before the SGH, shows that given time disruptions can be overcome if there is sufficient need for the technology.

> Within a 5 to 10 year period, farmers and laborers evolved a management arrangement that overcame initial resistance triggered by fears of laborers that they would be replaced. In this case, harvest laborers formed themselves into contract teams that would then hire the mechanical reapers from their owners if it meant they could harvest larger areas and earn more.

The amount of disruption a technology can cause and still be adopted will depend on its benefits and the ability of the farming system in which it is introduced to co-evolve to solve the problems.

A strategy should include consideration of risks, real or perceived, that may impede adoption of innovations.
The risks involved in adopting new cultivars are often fairly minimal, although in some cases, e.g., banana/plantain the risk is increased by the fact that farmers may not know for two years what kind of a crop they will get. Even when considered as systems, some agricultural innovations may not be particularly risky because they can be adopted partially or in stages. Other kinds of technologies, however, may involve considerable risk, both social and financial.

The SGH involved a financial risk that was probably too great for many farmers to undertake. The machine is expensive and not readily usable for other purposes. It is interesting that cooperatives, which were not subject to such large financial risks, put much less effort into solving early problems with the technology. Also important in the Philippines, however, was the social risk entailed in disrupting established traditions concerning acquiring and paying seasonal labor. Farmers were probably inhibited in adopting the harvester because they feared that they might be subject to labor boycott, and they may even have feared for their own safety or that of their property since some accounts of sabotage and other damage were noted. Indications are that farmers were aware of the risks they faced. Moreover, it probably would not have been easy to do anything about farmers' perceptions of the risks; the risks were real.

> The majority of smallholder dairy adopters in Kenya reported that they obtained an animal to have more milk available to sell. These milk sales offered the opportunity to have higher and more regular income. In contrast to this perceived benefit, there were also perceived risks. Prior to adoption, losing an animal to illness, increased workload, and fear of changes in household routine were all rated as highly important risks. These risks may have impeded adoption for some farmers.

Whether and how easily adoption decisions may be reversed is likely to be related to perceived risk and the readiness with which adoptions are achieved. Reversibility is likely to be related to perception of risk, but promoters of new technologies might devise any number of ways to enhance reversibility. With a cultivar of an annual seed crop, the decision is usually reversible each year when a farmer decides what to plant. The effects of reversibility may be positive, that is it may enhance risk taking and adoption. Conversely, the effects of reversibility may be negative with respect to maintenance of an innovation. That is, easy reversibility may make it easy for a farmer to decide to try an innovation, but the very ease of reversing it may make its abandonment likely at the first sign of any difficulties.

> In Ghana easily adopted planting practices and superior modern varieties are rarely disadopted, but nearly one-third of the farmers quit using fertilizer after initially adopting it. Disadoption of fertilizer resulted from its high cost and the uncertainty of crop production from year-to-year; farmers are less willing to invest in the cost of fertilizer if the expected return is questionable. Obviously, the use of fertilizer is highly reversible, which should, other things being equal, make it attractive to adopt but easy to abandon.

Adoption is more likely to occur if it can be done incrementally.
The possibility that an innovation can be adopted incrementally may make it more affordable and also minimize both disruptions and risks involved in adoption. Adoptions that must be made in a step-wise, or all or none, manner are likely to be difficult. An assessment of the degree to which it was possible for farmers to "buy into" innovations gradually, perhaps trying them out in a small scale or building them up in a piecemeal fashion is of interest.

> The SGH, for example, had to be purchased by the farmer on an all or none basis, but it might have been possible to introduce it on some other basis such as "rent to own" that would have been incremental. Apparently no such methods of promoting adoption of the SGH were made.[viii]
>
> Similarly, the system for chipping and drying cassava and the smallholder dairying innovation had to be adopted on an all or none basis.

Adoption of new cultivars on a gradual basis is usually fairly simple, and GPT in Vietnam tended to follow that pattern, with farmers planting at first small quantities of the new variety and gradually expanding the area devoted to it. Of interest, however, is the fact that very few farmers made a complete switch to a new variety. That may be partly because the greater expense or difficulty associated with acquiring seed, fertilizer, and so on, but it undoubtedly also reflects a desire on the part of farmers to hedge their bets. That is a practice often recommended to farmers.

> At the time the study was done, no farmer in the study had converted completely to the GPT. Given the option, it seems likely that farmers will adopt innovative technologies gradually.

Divisible innovations may be divided in the process of adoption.
Some innovations are "packages" of separate components that may be recommended to end users. Although the entire package may be identified as a set of innovations most likely to enhance productivity when used conjointly, users often divide up the package and adopt only a subset of the components. Acting in rational self-interest, end users will select the components that are most productive, acceptable, or affordable and ignore the rest.

> As noted in the Ghana study, divisibility reduces risks for farmers by allowing them to adopt only certain parts of the total package and makes it accessible to both large- and small-scale farmers.

