Technical Bulletin
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Listening to Farmers: Qualitative Impact Assessments in Unfavorable Rice Environments

Stephen Zolvinski
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Supported by ADB–RETA 6136 Project
Integrating and Mobilizing Rice Knowledge to Improve and Stabilize Crop Productivity to Achieve Household Food Security in Diverse and Less-Favorable Rainfed Areas of Asia

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The responsibility for this publication rests with the International Rice Research Institute.

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Preface

The Consortium for Unfavorable Rice Environments (CURE) focuses on rice farming systems where low and unstable yields are commonplace. These areas have extensive poverty, and food insecurity prevails among the 100 million farm households in Asia that depend on rice. Difficult environments with problem soils, reliance on unpredictable rains, and susceptibility to flooding have meant that, in the past, farmers continued to grow mainly traditional varieties and use very few, if any, external inputs. As a consequence, recent productivity gains have been small. In order to improve the livelihoods of the millions of farmers in these unfavorable rice environments, an innovative approach was needed to tackle the challenges of sustainability and raising productivity.

CURE began in 2002 and is based on long-term partnerships between IRRI and the national agricultural research and. extension systems (NARES) working in rainfed environments. The Asian Development Bank supported CURE with a project titled *Integrating and Mobilizing Rice Knowledge to Improve and Stabilize Crop Productivity to Achieve Household Food Security in Diverse and Less-Favorable Rainfed Areas of Asia,* also known as ADB-RETA 6136, for the period January 2004 to January 2007. This project was led by Dr. Mahabub S. Hossain.

CURE built on the body of knowledge and technologies that have been developed, and it has promoted a wider understanding of the role of farmer participatory research in technology development. CURE has encouraged the development and validation of technologies under farmer-managed conditions in order to tailor their development to "social, cultural, and economic factors, as well as external policy and market forces."

A series of case studies were undertaken to highlight the importance of linking technology development with farmer participatory research to achieve impact on the livelihoods of resource-poor households in unfavorable environments. The technologies evaluated in this bulletin are an outcome of this ongoing research process.

PART 1

Introduction to research in unfavorable rice ecosystems

CHAPTER 1. Partnering researchers with farmers in unfavorable rice environments

What is CURE?

Although the recent economic miracle has raised living standards in many Asian countries, “hot spots” of poverty still exist where rural households have difficulties growing enough food and making enough income to support their families. These are the unfavorable rice environments, or largely rainfed ecosystems, where farmers are at the mercy of nature as they lack reliable water control as in irrigated systems. The Consortium for Unfavorable Rice Environments (CURE) is an international network of rice researchers who work to develop technologies to raise the cropping productivity of these rainfed ecosystems. CURE consists of six interdisciplinary working groups each dedicated to working in an ecosystem affected by a predominant stress or that have low system productivity.[1] The working groups are drought-prone, submergence-prone, and salt-affected soils, for the lowland ecosystems. For the uplands, working groups are the sloping rotational systems, drought-prone plateau uplands, and intensive systems with long growing seasons. CURE is guided by a Steering Committee consisting of senior managers of national agricultural research systems of the host countries, which ensures that the research agenda conforms to the priorities of the respective countries. The IRRI member is the deputy director general for research. IRRI coordinates the management of Consortium activities.

CURE is the outgrowth of IRRI and NARES’ partnered research in rainfed environments dating back to the 1990s. This research was organized in the formal structure of the Rainfed Lowland Rice Research Consortium and the Upland Rice Research Consortium. Following the recommendations of an external review, these consortia merged into CURE in 2002 to focus efforts in one organization and to bring synergy to the research process. Consequently, a body of knowledge and technologies were developed and research relationships were established in the decade prior to CURE’s establishment. The new Consortium continued to pursue these efforts with a farmer participatory research strategy. The technologies evaluated in this bulletin are an outcome of this ongoing research process.

An internationally coordinated approach brings certain advantages to research in the unfavorable environments because of the diverse, complex, and severe nature of stresses that affect rice production. In Raipur, India, for example, farmers may face severe drought every three years, and frequent drought may occur every season. Northeast Thailand may face severe drought three times every 10 years. The occurrence of multiple stresses in a given season is also common in unfavorable ecosystems. At the coastal salinity site in Orissa State, India, farmers may face drought or flooding in a single season, in addition to the risks posed by soil salinity. In some cases, farmers have developed indigenous farming practices that are fairly well adapted to these ecosystems. In the *bolon* double-transplanting system of northern Bangladesh, farmers are able to manipulate plant height to grow taller seedlings that can better survive in flooded fields. In other cases, indigenous systems are overstressed by human and natural pressures that have rendered rural households vulnerable to food insecurity. In Laos, for example, population pressure has reduced fallow periods of upland rotational systems to just 4 years. Several decades ago, the literature reported these systems had 7- to 8-year fallows, which then was considered too short to maintain long-term productivity (LeBar et al 1964:114).

The Green Revolution of the 1960s and 1970s achieved formidable results in terms of higher productivity for the relatively uniform growing requirements of irrigated systems.[2] Technologies developed on-station could be transferred to farmers’ fields with relatively reasonable success because of the similarity of irrigated environments. For unfavorable environments, on the other hand, research results on-station do not readily translate into successful outcomes in farmers’ fields. Interventions have to be tailored to specific environmental,

[1]At its 2007 meeting in Vientiane, Laos, the CURE Steering Committee agreed in principle to merge into four working groups. The Steering Committee will consider finalizing the merger at its 2008 meeting.
[2]We recognize that there is some diversity within the category of favorable rice ecosystems (Lansing 2007), but the degree of diversity is relatively higher in unfavorable rice environments.

Table 1. CURE working groups per subecosystem, key sites, and collaborating host institutions, 2002-07.

Lowland subecosystem	Key site and collaborating institutions	Upland subecosystem	Key site and collaborating institutions
WG1 Drought-prone	Raipur, India Indira Gandhi Krishi Vishwavidyalaya Ubon Ratchathani, Thailand Ubon Rice Research Center	WG4 Sloping rotational systems	Luang Prabang, Laos Northern Agriculture and Forestry Research Center
WG2 Submergence-prone	Faizabad, India Narendra Dev University of Agriculture & Technology Rangpur, Bangladesh Regional station of Bangladesh Rice Research Institute	WG5 Drought-prone plateau	Hazaribag, India Central Rainfed Upland Rice Research Station
WG3 Salt-affected soils	Cuttack, India Central Rice Research Institute	WG6 Intensive systems with long growing season	Arakan Valley, Philippines University of Southern Mindanao Lampung, Indonesia Indonesian Center for Food Crops Research and Development

social, and economic contexts of these ecosystems, requiring scientists to develop technologies with farmers in the actual environments where the technologies will be deployed. For example, varieties and management practices suitable for transplanting systems of the salt-affected lowlands of coastal India would be entirely inappropriate for the sloping rotational upland systems of Laos, where seeds are dibbled into the soil, and soil microenvironments are more diverse. Or submergence-prone crop management practices may be inappropriate for drought-prone plateau uplands where flooding is less likely to occur. Beyond purely agricultural concerns, the unfavorable environments may differ according to social and economic contexts. Lowland sites may have better access to roads and different kinds of marketing opportunities compared with steeper upland sites, for example.

For these purposes, CURE's interdisciplinary working groups (Table 1) of IRRI and national agricultural research and extension system (NARES) scientists bring to bear a critical mass of scientific expertise to examine the multiple issues at stake in the unfavorable rice ecosystems (Bennett 2005). While IRRI brings the technical expertise of an international research center, the NARES partners bring their local familiarity with cropping systems, soils, climate, and social, cultural, and economic factors to the research table. Together, and working with farmers, they are able to fit a technology to the ecosystem conditions where farmers make a living. Furthermore, the CURE research network allows cross-fertilization of ideas among research sites with similar problems. For example, herbicide recommendations generated from the WG1-Raipur site were tested at WG5-Hazaribag. In another case, the community seed bank model developed at WG6-Arakan Valley has been implemented at the WG6-Lampung site in Indonesia.

Table 2. Rainfed rice area and poverty ratios for countries where CURE operates.

Region/country	Area[a] (000 ha) 2003-05	Rainfed area[b] (%)	Poverty ratio[c] (%)
Southeast Asia	42,866	58	25.6
Cambodia[d]	2,167	92	34.0
Indonesia	11,734	46	27.0
Laos	756	86	40.0
Myanmar[d]	6,176	70	25.0
Philippines	4,083	33	34.0
Thailand	9,864	77	10.0
Vietnam[d]	7,412	45	28.0
South Asia	58,382	48	33.9
Bangladesh	10,941	45	36.0
India	42,750	46	34.0
Nepal[d]	1,537	51	38.0

[a]FAOSTAT, FAO 2006 (accessed 30 Jan. 2006). [b]Estimated using data from World Rice Statistics and CORIFA of FAO. [c]World Development Indicators 2004. [d]Satellite site, not supported by ADB-RETA 6136 Project
Sources: as quoted in IRRI (2007).