These case studies provide several examples of the divisibility of innovations. The groundnut study in India revealed that the recommended package was very complex and involved adopting different seed varieties, and water, soil, and nutrient management options. In Vietnam farmers were introduced to a complex package of innovations aimed at increasing productivity and area under groundnut cultivation.

> The results from both countries indicate that seed varieties and fertilizer are adopted more quickly than soil and water management techniques.
> In the study of improved maize in Ghana, the complete package of innovations included row planting, modern varieties of maize, and fertilizer. Yet farmers adopted only 2 of the 3 recommended components: row planting and modern varieties were readily taken up, but the adoption of fertilizer lagged behind. Notably, two-thirds of maize farmers had adopted at least one of the components.
> Similarly, in Kenya the dairying package included Napier grass, crossbred cattle, and immunization for East Coast Fever. Adoption of Napier grass and cattle were strongly related, in part because an early development program required potential adopters to cultivate the Napier grass in order to obtain an animal. Lack of access to veterinary care and perceived risk of loss of the animal to illness appeared to be responsible for much lower rates of adoption of immunization.

If complex "packages" are not really separable elements, it should be made clear to users that that is the case and that the package must be adopted as a whole. On the other hand, if a package is divisible, then that fact may provide an important entry for the take-up of the innovation since users may be more readily persuaded to adopt some elements on a trial basis and add others later as the users either change their perceptions of risks and benefits or as they acquire resources needed for additional components of the package.

> The case of the IPGRI Descriptor List for Banana, produced in 1996, illustrates this point. This list was developed jointly with a database software (MGIS) and an identification software (MUSAID), both free of charge to the users and a great incentive to use the package. They are not, however, necessary to the use of the Descriptors for Banana which, can be used independently of the software.

Adoption promotion strategies should include demonstrations of the effectiveness of innovations.

The likelihood that an innovative technology will be adopted is almost certainly related to the extent to which its effectiveness has been directly demonstrated to potential adopters. "Demonstration" may range all the way from testimonials to on-site, hands-on trials. Similarly, demonstration may be very brief, like a try-out drive of a new automobile, or extended as in a season-long test plot of a new cultivar. Moreover, demonstrations may be planned by promoters of a technology or they may be by-products of other activities. Information about demonstrations of the effectiveness of innovations being studied should be available, and it is important that it be assembled for later synthesis.

> In India and Vietnam, the demonstration of the applicability of improved groundnut technology options was crucial to increasing their adoption.
> The on-farm adaptive research demonstrations of sorghum varieties in four states of Nigeria and the aggressive demonstrations of one sorghum variety by the Guinness Brewery in Kaduna State were both critical steps in enhancing awareness and adaptation of early maturing sorghum cultivars among Nigerian farmers.
> The importance of successful demonstrations was also seen in Brazil with the cassava technologies; as farmers saw other farmers adopting and increasing their profits, they were persuaded to join farmer's groups.
>
> To increase adoption by farmers, the Musa Testing Program held field days and invited farmers to visit demonstration plots.

Some demonstrations of the SG harvester in the Philippines that were carried out by inexperienced operators and with inadequate planning almost certainly had a powerfully diminishing effect on interest in it, particularly to cooperatives. When farmers could see with their own eyes the deficiencies of the machine, they were scarcely likely to rush to acquire one.

> On the other hand nearly all the farmers who bought the SG harvester did so after seeing a demonstration. It is interesting that even though the early demonstrations and machine quality left much to be desired, 2 out of 18 farmers bought the machine because they were themselves technologically sophisticated and thought that they could remedy the problems and end up with a useful piece of equipment.

Innovative technologies need actually to be effective.
It should be obvious that if farmers are to be expected to adopt innovative technologies, those technologies should be demonstrably effective. From the perspective of the ToT model, it is assumed that when technology is to be transferred, the technology will work as advertised. The broad-bed and furrow component of GPT in India and the SG harvester are examples of technology that was not easily demonstrated to be effective. Whether the SG harvester worked as advertised depended critically on the skill of the operator and the plan for the demonstration.

> In an effort to improve the quality of demonstrations put on by Department of Agriculture technicians in the Philippines, PhilRice and IRRI published a guide called "How to conduct an effective field demonstration of the stripper gatherer (SG) system".

Presumably an effective strategy would foresee the need for materials of that sort.

Part of the problem of ineffective technologies, even if there is only a failure of demonstration, is that such events may have create an impression of incompetence and untrustworthiness of the agricultural agency involved and of the kind of technology at hand more generally.

> In the groundnut growing states of central India, attempts to introduce broad-bed and furrow (BBF) technique met limited success as farmers were not persuaded of the effectiveness of BBF in improving farm productivity.
> In drought-prone areas of south India, attempts to introduce an improved groundnut variety with such a long maturation time that it would have preventing farmers from escaping drought or engaging in multiple-cropping of their land were bound to fail.

Those attempts may also have induced skepticism on the part of farmers that will be difficult to overcome when later and more satisfactory cultivars are developed. In contrast, the Integrated Cassava Research and Development Program (ICRDP) processing system in Brazil did not appear to have such problems.