The work in unfavorable environments can cover considerable areas of national rice production lands. In Southeast Asia (Table 2), the percentage of rainfed area ranges from 33% in the Philippines to 92% in Cambodia, while South Asian partner countries have no less than 45% of total production area in rainfed rice. In many cases, poverty alleviation has been slower in areas dominated by rainfed systems compared with other rural areas of these countries. Poverty rates in India's rainfed-dominated states of Bihar, Madhya Pradesh, Orissa, and Uttar

Pradesh were 43.1%, 38.2%, 47.8%, and 34.1%, respectively, compared to the national rural average of 29.2% for 2004-05 (Mahendra Dev and Ravi 2007). While poverty figures relate to economic conditions, data collected from CURE sites indicate other important problems regarding food production and food security. Where farmers depend on traditional varieties, yields may be as low as 1.0 to 1.5 t ha^{-1} and food shortages may last anywhere from 3 to 9 months, depending on the socioeconomic status of the household, which is affected by access to good-quality land, financial resources, and trading networks. Male outmigration for wage-earning opportunities to improve household food security is a common strategy for households to cope with food shortages.

What, then, is the role of rice research in fighting rural poverty? Technology alone will not get results, unless it is critically linked to the overall livelihood system of poor rural households. IRRI views increased system productivity as the entry point that can have a generative effect upon the livelihood system. If a technology allows farmers to use land and labor more efficiently, rural households have better chances of growing enough food, which allows them to divert their scarce resources into other income-generating activities such as cash-cropping. As incomes rise, farmers have the opportunity to reinvest back into the household, such as in children's education or in more sustainable farming practices that protect the environment. System productivity is further enhanced with a secure natural resource base. IRRI terms this cyclical process the "virtuous circle" (Fig. 1). CURE technologies are designed not just to improve rice yields but also to situate rice technologies to improve system productivity. This may mean new establishment systems that use less labor and allow an earlier rice harvest so that farmers can better time a postrice cash crop. Early-maturing rice varieties fit into this scheme, as they allow timelier harvests and sowing of sequential crops. In other cases, nonrice crops grown in tandem with rice buffer against crop losses and could provide marketing opportunities. In these ways, the rice-based system is diversified, allowing farmers opportunities to spread risk over various activities for an overall better livelihood.

What is farmer participatory research?

Farmer participatory research is a cover term for an array of methodologies intended to integrate farmers' knowledge, experiences, and perspectives into the agricultural research process. As technologies are developed under the controlled experimental conditions of a research station, there is a need to understand the actual circumstances under which farmers would use them. The variable environments of soil types, weather, and stresses that farmers confront, and the distribution of labor in the household farming system, may not be easily replicated on the station. This is well articulated by Chambers (1997):

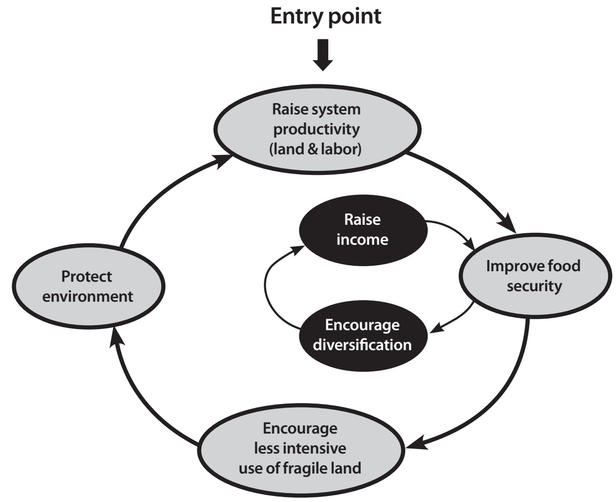


Fig. 1. The virtuous circle, IRRI's model for fighting poverty for its 2007-15 strategic plan (Pandey 2005).

> Often, though, the receiving environments differ from those in which the technologies have been developed, being more complex, more diverse, less controllable, and more risk-prone. The technologies then cannot on any scale fit local conditions or human needs.

Even if a technology is viable for biophysical parameters, on-station research cannot account for social factors, such as land tenure, poor infrastructure, and lack of access to capital, transport, and markets, that can constrain farmer adoption. Furthermore, farmers may have different criteria than scientists in evaluating the usefulness of a technology. Even if farmers find a technology useful, they will probably modify it to suit the circumstances of their local situations (Chambers 1983). Farmer participatory methods are designed to identify these sorts of constraints and to elicit farmers' criteria for judging the technologies. This is not just a matter of making sure farmers will adopt something coming out of research centers. This is a matter of mobilizing the research establishment toward committing resources to developing technologies that will make a difference in farmers' livelihoods.

The process of farmer participatory research requires scientists to welcome farmers as partners in developing new technologies. In that way, these methods bring together two sorts of "experts" into the research process. One group of experts are the scientists, whose knowledge grounded in empirical experimental research can contribute new technical procedures for growing and managing crops. The other group of experts are the farmers who have an intimate knowledge of the day-to-day conditions under which the technologies will be used. Channeling both experts toward a common cause is a relationship-building exercise that requires the development of rapport, trust, and mutual respect between scientists and farmers, and a realization that both parties bring valuable knowledge into the research process. Relationship-building may require scientists to develop a new skill set to complement their technical qualifications. Scientists must develop listening skills that are sensitive to farmers' concerns, and they must be willing to exercise patience as technologies are modified in the iterative process of on-farm experimentation. Of course, building good relationships requires research scientists to step out of their comfort zones to experience the sort of conditions that farmers actually face in rural areas. It will involve traveling long distances on poor, dusty roads and getting dirty and sweaty while walking fields in weather extremes in order to meet farmers where they make a living. The effort may also take considerable time away from scientists' usual research duties. However, it is a truism that the developing world is littered with technologies that started out as good ideas on the research station, but simply did not catch on with farmers. Farmer participatory research is essential for the efficient use of research resources as it can result in an effective application of scientific knowledge to real-world problems of rural areas.

So far, international agricultural research centers have developed several farmer participatory methods that are commonly applied in research projects. These are

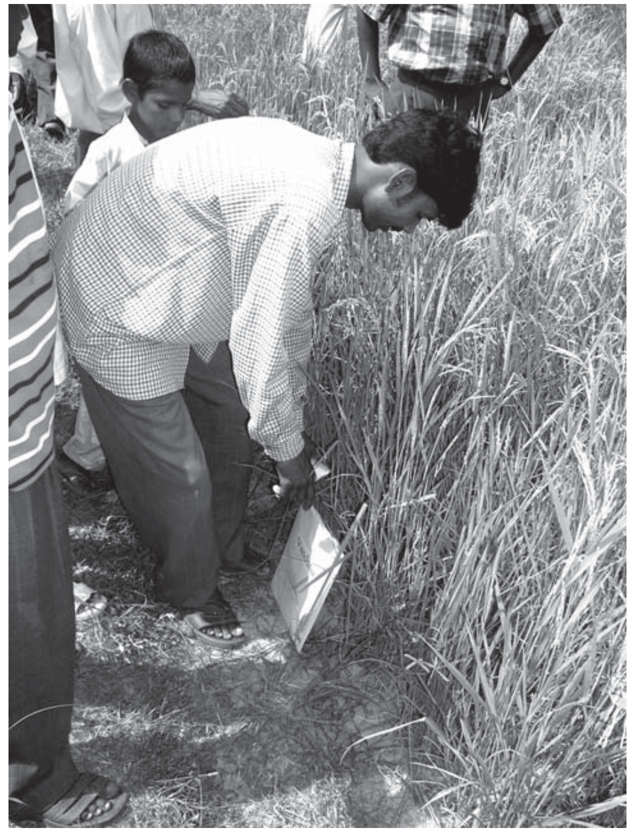
- The participatory rural appraisal (PRA): This is an exercise conducted early in a project for purposes of characterizing a village's natural social and economic environment where on-farm experiments will occur. PRA involves focus group discussions, key informant interviews, and the collection of secondary data, in order to describe the farming system, existing indigenous and new technologies, production problems, and social/poverty categories, as articulated by the farmers. Researchers use this information for designing interventions appropriate for the local context.[3]
- Participatory varietal selection (PVS): This is a process by which farmers evaluate new crop varieties/lines under on-farm conditions. PVS involves an initial round of researcher-managed on-farm "mother trials," from which farmers choose preferable materials, which are then evaluated in farmer-managed "baby trials," to give them actual experience in testing new germplasm. In both trials, visiting farmers vote their preferences, which is followed up with a group discussion to generate their criteria for their selections.
- On-farm experimentation: Scientists work with farmers to develop new crop management practices that may require households to considerably modify labor allocation, input levels, and the timing of seasonal activities. The introduction of direct-seeded rice establishment methods as an alternative to transplanting systems is an example. On-farm experiments are challenging because farmers do not observe the immediate results of the technology, as in the case of adopting new varieties. Furthermore, new "off-the-shelf" management practices may have to be modified considerably before farmers achieve the intended benefits of labor and cost savings.

The integration of farmer participatory research into project activities is not out of the reach of NARES partners who are more used to conducting narrower, discipline-focused research. Some CURE sites lack social science support, but biological scientists have done a commendable job through training and guidance from IRRI social scientists. In most cases, scientists' proper "attitude" is the way to earn farmers' cooperation and "gratitude" for successful outcomes. Experience in the ADB-RETA 6136 Project also shows that capable field assistants can be key in fostering relationships with farmers, as they are frequently in the village to guide farmers through experiments. They are an underestimated link that bridges the gaps in social status between farmers and scientists. Nevertheless, scientists need to be familiar with the key concepts and principles of farmer participatory methods in order to manage the research and also to sensitively handle farmer interactions when they visit villages.

Fortunately, IRRI social scientists have conducted training and workshops to educate NARES' scientists and staff about farmer participatory research. One such training is the two-week *Participatory Approaches to Agricultural Research and Extension* workshop conducted at IRRI headquarters, Los Baños, Philippines. Participants get actual practice in applying techniques at a rural village near IRRI, and they develop an action plan for their research center.

Some CURE sites have local social science support, people who work with biological scientists in the processes of building relationships with farmers. A good example is the CURE Working Group 6 site at Arakan Valley, Philippines, where social and technical specialists have established a Community Seed Bank, which is a network of seed producers who agree to follow proper seed health practices to provide a reliable supply of quality seed to the community. Farmers reported that their participation has helped them to overcome seed scarcity that made them vulnerable to food insecurity. Farmers took the initiative to formalize the network as the Arakan Community Seed Bank Organization, which is officially recognized by the Arakan municipal government. As

[3]We use the term "participatory rural appraisal" in the broadest sense as commonly understood by scientists in the CG system. Some specialists, such as Robert Chambers (1994, 1997), would describe these practices as a rapid rural appraisal, whereby "information is more elicited and extracted by outsiders" (1994). He distinguishes PRA as a community organizing tool to "enable rural people to share, enhance, and analyze their knowledge of life and conditions, to plan and to act" (1994). In either case, the knowledge gained from either practice is designed to involve rural households by informing the research process of their actual needs.



Participatory varietal selection (PVS), as conducted at Hazaribag, India, is now a standard at CURE key sites. PVS allows both men and women farmers to evaluate cultivars (left). Farmers can vote their preferences (right), which gives plant breeders direct feedback for varietal development.

a locally recognized institution, the ACSBO can sustain the benefits generated from farmer participatory research into the years to come.

What is the ADB-RETA 6136 Project?

The 2002 merger that resulted in CURE gave impetus to carry the body of research knowledge and technologies forward for farmer validation and the potential for dissemination beyond the CURE sites. With this view in mind, the Asian Development Bank (ADB) approved in late 2003 CURE's proposal for the three-year project *Integrating and Mobilizing Rice Knowledge to Improve and Stabilize Crop Productivity to Achieve Household Food Security in Diverse and Less-Favorable Rainfed Areas of Asia,* also known as ADB-RETA 6136. While much progress had been made in the prior years of research, CURE's proposal argued that actual impacts had yet to be achieved at the farm level because of the "diverse biophysical and socioeconomic conditions" in the unfavorable environments. To overcome these constraints, CURE proposed to further test new technologies under farmer-managed conditions in order to tailor their development to "social, cultural, and economic factors, as well as external policy and market forces…." In other words, CURE proposed to link technology development to its already established record of farmer participatory research for achieving observable and measurable impacts on the livelihoods of resource-poor households in unfavorable environments. The project, as approved by ADB, identified four major outputs:

1. **Feasible cropping innovations that combine complementary technologies for increasing productivity and reducing risks in rice-based cropping systems developed and evaluated with farmers; and experiences shared across key sites of the target rainfed environments**;
2. **Knowledge distilled into decision tools, management principles, and operational guidelines that are extension-ready; and extrapolation domains of improved production systems identified;**
3. **Capacity of NARES strengthened for implementing integrative and participatory technology development and dissemination; and**
4. **Farmer acceptability and viability of innovative production systems assessed; and policymakers and development authorities sensitized on supporting sector needs for wider adoption.**

Outputs 1 and 2 are conceived as "tangible products targeted at farmers." In other words, these outputs highlight the "downstream" nature of the CURE network in terms of developing technologies tailored to farmers' needs and actual social and natural environments, and then packaging them into

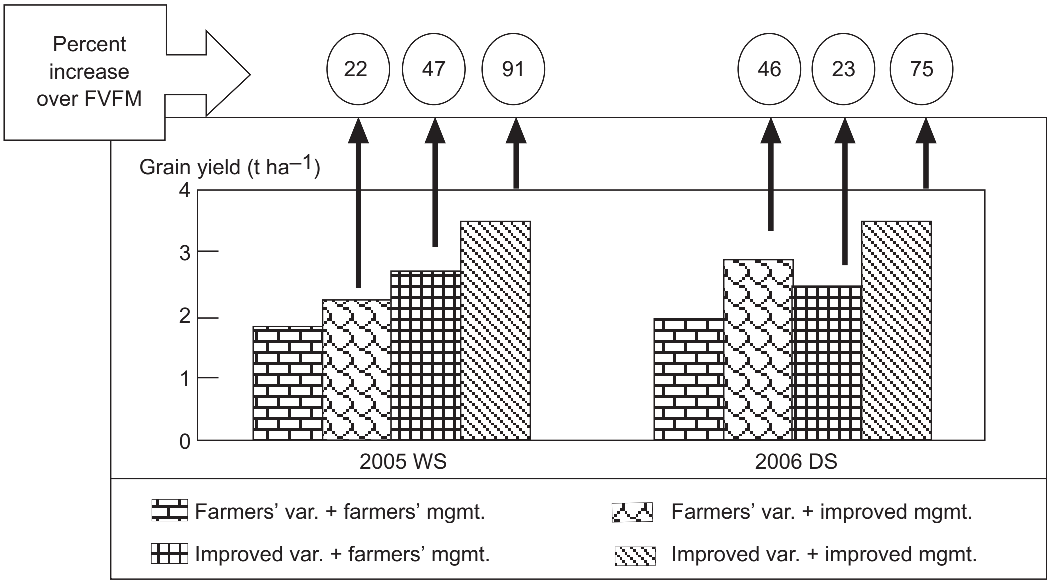


Fig. 2. Yield enhancement due to improved management practices and salt-tolerant rice varieties in farmers' fields in coastal saline soils, 2005 dry season and 2006 wet season. Source: Singh et al (2007).

deliverable products for wider dissemination where they can be adapted to similar environments. Although technology development is relatively site-specific in unfavorable environments, CURE's experience shows that some generalizations can be made about the research process. Germplasm was identified, or else developed, to better withstand the stresses related to these ecosystems, and matching crop management practices were developed that enhance the genetic potential of the new varieties. While better germplasm alone can achieve higher productivity, the integration of crop management practices can improve the chances of new varieties to more fully realize their productive potential.

Figure 2 makes this point explicit for the coastal salinity environment. Improved varieties with improved management outyielded farmers' usual management and usual varieties by 91% and 75% for the 2005 wet season and 2006 dry season, respectively. In both cases, the new varieties reached an output of 3.5 t ha^{-1}, which gives farmers the potential to stabilize yields over the two seasons. The data also indicate that management can be more important for germplasm to achieve its potential in the less-favorable conditions of the dry season when salinity is relatively high in comparison to the wet season. Improved management increased the yield of farmers' usual variety by 46% in the dry season vis-à-vis only 22% in the wet season. However, improved varieties with farmers' management achieved only a 23% yield increase in the dry season compared with a 47% increase in the wet season. This would indicate that varietal improvement can achieve significant results regardless of management under relatively "favorable" conditions of these "unfavorable" ecosystems. In any case, improved varieties and improved management practices give the highest absolute yield increases under any condition. Yields in the 2005 wet season and 2006 dry season were almost the same under improved varieties and improved management practices, but the absolute percentage yield increase declined from the average of 91% in the 2005 wet season to 75% in the 2006 dry season. The probable reason for this was that, just by observing, farmers had raised their base-level yields under the farmers' variety and farmers' management from 1.83 t ha^{-1} in the wet season to 1.99 t ha^{-1} in the dry season.

Although the technology development process is keyed to specific environmental contexts, other themes have emerged about the categories of crop management practices that could improve productivity in unfavorable environments. These practices can be generalized in the following categories:

- Improved nursery management practices to produce robust seedlings better able to withstand stresses after transplanting to the main field, and seedling handling practices for better timing of transplanting to the main field.
- Main field management practices, such as nutrient management, that promote the recovery of transplanted rice from the stresses of that ecosystem.
- Direct-seeded, line-sown crop establishment systems that improve crop productivity and usually allow for earlier rice harvest, and that give opportunities for system diversification through intercropping, mixed cropping, or sequenced cropping regimes.
- Proper seed health management and storage practices to assure a supply of good-quality seed for the next year's planting.