The contrast with the ICRDP is instructive. In Brazil a surplus of cassava for flour made an alternative use of the plant highly desirable, and the discovery that it could be mechanically chipped and sun dried for cattle feed was of great utility. Demonstration of the technology was relatively simple and persuasive, and the technology has by now been widely adopted. Other technologies that could be demonstrated to be effective, e.g., GPT in Vietnam, sorghum in Nigeria, maize in Ghana, were also readily adopted.

〈 The small holder dairy system in Kenya was inherently more difficult to demonstrate since it required considerable time to implement, and results may have been somewhat less apparent. Nonetheless, it appears to be a generally successful, even if as yet only modestly disseminated, program.

Reliance on "progressive" farmers as models may be a useful part of a strategy.

A frequent recommendation for introducing innovations and increasing the rates of their adoption is the involvement of "opinion leaders" early in the adoption process. In agriculture, however, opinion leaders are likely to be mainstream, conservative practitioners at least reasonably successful by using traditional methods. Bringing about innovation may require the identification of progressive farmers interested in new methods. Obviously, to be effective in demonstrating the effectiveness of innovative methods, progressive farmers need to be well known and respected by their peers, but they may not need to be those to whom other farmers turn naturally for counsel.

If one is to rely on opinion leaders, it may be important to assure that there is a univocal opinion. The fact that an IPGRI Descriptor List is recommended by a particular crop network for use by its members will also increase its likelihood of adoption. The case of coconut illustrates this point but in the negative sense, for the International Coconut Network (COGENT) developed a database with different descriptors and produced another descriptor list three years after the IPGRI list, and the rate of adoption is much lower than for the other two crops studied.

The introduction of GPT in Vietnam and India are examples of deliberate use of progressive farmers in targeted districts. The introduction of the technology package among progressive farmers first was necessitated by the nature of the complex set of options comprising GPT.

Maintained adoption of improved groundnut innovations is noted among those farmers who maintain their membership in the Farmer Science Club in the State of Maharashtra.

The SG harvester case study found that the first farmers to adopt the SG harvester closely matched Rogers (1995) profile of an innovator-adopter, namely someone who is venturesome, has more cosmopolite social relationships, is relatively rich so he can absorb possible loss from unsuccessful innovations, can understand and apply relatively complex technical knowledge, and can cope with a high degree of uncertainty about the innovation.

These innovator-adopters often selected themselves by following up information they had received about the technology from the media. They often expended a considerable amount of their own time and resources in developing management innovations to make the machine work better, and improving the machine itself. IRRI, PhilRice and the manufacturers were able to incorporate many of their innovations in subsequent generations of the SG harvester. It is possible that opinion leaders (mainstream conservatives) become more important in the adoption of technology once it has "matured" further.

A specific and formal plan for promoting adoption facilitates that process and should be a part of any adoption strategy.

Successfully adopted innovations are often the result of a well-planned dissemination effort. The nature of the original plan for dissemination of the innovation should be detailed.

Several of the case studies showed that well-articulated plans for dissemination were in place, although none of the plans was comprehensive and strategic. In several instances a program or project was developed with the primary goal of facilitating adoption.

In India a program known as LEGOFTEN was developed to launch the groundnut package in farmer's fields.

The National Dairying Development Project (NDDP) emerged in Kenya to disseminate smallholder dairying information.

The Ghana Grain Development Project (GGDP) was responsible for disseminating improved technology for maize and grain legumes.

The SG harvester was disseminated to cooperatives by a government program called the Gintong Ani (Golden Harvest) Program.

Similarly, adoption of cassava agro-industry was greatly aided by the Integrated Cassava Research and Development Program (ICRDP). Sponsored by CIAT, the ICRDP's initial plan for introducing the new technology involved various methods of dissemination including demonstrations, press releases, field days, and seminars for farmers. Working together with the NARS, they also organized a study-tour for technicians.

Informal dissemination was shown to play a much larger role in facilitating adoption than previously thought. By informal dissemination, we are referring to less structured or formal transmissions such as those that occur among farmers. Farmer-to-farmer exchanges were important in the cassava case study because farmers shared their experiences with one another.

In one village in Vietnam, all the seed for a particular groundnut cultivar had come from one farmer; he had shared his seed with neighbors and the majority of land in that region was planted in that variety. Sharing seeds was also common among groundnut farmers in other areas of Vietnam.

In the Philippines, one farmer leant his SG harvester to a manufacturer to copy and got three orders for that manufacturer.

Information distribution of the descriptor list publication by IPGRI staff members while travelling or attending meetings and workshop is responsible for 48% of the distribution of the publication of the descriptors for banana and for raising the awareness of 27% of the principal target end users (banana germplasm collection curators.

Farmer-to-farmer transmission was judged by smallholder dairy adopters in Kenya to be more important than demonstrations or courses offered by extension agents. The National Dairy Development Project (NDDP) developed a plan for dissemination that relied heavily on extension agents to visit interested families and to sponsor demonstrations. These two sources, other adopters and the project's extension agents, were the primary sources of information that influenced adoption. Farmers indicated that other methods such as publications or salesmen were not nearly as important.

The sorghum growers in Nigeria were made aware of improved varieties primarily by OFAR demonstrations sponsored by IAR and ICRISAT and by the extensive campaign initiated by Guinness Brewery to motivate contract farming to meet the increased demand for sorghum in the brewing industry.

The fact that informal channels of dissemination are important in adoption of agricultural innovations is not contradictory to the idea that a detailed plan is highly useful. In fact, a good plan for promoting adoption of an innovation would give consideration to the role that might be played by informal transmission and how that process could be facilitated.

Strategies of adoption should take into account that both technology and the process of its adoption are dynamic.

Assessment of any technology can only be in terms of its characteristics at some point in time. Technologies are, however, very often dynamic. A potential problem with the use of modern varieties of maize in Ghana and sorghum in Nigeria is that those varieties are propagated by open pollination. Although that feature of the technology makes it possible for each farmer to produce his or her own seed, it also means that the modern variety may be degraded over time by outcrossing with other, genetically distinct, varieties growing in nearby fields, hence losing its advantage in productivity. However it also allows farmers to carry out their own breeding.

> An interesting contrast is provided by the SHG as it developed in the Philippines, for the technology evolved over time, undoubtedly being improved in that evolution. Consequently, one's sense about the effectiveness of the SGH should be dependent on just which version is being evaluated, and that same thinking would apply to assessments of its price also.
>
> In fact, it also appears that over time, the social conflict over the use of the SGH and displacement of labor between rice farmers and field laborers in the Philippines resolved itself in favor of a compromise that let the SGH be used in dry field conditions and hand labor in very wet ones.

Thus, too early an assessment of prospects for adoption of the SGH technology might have produced a more pessimistic conclusion than warranted.

Adoption is a dynamic process. Farmers do not simply adopt or not adopt a technology. They may proceed by increments, as in adoption of GPT in Vietnam, where no farmers appear to have converted completely to GPT. Farmers appear to try to hedge their bets on new technologies by maintaining sufficient production in traditional methods that they are insured against disaster. They try out technologies by steps, and they adopt some parts of a technology at first and may or may not add other parts later on.

> Farmers in Ghana appear to have adopted modern variety maize and row planting as a package, but they have proven not only variable among themselves but also over time in adoption of fertilizer as part of the system. Moreover, maize farmers change their levels of fertilizer use from time to time depending on their financial resources and their knowledge of the fertility of the soil. They have learned, for example, that land left fallow for a period of time need not be fertilized for a period of time.
>
> Incremental adoption characterizes the Crop Descriptor lists, for which users often choose only a few descriptors to document and gradually complete the description over the subsequent years until a revision is published, which occurs at ten-year intervals.

Technologies may play out in ways somewhat different from those originally imagined. In Kenya, for example, the smallholder dairy system was originally thought to require a mechanism for marketing the milk that would be produced. That has proved not to be the case, however, as most farmers are able to sell their milk themselves directly from their own farms, customers often being nearby residents.

Models for adoption of technology generally do not deal with the probability of changing circumstances, but changes must be considered both in relation to the adoption and the maintenance of agricultural innovations. Climate, for example, is not constant, and a cultivar that may be well suited to a location at the time of its introduction may soon fail and be abandoned if the climate becomes either wetter or dryer by much. Markets also change, and a crop that may be economically viable at one time may become uneconomical if prices change over time, e.g., with greater productivity resulting from widespread adoption of the very technology in question.

> The expectation that farmers in Brazil would increase their production of cassava to meet the opportunities offered by chipping and drying operations was not met, probably because farmers discerned that further increases in production would not be sufficiently profitable to make them worthwhile.
>
> Another example is afforded by a dramatic increase in the price of fertilizer in Ghana that virtually precluded its profitable use.

If change were anticipatable, its possibility could be incorporated into programs for technological development and adoption. In fact, if change is anticipatable, it is incorporated into technological development, and its influence becomes invisible. Cultivars are developed with some allowance for anticipatable changes in climate and moisture; it is the unanticipatable changes that are the problem. The possibility of change, however, should be considered in planning for adoption, and especially for maintenance. That circumstances have changed since the introduction of some innovative technology has to be considered in evaluating longer-term maintenance of the innovation.

> The creation in Vietnam of a market for rice straw in one area where the SGH was adopted in Vietnam contributed to its subsequent disadoption.
>
> Drought conditions in Brazil greatly reduced the supply of cassava and, therefore, the usefulness and profitability of cassava chipping and drying operations.

If innovations are adopted and later abandoned, that may not point to any fundamental failure in the technological innovation system but simply result from inevitable change in the way things are.

End-users should be active participants in the innovation and adoption process

As many others have noted (e.g., Bauer, Hoffman, and Keller, 1998; Chambers, Pacey, and Thrupp, 1989; Contado, 1998; Rolling and Groot, 1998), and as is recognized in one of the widely known models of adoption, Participatory Action Research, innovation is likely to be more successful, particularly if considered through the adoption stage, if ultimate users are involved in the process of identifying, developing, testing, and implementing innovations. That idea is so important but, apparently, so often overlooked, that it deserves explicit reiteration here.