Outputs 3 and 4 have less immediate impact on farmers but involve other important stakeholders who can affect farmers' welfare in the long term. These are more strategic outputs that work toward building a knowledge framework of common understanding for continued research and policy initiatives needed to improve livelihoods in unfavorable environments. The ADB-RETA 6136 Project provided the support to build NARES capacity to conduct farmer participatory research through IRRI training, workshops, and IRRI social scientists' consultations with NARES. This was also necessary for successful completion of the project, as farmer participatory practices were built into the logical framework. The first CURE Steering Committee meeting during the project included the workshop *Innovative Research Methods and Strategies* in June 2004 at Ubon, Thailand, to expose the CURE key site coordinators to these methods. A few months later, an IRRI social science team conducted comprehensive in-country training for partners in Laos, where social science capacity is not as well developed as in other countries where CURE operates. To further upgrade farmer participatory skills, the CURE Steering Committee recommended that all key sites should make available to staff the *Participatory Approaches to Agricultural Research and Extension* annual training workshop at IRRI. All key sites sponsored at least one participant to receive this training in either 2005 or 2006. This training laid a foundation of basic skills in implementing farmer participatory approaches at the CURE key sites. Further training is needed to continue to train additional personnel (as some trained personnel have since left), build skills levels for more effective implementation, and also update national system practitioners on the latest advances in participatory approaches. On the other hand, national system practitioners can use their in-the-field experiences to contribute to discussions to further develop these methods.

Efforts to achieve Output 4 brought mixed results, as the policy arena is a relatively new venue for agricultural scientists more used to a narrower sector for technology development. Furthermore, the vagaries and intricacies of local and national political systems are often difficult to influence for positive outcomes. Nevertheless, some sites succeeded in getting the local government's agricultural officials to support CURE activities through seed distribution and by extending credit to farmers for purchasing crop inputs. CURE has also developed NGO partnerships through which promising technologies could be distributed to wider areas beyond the project sites. NGOs with agricultural field staff usually achieve the best results, as CURE's staff at key sites may be too limited to scale out technologies over a broad geographic area. Capable field staff are a critical link should farmers encounter problems and need follow-up support in guiding them in the use of the new technologies.

CHAPTER 2. The methodologies of this study

Why qualitative methods?

This study employed qualitative methodologies to assess the impacts of CURE technologies on the rural households where they were tested. Qualitative methods seek out farmers' perspectives on the new technologies in an effort to uncover their rationale for adopting or not adopting them. In other words, qualitative methods seek to answer the question "why" in the words of farmers. In this way, we can identify critical constraints and opportunities in the technology adoption process. This provides useful feedback for researchers to modify technologies to make them more useful to farmers. If the study finds that the technologies are useful, researchers can then gain insights into farmers' decision-making processes for developing future technologies that meet farmers' criteria. It is obvious that qualitative methods are a natural fit for farmer participatory research in which researchers continually interact with farmers to tailor technologies to their requirements.

Qualitative methods can be best contrasted to quantitative methods in which researchers use numerical indices to describe the outcomes of farmers' behaviors. There is a vigorous debate in the research community about the merits of the use of either methodological approach. It sometimes seems that quantitative methods are more "objective" as results are reduced to a single number that is sanitized of researchers' biases. It may also seem that qualitative methods are too dependent on the researchers' subjectivities and may even reflect an ideological persuasion. The arguments either way can be overstated and even polarizing as practitioners of either method claim that their approach is more effective in getting to the "truth" about events in the real world. We contend that this debate is a needless expenditure of intellectual energy, as both methods have their strengths and weaknesses, and both methods can contribute considerable insight to research questions. The old research adage "garbage in, garbage out" applies here. Either method can obtain poor results if the methods are improperly applied. To be sure, qualitative methods are now a standard in social scientists' toolkit, and they have been shown to be effective in research in both the public and private sector (Krueger 1994:27-30).

Although quantitative results can be very accurate, researchers are still left to their assumptions about why farmers behaved in the ways indicated by the numerical indices. Qualitative data can confirm whether farmers' rationale for adoption is the same as scientists' rationale for proposing the technology, and, if not, why not. The qualitative data can also identify cultural constraints not readily identifiable as the NARES partners may come from a different social class or even cultural background than rural householders. Our Bangladesh data identified social class prestige factors that prevented farmers with medium-size landholdings from seeking outside employment during slack laboring periods, for example. Furthermore, a rigorous quantitative survey may be too costly and may take too much time for project monitoring. In this case, results were obtained rather rapidly within the means of the project budget in order to apprise essential project personnel about the effects of the research on rural households' livelihoods.

Methodologies employed for CURE's qualitative assessments

The basic social science tool employed for this study was the focus group discussion with participating farmers. A set of open-ended guide questions was designed to elicit discussion about a range of issues about farmers' specific experiences in using the technologies, the results on crop performance, intent to adopt, and overall issues of food security and effects on household livelihood. The questions were formulated from project documents that specified the expected outcomes, so farmers' responses could be judged against scientists' original assumptions. The questions were usually asked in the local language using a field assistant or scientist involved in CURE activities. Notes were hand-written during the discussions and, as soon as practicable afterward, written into a word-processing program for later analysis.

In general, we were able to follow the social science literature regarding a prescribed size of 4 to 12 participants per group (Krueger 1994:17). However, sometimes the groups were double the recommended size. A focus group in the NGO

Table 3. Sites of CURE qualitative assessments for ADB-RETA 6136 Project.

CURE key site	Dates	Sites
Hazaribag, India *WG5 drought-prone plateau uplands*	2-5 Nov. 2006	**CURE sites** Amin Village, Chatra District; Lupung Village, Hazaribag District; Kuchu Village, Ranchi District **NGO sites** Ankaran NGO Training Center, Chatra District; Pawo Village, Chatra District; Asani Village, Chatra District
Cuttack, India *WG3 salt-affected lowlands*	29-30 Nov. 2006	**CURE sites** Kimilo, Erasama block, Jagatsinghpur District; Chaulia, Erasama block, Jagatsingphur District
Luang Prabang, Laos *WG4 rotational sloping uplands*	27-28 Feb. 2007	**IFAD Project sites** Nam Haeang Tai, Oudomxay Province; Nam Haeng Neua, Oudomxay Province
Rangpur, Bangladesh *WG2 submergence-prone lowlands*	27-29 March 2007	**CURE sites** Dharmondas Village, Tampat block; Sheikpara Village, Darshona block; Kishamot Habu, Gangachara upazilla **NGO site** Babarighar Village, Nilpharmari Shadar upazilla
Arakan Valley, Philippines *WG6 intensive upland systems with long growing season*	26-28 June 2007	**CURE site** Arakan Valley, North Cotabato Province, Mindanao Island
Raipur, India *WG1 drought-prone lowlands*	30 Oct.-2 Nov. 2007 (analysis under way and unavailable for this publication)	**CURE sites** Tarra Village, Raipur District; Hingnia Village, Durg District; Kotanpali Village, Mahasas-mund District

village, Asani, India (WG5), involved about 25 farmers. In this case, farmers came from three neighboring villages as transportation would have been difficult for us to reach each village for separate discussions in such a limited time frame. This was also the situation in Arakan Valley, Philippines, where about 25 farmers involved in three different technology interventions assembled at one location due to logistical constraints in doing separate focus group discussions. In most cases, the focus group "event" attracted nonparticipating farmers from the same or a nearby village. Many of these farmers actually provided useful comments on whether or not they would be interested in trying the technologies used by their neighbors. In other cases, some of the nonparticipants provided extraneous information that seemed irrelevant to the issues at hand, which required a tighter management of the discussion.

Where farmers could not be easily drawn to a location as a group, key informant interviews were conducted of individual farmers. A "key informant" is a person with a specialized knowledge of a certain topic, in other words, an "expert" who can fluently discuss most aspects of the subject. We can consider the participating farmers "experts" in the technology adoption process as they could relate their firsthand experiences in trying out the technology under their actual conditions. This was the case at Hazaribag, where farmers in two villages were extremely busy sowing fields with a postrice chickpea crop. In this case, we conducted interviews with farmers in the field. Although the data were not as extensive as in formal focus group discussions, the fact that farmers were sowing a postrice crop indicated to us that a project outcome had been achieved, that is, crop diversification. Furthermore, we obtained valuable insights into scientist-farmer exchanges as the fields were being sowed. We also had to resort to key informant interviews when there were problems in being able to arrange for farmers to assemble at a particular location. This was the case for an NGO village at Hazaribag, and security precautions prevented us from visiting the village.[4] Instead, we were able to interview two farmers who happened to be at the NGO's training center in Chatra Town.

Logistical and scheduling difficulties prevented us from doing impact assessments at all key sites (Table 3). However,

[4] At a few CURE sites, some villages are located in areas affected by political and social turmoil, often requiring precautions to assure security of visitors. In Jharkhand State, India, the Naxhalite insurgency continues to be active, including at some areas where CURE and NGOs work with farmers.