End users have perspectives that are valuable, indeed, in some instances quite essential, on problems and their solutions. The nature of the involvement will differ depending on a wide variety of circumstances. In some instances involvement may be satisfied by observations of or interviews with users; in other instances, they may need to be active partners in actual design and construction of innovations. In most instances, technological innovations are likely to come about under the leadership of some organization or group, and it is up to that leadership to ensure that participation of users is appropriate and sufficient. That leadership should not, however, have the option of deciding whether participation is appropriate.

Some technologies are, of necessity, iterative in nature and require successive episodes of testing and feedback in the field.

> The SG harvester provides a notable example of how a technology evolved in an iterative way, benefiting from testing in the field by farmers, suggestions from them about redesign, and subsequent refinement. Moreover, the farmers using the SG

harvester provided useful suggestions about effective patterns of its use under actual production conditions.

Similar suggestions for improved technology and its use came from other places and for very different products.

In Vietnam, for example, GPT was found to be compatible with intercropping of beans, thus making the technology even more attractive to farmers. That intercropping practice could then be passed along as a recommendation to other farmers.

By contrast, the attempted dissemination in India of a groundnut cultivar that had an unacceptably long time to maturation could possibly have been avoided by more extensive consultation between plant scientists and the farmers who would eventually need to use the material.

Technologies differ in their response to adaptive efforts.

Farmers can watch a mechanical device in action and can not only see how it works and where it needs improvement, but the more mechanically-minded among them may be able to make specific suggestions for redesign of the equipment, or even make modifications themselves. They may also fairly readily make useful suggestions for alterations in ways of using the machines. By contrast, farmers have much less capability of altering plant material. Farmers may discern that a prospective new cultivar is sensitive to water requirements, but they might not have the plant material available to be able to make changes themselves in order to deal with that problem. Altering conditions of use of plant material is often quite difficult because of the slow and uncertain process by which feedback occurs.

Not all aspects of plant cultivation are beyond the adaptive responses of farmers, however, and they may contribute to the evolution of a technology system even if they cannot affect all parts of it. We are thinking here of alterations that are passed on to other farmers so that they are the technology; many individual farmers adapt technologies in various ways without affecting the technology generally.

Farmers in Ghana adapted their practices to the resources they could devote to fertilizer, but that was an individual, rather than a systemic, change.

On the other hand, groundnut farmers in India provided feedback concerning configuration of fields for planting that resulted in changes in recommended practice.

Similarly, a farmer in the Philippines devised a pattern for use of the SGH that increased efficiency of harvesting, and, if the SGH ever became widely used, that pattern would probably be part of the technology transmitted to other users. IRRI and PhilRice promoted a farmer-devised harvesting pattern in the training material developed for the second generation SGH.

The time-frame for many agricultural technological innovations is long.

The time required for development of many agricultural innovations is long and, in some cases, very long. Collinson and Tollens (1994) state that from project initiation at a CGIAR center to usable technology takes about 10 years, and that it takes another 10 years for widespread adoption to take place. Development of new plant material can require years of effort. In fact the breeding time for a new cultivar of banana/plantain is ten years! Moreover, the time that, of necessity, must elapse before a farmer can discover whether an adopted innovation is effective in his or her particular case may also be very long, particularly in relation to Third World farmers' perspectives focused on survival. A farmer planting a new cultivar of groundnut, for example, must wait weeks before being assured that germination and plant health are really satisfactory and three or four months before being assured that yield and quality of product will be good. Other innovations such as smallholder dairying entail even longer waiting times to determine whether decisions will have been wise. With extended time required for feedback about success of innovations, evolution of those innovations is likely to be slow, perhaps too slow to be counted upon. An innovation may fail before it can be adapted to local conditions.

That long lag-time between decision and consequence may be a particular impediment to adoption of some innovations, and the only effective way of bridging it is likely to be by demonstrations that are credible and persuasive. "Demonstrations" need not be formal and official since farmers may well be influenced by observing the results obtained by their neighbors. If, however, such informal processes are to be part of a strategy of promoting adoption, considerable knowledge is required about social networks among farmers.

> For example, the Krishi Vigyan Kendras established in India may provide a network among farmers for promotion and dissemination of new knowledge in agricultural development.

Not all innovations require extended time for feedback about their effectiveness. Mechanical devices, for example, may be tested under conditions that provide immediate information about their effectiveness. The SGH is now in its third generation, five years after the first unit was sold to a farmer. It has improved substantially in this time. That rapid feedback made it possible to see the evolutionary process at work in the development of the SGH. It also clearly shows that there is a need for a large overlap with complex technologies between R&D promotion, initial adoption and adaptation. Proponents of the ToT approach might argue that most of the improvement seen with the SGH should have taken place in research institutes before promotion began. The case study shows that releasing new technology early to manufacturers and farmers is likely to be more parsimonious and more effective at capturing local knowledge and innovation essential before widespread adoption takes place. The proviso is that manufacturers and farmers should be seen as equal partners in the process, and given appropriate support to offset their risk and expenditure. The ISNAR experience with project monitoring and evaluation innovations—which also lend themselves to user modification—tend to support these conclusions.