Focus group discussions for qualitative assessments took place where farmers could be easily assembled: (from top, clockwise) in the field, Kotanpali Village, India; a local restaurant, Arakan Valley, Philippines; a popular village meeting area, Kuchu Village, India.

we believe that we have selected sites that fairly represent the kind of work that was done under the ADB-RETA 6136 Project. In all, we have two lowland ecosystems and three upland ecosystems represented. Furthermore, the Hazaribag site, although an upland site, is a continuum with the lowland drought-prone ecosystem with which it shares certain characteristics.[5] At each site, we attempted to prioritize our efforts on CURE villages, although in some cases we were fortunate to have access to nonparticipating villages where NGOs or local government units had introduced the technologies. This was entirely the case in Laos, where the WG4 team had handed off new technologies to local governments in Oudomxay Province through an IFAD loan program. We were very interested in nonproject sites as this would allow us to assess the acceptability of the technologies to farmers beyond the CURE sites where they were developed.

[5] While this publication was in progress, a qualitative assessment was conducted at the WG1 key site for drought-prone lowlands at Raipur, India (30 Oct.-2 Nov. 2007). Results were being compiled and were unavailable at the time of producing this publication.

The results of this study are limited by several factors in the application of qualitative methods in an international agricultural technology context. Briefly, they are

- Lack of a control group: Qualitative research can benefit from the usual quantitative methodology of doing a parallel survey of a disparate group for comparison purposes. For this study, however, focus group discussions were conducted only with project participants, who were obviously committed to the program. We did not interview people who dropped out of the research program, which would have given us insights into farmers' constraints about the technology.
- Language fluency: Anthropologists have long advocated the use of the informants' local language in order to get an "insider's" rich view of the culture. Some CURE sites are home to ethnic minority groups that use the national language as a secondary means of communication, usually for marketing or dealing with outside officials. Our farmer discussions in Laos were such a case, where the Lao national language was used in discussions with the Khmu ethnic minority.
- Gender divide: It was not always possible to do separate group discussions with women, although this did occur at Cuttack. But, in that case, the discussions were facilitated by male researchers, which can affect an open exchange of ideas between genders.
- Social and cultural gaps: Resource-poor farmers are generally of a lower social status than researchers with a formal education from national universities. There may be a tendency for farmers to say what researchers "want to hear" out of respect for the higher status of the researchers, or else to assure the continued flow of project material to the village. Although this is possible, farmers did often come forth with negative points about the technologies, which indicates the forthrightness of their opinions. We can also attribute farmers' openness to a spirit of trust that was built between the researchers and farmers during the life of the project.
- Translator fatigue: After an hour or so of group discussion, researchers can become mentally fatigued with translating the dialogue from the local language to English. This may affect the extent and precision of the translation late in the discussion as the researcher is too tired to elaborate all points made by farmers. This is also a management issue, as the social scientist should craft a more deliberate question guide that addresses the main points of the research rather than copious minutiae.

We note that the above limitations can occur with any research method, qualitative or quantitative. The key is to be aware of limitations and control for them as much as possible and try to overcome them with redundant methodologies. As a corrective, we conducted more than one focus group discussion, when possible, at each site, with the intent to record common themes emerging from farmers' perspectives.[6] In this way, we could evaluate which points were significant for the technology development and identify minor points as an outlier category.

[6] Only in Arakan Valley did we conduct a single focus group discussion, but this was followed up with farm visits, which helped us to relate farmers' comments to their field conditions.

PART 2

Impacts assessed at CURE key sites

CHAPTER 3. Rangpur, Bangladesh: Working Group 2 for submergence-prone lowlands

The Rangpur Regional Station of the Bangladesh Rice Research Institute (BRRI) is one of CURE's two key sites for the submergence-prone lowlands. The other site is located at Faizabad, India. Rangpur is in northwestern Bangladesh, where there are three predominant growing seasons, each of which has its own cropping requirements based on climate and water availability. The traditional wet-season crop, T. *aman*, is grown during the monsoon season that extends from mid-June through November/December. The dry-season crop, *boro*, which is irrigated by tube wells, is from November/December to about mid-June. A third crop, *aus*, is possible by taking advantage of the early monsoon from about March through July/August. In some cases, farmers may combine the irrigated season of boro with the rainfed potential of aus, for the *braus* season.

Flash floods and seasonal stagnant waters are constraints to rice production in this environment. However, the 2006 wet season was atypically dry, which limited our ability to assess technologies developed for the submergence-prone environment. Only one village reported a flash flood, and it lasted only 2 days, although the technologies were designed to allow rice to survive submergence for up to 2 weeks. While it was fortunate that farmers did not have to endure flood damage,

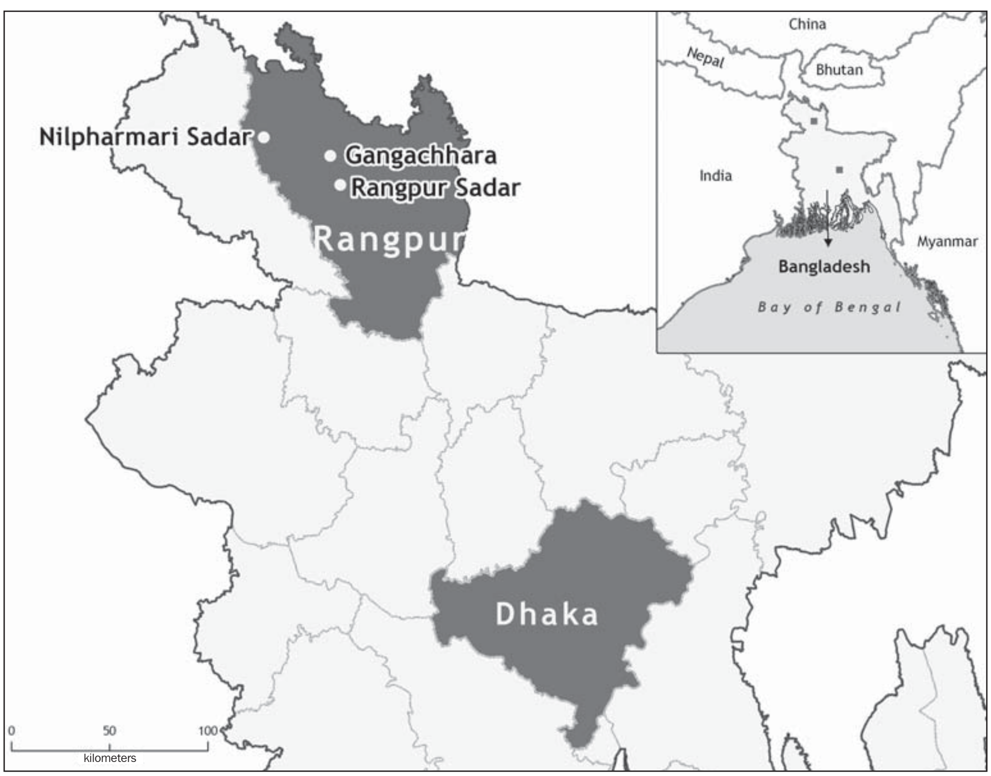


Fig. 3. Rangpur District, in northwestern Bangladesh, is a CURE key site for submergence-prone lowlands.

Table 4. Social structure of *monga*, Rangpur District, Bangladesh.

Landholding category	Landholding size (ha)	% of population	Food security status
Large (wealthy)	1.0–2.0	10	Secure
Medium	0.50–0.60	20	Vulnerable 2–4 months
Agricultural laborers	0	25	Purchase food
Nonagricultural laborers	0	45	Purchase food

the conditions were not suitable for the first year of on-farm tests of the submergence-prone variety Swarna-*Sub1*.[7] Other technologies introduced here were nursery practices designed to raise quality seedlings able to better withstand and recover from submergence.

However, we were able to engage farmers in considerable discussion about WG2-Rangpur's introduction of early rice establishment systems for mitigating *monga*, the food-short and labor-slack period right before harvest of the T. aman rice crop. An earlier rice establishment provides better timing for planting two later (rice or nonrice) crops, which can intensify the farming system with year-round production on the same plot of ground. The objective is to relieve food shortages and unemployment during hungry months, while raising the overall system productivity for remunerative cash crops. Actually, a second *monga* occurs in boro, but WG2-Rangpur prioritized the T. aman period as they consider it to be more severe.

Testing direct-seeding practices to mitigate *monga*: the rice-potato-maize cropping system

Monga occurs from mid-September to mid-November (in Bengali, these are the months from *Ashwin* to *Kartik*) when rice is at the flowering to ripening stage. At this time, owners of medium-sized farms have to borrow from moneylenders at unfavorable rates to secure cash for buying food, whereas landless laborers have to seek employment inside and outside of the village. The additional debt is burdensome for the medium-landholding farmers who have already incurred educational expenses for their children. These farmers are of a higher social status, and prestige factors inhibit their willingness to find laboring jobs to earn income. As one man put it, "How can I go to other people asking for work? I hire people for my farm." *Monga*, then, has implications that radiate through the community social structure (Table 4) as it affects owners of medium landholdings, who, as a class, are upwardly mobile, and the landless laborers who depend on the large and medium-landholding farmers for employment. WG2-Rangur's *monga* mitigation approach involves the introduction of direct-seeding practices to establish rice 3 to 4 weeks earlier than by the traditional transplanting practices. The long-duration popular variety BR 11 can be seeded by mid-June, and the newly introduced short-duration variety BRRI dhan 33 can be seeded by late June. The direct-seeding practices introduced to farmers include wet direct seeding by a drum seeder in puddled soil and dry direct seeding by a *lithao* in dry soil on medium lands and highlands. These new practices contrast with farmers' use of single- or double-transplanting methods known as *naicha* or *bolon*, respectively. *Naicha* is done on medium and high levels of the toposequence, where flooding is less likely to occur (Azad and Hossain 2006: 2-4). *Bolon* is an indigenous management practice in which farmers manipulate seedling growth to get taller plants that are better able to withstand the high water level in the lowland after flooding. After seeding in the nursery (*bechan bari*), seedlings are transplanted at dense spacing (10 × 10 cm) in a fertilized plot on highland (*bolon bari*). When the risk of floods recedes about 1 month later, farmers finally transplant to the main field (*dhan bari*) in the lowlands. Even if flooding should occur, the aged, tall plants are better able to survive floodwaters.

Farmers' perceptions of *monga* mitigation technologies

Rice component

Farmers indicated that BR 11 gave better yields when direct seeded by a drum seeder compared with *naicha* and *bolon* traditional practices. Yields ranged from 4.0 to 6.5 t ha^{-1} with a drum seeder compared with maximum yields of 4.6 and 4.0 t ha^{-1} with *bolon* and *naicha*, respectively. These figures cannot be generalized to the whole project because they do not include yields from farmers who used these practices but did not participate in the focus group discussion. However, the fact that farmers were able to harvest by mid-October to early November (versus late November or December) indicates that the project achieved a major objective for earlier harvesting with little yield penalty, and with probably a yield gain by using their usual variety. When asked why they could not establish rice earlier with traditional methods, farmers said that it would require irrigation, which would be cost-prohibitive. They said they were unaware of any other methods for earlier crop establishment until CURE began to work in their villages.

[7] WG2-Rangpur had better success evaluating Swarna-*Sub1* under natural flooded conditions with extensive area-wide on-farm tests in 2007.

CURE was able to introduce a limited amount of short-duration variety BRRI dhan 33 to some farmers, and it attracted considerable attention from their neighbors because of their interest in the earlier maturity. As one farmer put it: "I would like to use BRRI dhan 33 because it is an early-maturing variety. Up to now, I didn't know much about it until I saw my neighbor planting it. You can harvest it 15–20 days early." Farmers' interest appears to be widespread because farmers at Babarijhar Village indicated that BRRI dhan 33 is now preferred over BR 11 in the highlands because of the promotional efforts of the Udyonkur Seba Sangstha (USS), a local NGO working in Nilpharmari District.

The labor-saving aspects of direct seeding drew favorable comments compared with the labor-intensive *bolon*. As farmers reported, the numerous tasks in *bolon* involve nursery preparation, sowing, and uprooting seedlings from the nursery, and then field preparation and transplanting to the first field in the highland, and field preparations and final uprooting and transplanting to the second main field in the lowland. Uprooting and transplanting operations may require as many as 4 to 5 laboring-days per *done*, a local unit of land measure equivalent to 0.10 ha, which can be a considerable labor cost that is not incurred using direct-seeding methods.

Sequence crop component

System intensification to mitigate *monga* also has positive benefits for establishing an early sequence crop of potato. Farmers related that early-established potatoes avoid late blight that requires a spraying at 7-day intervals for a total of 10–15 sprayings per potato-growing season. As they continue to spray over several seasons, the treatments become less effective, requiring higher application rates and obtaining lower yield, they said. One spraying costs taka (Tk) 3,705 ha^{-1}, which can amount to a production cost of Tk 44,460 ha^{-1} for 12 sprayings. Cutworms also infest late potato, requiring one or two sprayings. A bottle of insecticide is Tk 70 per 0.10 ha, or about Tk 700 ha^{-1}, excluding application costs.

Farmers said that early potato establishment considerably decreases the number of sprayings to control late blight to as few as two or three per potato growing season. As one farmer put it, "This year, I tried Diamant (a potato variety) supplied by the project. Potato was sown on 30 November, and I sprayed only four to five times. Without the technology, I would have to spray at least 10 times per potato growing season."

The fact that the project supplied foundation seed from a potato seed multiplication center might also raise the system's productivity, as it is often out of the financial reach of especially the poorer farmers. The project supplied 60-day potato variety Patronees, and farmers averaged about 18.0 t ha^{-1} compared with on-station results of 17.7 t ha^{-1}. Farmers were also supplied with 90-day Diamant, which averaged 20.4 t ha^{-1} on-farm compared with 22.0 t ha^{-1} on-station. Farmers complained that good-quality seed is expensive, so they take out production loans at unfavorable rates from moneylenders. Therefore, the lowered productivity from poor-quality seed reduces their return on investment. This appears to be a chronic problem in potato-growing areas that may not be easily addressed. Some farmers said they could avoid this debt cycle by growing crops such as mustard and wheat, which also require less labor.

Table 5. Seasonal rice price fluctuations as reported by farmers, Rangpur District, Bangladesh.

Month	Price (taka $kuree^{-1}$)[a]	Price (taka kg^{-1})
Mid-march to June	170	12.97
June to mid-September	120–125	9.16–9.54
Mid-September to end of November	150	11.45
December to mid-March	120	9.16

[a]A kuree is a local unit of volume equivalent to 13.1 kg.

Food security/employment situation during monga

Farmers described *monga* as a serious problem, which they say is being mitigated by the new technologies. A farmer in Kishamot Habu Village related: "There is *monga* here. There is no employment [at that time], and rice prices are high. There is no food in the house." By harvesting rice early, rural households can benefit from higher prices due to rice shortages at *monga*. According to farmers' reports, the cost of rice can fluctuate by Tk 3–4 kg^{-1} between *monga* and the months when supplies are plentiful (Table 5). Another economic benefit is that straw prices are higher because of supply shortages at *monga*. Straw is used for livestock feed.

With the adoption of new technologies, a certain kind of community dynamic occurs that results in tangible benefits to the various categories of people, both well-off and very poor. The landless agricultural workers are able to get work and the medium-landholding farmers can harvest rice early to improve their food security. Both medium-landholding and large-landholding farmers are able to sell their rice and also straw when prices are higher because of the *mon*ga shortages. The landowners said they benefit from lower wage rates during the high unemployment period of *monga*.

A good example of this dynamic is the case of a medium-landholding farmer who holds an off-farm job, so his land is cultivated entirely by nonhousehold laborers. He is supporting a 22-year-old son in college, and the education of two younger sons and a daughter. He reported that the amount of money borrowed to get through *monga* has been halved from Tk 20,000 to Tk 10,000. He said, "If people can grow rice, many people will have opportunities to work in the fields. The landless people will be able to work in the field and will benefit from the jobs.

"These technologies might not reduce *monga* 100%, but at least 50% of the landless people could benefit from *monga* mitigation," he added.

Villagers also mentioned that improved rice production also smoothens the relationships between the better-off and poorer social groupings. The rich farmers' social status increases because they have enough rice to lend to poorer relatives for surviving during *monga*. There is no interest charged for lending rice to relatives. The borrower pays it back with no interest or can sometimes pay it back with labor. In addition, rich farmers can give work opportunities to day-laborers during *monga*.

Evidence of the adoption of direct-seeding practices to mitigate *monga*

Evidence of farmers' adoption was apparent from their expressed intention to expand direct-seeding practices in the coming cropping season. "It is important to be able to test it first," a farmer related. "We got a good crop, and the other people saw it and were surprised. So now they want to participate." Farmers said they devoted a small amount of land, perhaps 0.1 ha, to the new practices for testing in the first year, and then they planned to expand the area by about threefold in the next cropping season. For example, in Kishamot Habu village, there were two farmers with 0.9 and 1.0 ha total landholdings, who planned to expand the new practice from 0.1 ha in 2006 to 0.3–0.4 ha in 2007. At the NGO village Babarijhar, Nilpharmari District, one farmer plans to double potato area to 0.53 ha in 2007. "Because of the early potato establishment due to early harvest of aman rice, I am interested in growing more potato," he said.

In the meantime, nonparticipating farmers have been watching the results in neighbors' fields, and they decided to try out the new practices. For example, one nonparticipating farmer will try out direct seeding on 0.2 ha of his 0.6-ha landholdings, citing labor savings, earlier rice harvest for more timely potato seeding, and ability to intensify to three crops per year. "These people are doing it," he said. "I ask myself, 'Why am I not doing it?'"