Other case studies looked at more mature technologies and did not specifically look at stakeholder participation in the R&D and adoption process. Some, like the seed-based technologies, were difficult for the farmer to alter. As a result the adoption process was less clearly evolutionary.

Active involvement of NARS in the entire innovation process is essential

The extent of the involvement of NARS in the dissemination and adoption process is of considerable interest. It is important to know the extent to which the NARS in each country are involved in identifying the original problems meant to be addressed by innovations, the planning and development of the technology involved, and in the formulation and implementation of plans for dissemination and promoting adoption.

> The role of NEPs in the promotion of the IMTP varieties is crucial in adoption by farmers.)

The stage of problem identification per se may not be of critical importance; many problems identify themselves. For example, plant diseases are obvious in their effects, e.g., black Sigatoka in the case of bananas. Presumably, however, the NARS have the critical task of setting priorities and determining which problems will be worked on and what allocation of resources.

PhilRice, as an instance, was very heavily involved in the development of the SG harvester, from initial planning through its development. In fact, PhilRice continued to be involved in attempts to improve and refine the machinery even though not all their efforts were necessarily helpful. They were also involved in promotion of the harvester, but there was never a comprehensive plan for those activities.

The case study of cassava drying agro-industry provides another example in which the NARS were extensively involved from the earliest stages of the project. NARS collaborators from Brazil who had visited countries where this technology was in use identified it as an approach with potential for their homeland. They became actively involved in dissemination and implementation in Northeastern Brazil using the same approach as the Integrated Cassava Research and Development Projects (ICRDP) that arose in Ecuador and Columbia with full participation of the NARS. Following discontinuation of the active phase of the ICRDP, Brazilian NARS was solely responsible for maintaining the innovation through technical skill and knowledge.

The NARS had a great deal of direct involvement in the development of roughly one-third of the farmers groups. It is important to note that the other two-thirds of the agro-industries—those without NARS involvement—have not achieved the same level of success and in some cases, are not functioning at all. The NARS played an important role in the adoption of cassava agro-industry by facilitating its introduction into the region, subsidizing the cost of adoption, and offering ongoing technical support to farmer's groups.

In Ghana, the extension agencies of the NARS were invaluable in assisting in the dissemination of the innovative package there. The role of these agencies is referred to as "complementary" because it is often critical in adoption, but it is rarely under the direct control of the entities conducting agricultural research.

Involvement of the NARS in India and Vietnam has greatly facilitated groundnut technology innovations. In fact, it was through concerted efforts of the CLAN-Vietnam-ICRISAT OFAR program that both partners were actively involved in the original identification of production constraints and alternative solutions, and in formulating plans for ultimate dissemination and adoption of the technology. NARS active role in disseminating information and offering demonstrations as well as technical advice, has led to higher levels of adoption. The author of those reports noted that in comparing these two countries there appears to be a direct relationship between NARS involvement and adoption.

In India, where the NARS has played a more minor role, the rate of adoption has been much slower. Vietnam has benefited from the full collaboration of the NARS.

The NARS are also full partners in the International Musa Testing Program (IMTP). The purpose of the IMTP is to link Musa breeders to the NARS who in turn will provide material directly to farmers. In reporting the results of the case study, IPGRI notes that the National Evaluation Programs (NEPs) set up by the NARS to evaluate germplasm under local conditions is vital to achieving the goals of the IMTP.

Participating NARS are motivated by the opportunity to obtain improved germplasm such as cultivars that are resistant to disease. Based on the data collected, it appears that the IMTP is successfully linking the NARS and breeders by facilitating transfer of germplasm and attempting to coordinate evaluation efforts.

It is also important to know the nature and extent of the involvement of farmers at each stage of the process of improving farming techniques. Specifically, it would be desirable to know whether farmers are involved in the original identification of the problem, in planning for its solution, and in formulating plans for ultimate dissemination and adoption of the technology. Farmers were the ones who identified the problem of labor shortages that led to the development of the SG harvester. Farmers are, of course, acutely aware of crop failures, such as the diseases that afflict banana plants, and they know what the problem is. It may even be that farmers know what the solution is for such problems: the breeding of a new, disease resistant plant variety. They almost certainly do not, however, have the technological capability to deal with the problem, so they must have help.

> The development of the SG harvester in the Philippines the subsequent switch to develop a stripper combine harvester in Vietnam were heavily influenced by farmers. In the Philippines, farmers provided information concerning performance of the harvester in the field; they suggested and actually made modifications to the machine itself and the way it was used. A number of adoptions were made by farmers who had some engineering or other background that led them to believe that they could themselves solve some of the obvious problems with the harvester, and some farmers did solve problems. Modifications incorporated by at least one manufacturer resulted in development of the harvester by an iterative process. The latest version of the SG harvester is based heavily on the re-design of one manufacturer, who subsequently gave IRRI and PhilRice permission to distribute his design freely. The current operator's manual and training videos feature farmer innovation in the harvest pattern.