Regarding the use of a *lithao* for direct dry-seeding establishment, a landless farmer in the NGO village reported that his rice looked the same "as transplanted rice" on 0.15 ha of rented land. He wanted to expand to 0.3 ha in 2007. If his situation is representative of that of similar farmers, then adopting the *lithao* may be feasible for landless farmers. Another farmer established one-third of his 0.4-ha land area with a *lithao,* and he wants to establish rice with a *lithao* on the entire farm in the next year. Of the group of 12 farmers in the discussion, about four raised their hands when asked if they wanted to use the *lithao*. "If the USS (NGO) does not continue to work with us, we will continue because direct seeding gives better yield than transplanted rice," one farmer said. Any expansion here might be limited by the fact that the only two *lithaos* were available in the village, supplied by the BRRI Regional Station, Rangpur. But the farmers discussed possible ways they could support additional implements, perhaps by pooling their funds. The fact that farmers were discussing an initiative to pursue this technology is further indication of their deep interest in adopting it. This is the sort of self-help approach taught by the USS NGO that seeks to energize community members to seek out their own solutions.

Testing technologies for submergence-prone environments

Although the rainfall shortage did not make 2006 an ideal year for doing on-farm research for submergence-prone environments, we did pursue discussions with farmers on technologies deployed for flash-flood conditions. The FGDs revealed insights into farmers' thinking on these technologies and how they would fit into their farming systems. Through the process of discussion, we could discern how the technologies would have to be modified to make them acceptable for eventual adoption. What follows are farmers' perceptions of quality seedling raising and the newly released Swarna-*Sub1*, which was developed to improve rice survival under flooded conditions.

Quality seedling raising

The working group has been developing nursery management practices involving lower seeding rates and the use of nutrient inputs that would develop healthier seedlings better able to withstand submergence. The researchers intended for this new technology to replace the *bolon* system as it would save the labor of the various tasks involved in double transplanting. However, a socioeconomic study done at Rangpur (Azad and Hossain 2006:16) found *bolon* to be an efficient practice in terms of rice yield and net return despite higher labor costs than with single transplanting. The report recommended that researchers refine the system rather than replace it altogether. Farmers' comments from the focus group discussion complemented the quantitative study, as farmers indicated they would prefer to use *bolon* on flood-prone lands and reserve the quality seedling practice for medium-level lands where single transplanting was dominant. The qualitative data were able to discern farmers' decision-making process to further educate researchers about the crop production requirements for this village's particular ecology.

Kutipara Dharmodas under Sheikpara village is a tribal (*adibasi*) community in which farmers divide their lands into five categories, of which three are cultivated for rice. These are the highlands, or 12.5% of the available land on which rice is established by single transplanting. The medium section consists of medium highland, medium land, and medium lowland. Of this land, farmers cultivate only medium lowland by using a transplanting practice involving split tillers. The medium lowlands are 12.5% of the available land cultivated here. The lowlands are the largest land category, 75%, where rice is established by *bolon* double transplanting. The varieties used are BR 11 and Red Swarna, the latter an Indian variety that is not registered in Bangladesh but is available through farmer-to-farmer seed exchange. Farmers were able to get Swarna-*Sub1* through CURE, although flooding was not a problem during the season.

In the usual system, farmers use very few purchased inputs for nutrient management. The usual input is cow dung applied to the nursery. If seedlings are yellowing, then farmers may apply urea at 20 days after seeding. Other purchased inputs may be insecticides to control thrips.

For the quality seedling raising trials, the research team recommended a lower seeding rate (at 50 g m^{-2}), and a nutrient regime consisting of

- Farmyard manure (FYM), 40 kg per decimal[8]
- Urea, 528 g $decimal^{-1}$
- Triple superphosphate (TSP), 253 g $decimal^{-1}$
- Zinc, 225 g $decimal^{-1}$
- Furadan (carbofuran), 40 g $decimal^{-1}$ (for nematode control)

Farmers were able to get much better yield with quality seedlings than with their usual practice. BR 11 yielded 4.63–4.94 t ha^{-1} versus 3.08–3.85 t ha^{-1} with *bolon* and Swarna-*Sub1* yielded 3.85–4.01 t ha^{-1} versus 2.77–3.08 t ha^{-1} with *bolon*. We note that the researchers recorded higher yields (BR 11, 5.0–5.1 t ha^{-1}, and Swarna-*Sub1*, 5.4–5.7 t ha^{-1}). The discrepancies might reflect the experience of the three farmers interviewed, whereas others might have had better results. Farmers also mentioned the labor savings of raising quality seedlings compared with *bolon*. Using cost data supplied by farmers, the total cost of raising quality seedlings was Tk 1,274 per 0.1 ha compared with Tk 1,547 per 0.1 ha for *bolon*. The 17% difference was largely due to the labor savings in raising quality seedlings.

Despite the labor savings and good yields in 2006, farmers perceived that quality seedling raising would be a good practice for the single transplanting system in medium lowlands. They discussed two main constraints for applying it to flood-prone lowlands. One was that highland nursery area was very limited, so a higher-density seeding rate is required in order to have sufficient seedlings to cover the wide area of the lowlands. Second, they felt that the *bolon* system allows better coordination of transplanting relative to floodwater levels in the lowlands. The first transplanted plot gives them the flexibility to wait until floodwaters recede for the final transplanting. This flexibility is not available with a single transplanting system, as would be used with the newer technology.

We must caution that 2006 was not a flood-prone year, so farmers did not evaluate the practice under the conditions for which it was developed. A second point is that lower-density seeding rates may be suitable for some areas where sufficient nursery area is available or there is less lowland area to cover. In this way, the specific ecosystem requirements need to be considered before upscaling the technology to other villages. We should also note that the fertilizer regime seems rather complicated for an on-farm field experiment. Certainly, under researchers' guidance, farmers might be able to achieve favorable results, but farmers may forget the exact rates once the project support ends.

Swarna-*Sub1* performance

Swarna-*Sub1* is the first product of advanced molecular techniques, and 2006 was the first year that the variety reached farmers at CURE's submergence-prone sites in Bangladesh and India (WG2-Faizabad) for testing. Although developed to tolerate up to 2 weeks of flash floods, the sites doing on-farm testing experienced an unusually dry year in 2006 in which flash flooding was not a serious problem. At Rangpur, one of the villages, Kishamot Habu, tested Swarna-*Sub1* under only 2 days of flooding. Nevertheless, we report here farmers' perceptions of Swarna-*Sub1* as it could influence their future acceptance of this technology.

Farmers perceived that Swarna-*Sub1* was not tall enough for it to survive stagnant waters that are frequent in these ecosystems. Seedling height of Swarna *Sub1* is shorter than that of BR 11. This is a sound point because Swarna-*Sub1* was not developed for stagnant water conditions. A good case in point was provided by a farmer at Kishamot Habu village who used an improved *bolon* practice to plant BR 11 (a traditional variety), Ajon, and Swarna-*Sub1*. The 2-day flood covered BR 11 and Swarna-*Sub1*, but not the taller traditional variety, Ajon. For yield, BR 11 gave 4.85 t ha^{-1}, whereas Ajon and Swarna-*Sub1* gave 4.04 t ha^{-1} each. In this situation, then, the farmer preferred to use BR 11 and Ajon in the lowlands, using *bolon* practices. He did value Swarna-*Sub1*'s tillering ability, so he thought it would be a good choice for medium-level lands.

Such a result does not dispute Swarna-*Sub1*'s performance for flash-flooded ecosystems because those kinds of conditions did not occur at the CURE villages at the Rangpur key site. It does appear, though, that farmers perceive Swarna-*Sub1*'s shorter stature as a drawback for flood-prone areas, even though it has the genetic potential to survive certain kinds of floods. This is a case in which farmers are expressing their need for the kind of plants they perceive can survive stagnant water conditions to which Swarna-*Sub1* would be vulnerable. In any case, if the research investment in marker-assisted selection is to be realized, Swarna-*Sub1* should be targeted for the kinds of flash-flood-prone areas for which it was developed, which was accomplished in widespread testing in 2007. This also underscores the continued need to used advanced molecular breeding techniques for developing materials for stagnant water conditions. Already, the BRRI Regional Station, Rangpur, has identified a local landrace, Jati Balam, among others, that can be investigated for stagnant water tolerance.

[8] One decimal is a unit of land equal to 0.01 acre in the English system. One hectare is equal to 247 decimals.

CHAPTER 4. Cuttack, India: Working Group 3 for salt-affected soils

The Central Rice Research Institute (CRRI), Cuttack, in Orissa, India, is CURE's key site for coastal salinity. The CURE villages are in Erasama block, Jagatsinghpur District, 15 km inland from the Bay of Bengal (Fig. 4). Saltwater intrusion is a major constraint to improved rice productivity; equally problematic are submergence and drought, all of which can affect crops in a single season. Until CURE's Working Group 3 started its participatory research, farmers could expect rice yields of up to 1.5 t ha^{-1} using traditional varieties, resulting in 3–9 months of annual food deficits, depending on household and landholding size. The main cropping pattern was a single wet-season crop, whereas poor irrigation water quality limited dry-season rice cropping to about 5% of the cultivable landholdings. Although traditional varieties yield much lower than improved germplasm, farmers appreciated their steady and reliable yields with almost zero or bare minimal inputs under saline soil conditions and highly erratic rainfall patterns. This is because of two major reasons: first, small and marginal farmers do not have enough resources to puchase inputs; second, they want to avoid the risk of losing their investment in inputs to the prospect of crop failures under salinity stress. In addition, farmers faced a knowledge gap about new varieties because extension and development outreach organizations seldom visit this area. As the farmers put it, these sorts of organizations "don't know us."