Here is another point at which greater involvement of NARS might have been helpful since some of the improvements made by farmers could have been implemented nationally.

> In Vietnam involvement of farmers was a major factor in the failure of the SG harvester to catch on. Farmers identified a problem that was a direct consequence of the harvester, leaving straw in the field, and they also showed their preference for a combined harvester-thresher, which the University of Agriculture and Forestry subsequently began developing.

Some mechanism needs to be developed to elicit the views and preferences of farmers on a regular basis and particularly in relation to the introduction of any new technology that may require fundamental changes in the ways in which farmers operate.

Farmers are often involved in adapting recommended innovations to match local conditions.

> In the case of GPT, recommended groundnut planting practices were substantially altered. As part of the innovative package, farmers were encouraged to plant seeds using a broad-bed and furrow method, but in India this was not easily accomplished with the bullocks available to farmers so they shifted to a raised-bed and furrow method.
>
> In Ghana on-farm experiments offered the opportunity to experiment with varieties under local conditions as well as play a role in dissemination.
>
> The testing of the IMTP varieties under local conditions is crucial for their adoption. Plans are in process for the IMTP to have a greater regional focus in its future.
>
> The SG harvester case study found that eliciting farmer feedback from field demonstrations of prototype equipment was far more effective, and probably cheaper, than more abstract surveys.

If adoption of technological innovations in agriculture is to be enhanced, more deliberate planning to produce adoption will be required. The NARS are in a position to take responsibility within countries, but the NARS may not be uniformly committed to maximizing adoption of innovations, nor do they necessarily have the technical capability of formulating and carrying out strategic plans for bringing it about. The NARS, although critically important, are not even a specific organization but a congeries of organizations that may or may not work effectively as a whole. Some means needs to be developed in order to make clear the necessity for planning specifically for adoption, to promote the formulation of strategic plans, and to oversee the carrying out of those plans.

It would be misleading and unfair not to point out that NARS probably never have adequate resources with which to plan and carry out strategic adoption campaigns. To do a really good job would require personnel dedicated to and knowledgeable about the tasks involved, travel funds to get to field sites, funds to provide for multiplication of seed and its distribution, possible funds for initial subsidies of different activities, capacities to put on persuasive demonstrations, and so on. And that would be only the beginning because a strategic plan would include steps to monitor and maintain adoption until the innovation were fully established. That sort of activity would be obviously expensive. We believe that the expense would not be large relative to the total costs involved in developing and testing innovations, but it would not be trivial. Where such investments might come from is not apparent under present conditions.

In many ways the International Service for National Agricultural Research (ISNAR) is well positioned to focus on developing capacity for training for promoting adoption of innovations. The kind of activity that would seem to be required is first to promote awareness of the need for specific planning for promoting adoption and for allocating responsibility for it as explicitly as possible. It is likely that NARS would require some level of training, both with respect to responsibility for adoption and for the kinds of interventions required in order to enhance it. They may also need assistance in determining the kinds of organizational structures that are required for effective operations in the fields to ensure that plans are carried out.

There is, in fact, no specific mechanism, let alone any organization, designed or designated to carry out the tasks involved in planning and coordinating efforts to bring about the activities and processes required if adoption of technological innovations is to be other than a haphazard enterprise of highly uncertain success. The international agricultural research community needs in some manner to organize itself to pursue the identification of activities that will be required if its many worthwhile technological innovations are to have reasonable prospects for dissemination, testing, and adoption in the field.

Enhancing of adoption of innovations cannot be achieved without more active intervention to bring it about, and those efforts will involve financial commitments. The money that would be required in order to increase effectiveness of adoption efforts are probably small in relation to costs of developing innovations, and the costs of having those innovations unused does become large. Whether more explicit and careful planning could help make the case for increased funding for promotion of adoptions of innovations is uncertain, but the idea is sufficiently compelling to warrant a serious trial of it.

IMPACT OF INNOVATIONS ON WOMEN AND CHILDREN

The adoption of innovations in international agricultural research can be expected to have a wide range of impacts: improved nutrition, changes in demand for labor, increased food supply, increased income, and so forth. Some donors and sponsoring organizations are keenly interested in the impact of the work they support on the welfare of women and children; they are eager to know how innovations affect the lives and well-being of these segments of society. Although the chief aim of these case studies was to look at adoption, some sites were able to look a little beyond adoption to begin to explore the impact of the innovations. The welfare of women and children was not systematically studied in depth by any of the sites, but there are some relevant findings.

> Kenyan families who purchased a cow and engaged in small holder dairying were expected to benefit nutritionally from the extra milk produced. Analyses of anthropometric measures taken from children in adopting and nonadopting households failed to detect differences in acute malnutrition although there were fewer children suffering from wasting in adopting households. There was a trend, however, for children in adopting families to be less stunted. These data indicate that there is some impact of dairying on the nutritional status of children on the Kenya coast, although the impact was limited.
>
> In Ghana the modern maize varieties were promoted as weaning a food ingredient, but surveys showed that few families actually adopted this high-protein supplement.

In addition to nutritional concerns, it is important to examine how innovations affect the demand for child labor. None of the innovations appears to have led to an increase in demand.

> In the case of the SGH in the Philippines, increased adoption of the technology led to lower demand for child labor. One of the technologies considered by IRRI and UAF was a low cost dryer, costing $100, which was found to reduce time family labor spent drying by 39 hours per ton. This allowed children to spend more time studying, and freed men and women to do more profitable things. It also reduced the cost of drying from 10% of the value of the yield to 3.5%
>
> Even among Kenyan families with cross-bred cows, there was no evidence that children were held responsible for assuming more of the work related to maintaining the cows, although they certainly benefited from the increase in family cash income: the primary use of increased cash reported by adopters was to pay school tuition for children.
>
> The workload of women was reduced in communities adopting cassava agro-industry. The shift from producing labor-intensive cassava flour (farinha) to cassava chips relieved the women from that chore. In some groups, the women reported planting cassava plots by themselves and raising animals with the chipped feed. Extra cash income derived from the sale of cassava chips was used to purchase staples for the children such as food and clothing, as well as to send them to school and obtain reliable health care.
>
> Women in India had different perceptions of ICRISAT's groundnut from those of men. They liked the broad-bed and furrow system because it allowed for easier weeding and harvesting, but they disliked the drudgery involved in pod shelling of certain recommended varieties. Adoption for these women meant an increase in labor—both in the field and at home since they often shelled groundnut pods at home to have loose seed to sell. In focus group discussions, the women repeatedly called for improved technology to reduce the chores they perceived as tedious. It is

important to note that the increased labor demand is often met by hiring women from outside the family. Despite the fact that adoption of new groundnut varieties increased the workload of women, the family overall benefited from an increase in income.

Generally, the impacts of all these innovations resulted from increased disposable household income. With more purchasing power, families are able to obtain goods and services that greatly enhance their quality of life.

IMPLICATIONS FOR THE CGIAR

This project has not uncovered any miraculous ways of fast-tracking adoption of CGIAR technologies. Indeed, it has shown that there are many factors that contribute to successful uptake, and expectations of rapid and automatic uptake are naive. Substantially increasing the rate of adoption of technologies is not a simple task, especially those that are embodied within
sophisticated packages. A determination by the CGIAR to achieve an improvement in adoption has implications for the Centers, their NARS partners and for donor members.

Centers will need to:

- Put significant effort into the formulation of strategic adoption plans
- Develop the necessary skills to focus on adoption
- Devote significant resources to facilitating adoption
- Put extra effort into developing and maintaining effective relationships with in-country institutions
- Provide assistance to in-country institutions to develop appropriate capacity and skills for participating in the adoption process

NARS will need to:

- Develop the appropriate capacity and skills within the in-country institutions that will enable effective development and implementation of strategic adoption plans
- Strengthen links with CGIAR partners
- Promote increased interaction with farmers and farmer groups
- Devote significant resources to facilitating the uptake of beneficial technologies

Donors will need to:

- Recognize that promotion of adoption requires significant effort and lead-time
- Specifically allocate resources to the adoption effort as part of technology development projects
- Have realistic expectations of what is achievable.

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FOOTNOTES

[i]Although it is not possible to define exactly what is a "National Research System" or in some instances to even list what organizations comprise such a system, the term is used here to refer to the collection of organizations and other entities specific to a country that are involved in agricultural research and dissemination of its findings. In some countries these national (or regional) organizations are fairly institutionalized linkages while in others they are little more than a loosely connected group with a common purpose.

[ii] This study was already underway when the IAEG project was launched; and is still in progress. Nor did the ISNAR group participate in the project design workshop. The study thus does not share the common methodology with the other studies. This synthesis does not draw heavily on the findings so far. The study was included in the IAEG project to add strength to the institutional aspects of the project.

[iii] From the standpoint of economic investment criteria, a satisfactory outcome would occur once the discounted benefits outweigh the discounted costs of the research, in an admittedly narrow sense.

[iv] The agent is likely to be an organization, not an individual person.

[v] No implication that subsidy should have been provided is intended. Subsidies for any activity may or may not be desirable at any given time, depending on overall aims of a government or other agency.

[vi] Interestingly, although loans were offered to cooperatives on far more lenient terms than those offered to individual farmers, sales to cooperatives were very limited.

[vii] The maize system in Ghana was devised to be scale neutral, but it is possible that farmers with larger land holdings may still have perceived themselves as having more resources available to be risked. The point here, however, must be that the results are consistent with the resource hypothesis, not a direct test of it.

[viii] The SGH was offered to cooperatives under an arrangement in which they could have taken 10 years to pay off the cost, but cooperatives made few such purchases, apparently because of their difficulties in responding to new technologies.