Convincing farmers to participate in CURE activities took a patient and sensitive approach by WG3. Farmers at Kimilio village said they distrusted outside officials, who,

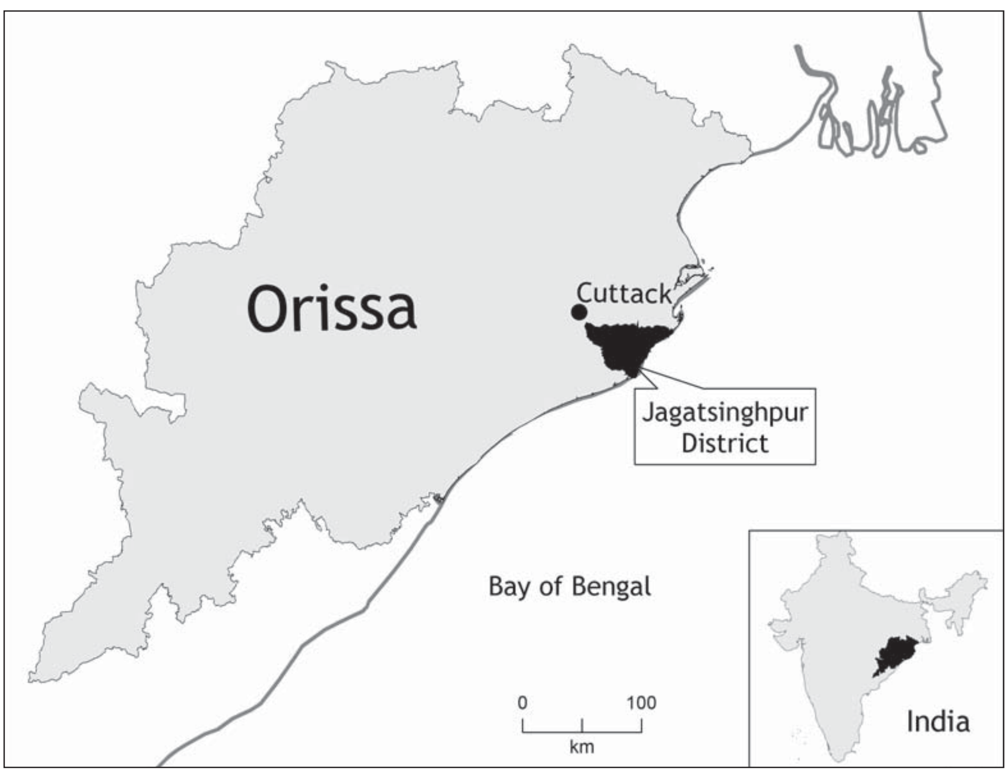


Fig. 4. Jagatsinghpur District, Orissa, India, site of CURE villages for Working Group 3.

they perceived, used the publicity of village visits to further their political agendas and then never returned. The villagers' comments echoed the words of British social anthropologist F.G. Bailey (2000:69) that "The peasant looks upon outsiders (including officials) as his enemies."[9] With some reluctance, the village agreed to participate in CURE research in the second year of the three-year project. Farmers at another village, Chaulia, seemed to be more open to outsiders. Chaulia was settled 50–60 years ago by migrants from West Bengal. They agreed that they were more comfortable with outsiders as they kept in contact with residents of their village of origin, and they were always looking for new ideas to improve their farms' productivity. In some cases, they brought back new technologies from their relations in West Bengal. In this case, Chaulia residents were early participants in CURE activities. This "tale of two villages" points to a social context that agricultural researchers face when making inroads into a local community. It is tempting to blame noncooperative farmers as "backward," "less progressive," or "laggards," when negative strands of a deep history run through the mental outlook of farmers, giving them legitimate reasons for not participating. This illustrates that farmer participatory research is about more than just introducing new technologies to farmers. It is about, first, building a foundation of trust upon which productive collaboration can occur.

Testing new germplasm for coastal saline ecosystems

WG3's strategy has been to (1) introduce salt-tolerant germplasm and crop management practices to improve wet-season yields of the main crop, (2) introduce suitable crop varieties and management practices for the dry season so farmers can either initiate or expand rice cropping area, and (3) introduce salt-tolerant nonrice dry-season crops to improve household livelihoods. The introduced germplasm may be "new" to the farmers, but the varieties were developed 15–30 years ago (Table 6). A lack of information sources made them unavailable to farmers until CURE came to these villages. To overcome the lack of outreach agencies, the Working Group contracted farmers to multiply seed for scaling out in the one-year Project extension in 2007. In the 2007 dry season, the Working Group multiplied 1,800 kg of seed for scaling out to the CURE villages and non-CURE villages for the wet season, and also multiplied 1,000 kg of seed in the 2007 wet season, despite extensive crop damage due to severe multiple stresses, to distribute in the following dry season.

The Working Groups also tested several nonrice crops for dry-season tolerance for the coastal saline system. Sunflower dominated the discussion in the farmers' groups, and they assessed it favorably compared with other tested crops. The latter included chilli for highly saline conditions and watermelon and okra for medium saline conditions.

Table 6. Improved varieties introduced to the coastal saline ecosystem, Jagatsinghpur District, Orissa, India.

Wet season Yield potential 4.0 t ha^{-1}		Dry season Yield potential 3.5 t ha^{-1}	
Variety	Year released	Variety	Year released
Lunishree	1992	Canning 7	1991
SR 26	1988	CSR 10	1989
Patnai 23	1988	CSR 4	1981
Pankaj	1978	Annapurna	1971

Farmers' perceptions of new germplasm for coastal saline ecosystems

Wet-season varieties withstand multiple stresses

Crop production in the 2006 wet season was "typical" in terms of its irregular pattern of drought and flooding stresses. The season had an early dry spell, and August brought extreme rainfall that required some farmers to transplant under flooded conditions. A sluice gate built to control tidal intrusions remained closed, which compounded the problem. Frustrated farmers eventually ruptured the structure to open the gate in order to drain their lands. Under these conditions, farmers favorably evaluated the performance of improved varieties that tolerated both salt and submergence stresses. The improved varieties' stems elongated with the rising floodwaters and they were able to flower and produce a crop. The traditional varieties became waterlogged before flowering and produced little, if any, grain.

Farmers were provided with improved salt-tolerant varieties SR26B, Pankaj, and Lunishree. They reported yields of 2.5–4.0 t ha^{-1} compared with the traditional varieties' usual yield of 1.5 t ha^{-1}. Even if we conservatively accept the farmers' report, they would have at least achieved a considerable yield improvement of 1 t ha^{-1} over the traditional varieties. Farmers also wanted to try Patnai 23, which they selected in the 2005 PVS, and seed was being multiplied for the 2007 growing season. The traditional varieties are Rahspanjar, Bhaluki, Nonabokra, Kaidisola, Bhundi, Malabati, and Pagnigola. As for other characteristics of the new varieties, farmers said that the straw is a good thatching material for their house's roof. In addition, cattle prefer the larger leaf area for fodder compared with the thin leaf area of traditional varieties.

[9] Bailey actually conducted ethnographic research in Orissa, but in the interior upland areas.

In terms of taste and cooking quality, farmers like the white grain color of improved varieties, which is an appealing appearance for meals and selling. The medium slender grain draws a higher price, 8 Indian rupees kg^{-1}, compared with those of bolder grain, 6 Rs kg^{-1}. Farmers did say the slender grain digests too easily and does not give a "full" feeling in the stomach.

However, some farmers said this is a moot point now, as they produce more rice now and have more available to eat. The only negative comment about food quality was that improved varieties are not suitable for making a fermented breakfast dish, *pokhal*. Farmers reasoned they might have to give up this traditional food in order to use improved varieties for higher yields, or else they might still grow some traditional varieties for preparing this dish. It would be a good outcome, they said, if some improved varieties could be found that are suitable for making *pokhal*.

The main complaint about the improved varieties concerned stem borer infestation that damaged 10–20% of the crop, whereas traditional varieties have good pest tolerance. Researchers said the infestation was peculiar to that year's weather, and it should not recur every season. Another complaint concerned grain shattering, which was specific to Lunishree.

Although the discussions indicated that farmers were impressed by the new varieties, they also said they will need several more years of evaluation before totally adopting them. Some farmers said it might take as much as four years before they are fully convinced about the performance of the improved germplasm. Farmers trust the traditional varieties because they give reliable but low yields under the wide range of stresses that can be expected in a growing season. For example, they will continue to sow the traditional variety Bhaluki for its good salinity tolerance.

In sum, farmers are looking for varieties with good salt and submergence tolerance that also resist lodging. Other preferences are pest/disease tolerance, good cooking quality, finer grain, and suitability for preparing *pokhal*.

Dry-season rice gives opportunity to expand dry-season cropping

Until the introduction of new varieties, dry-season fields remained mostly fallow except for small pockets with irrigation. Now farmers said they could obtain 3.0–3.5 t ha^{-1} with the new varieties, which would be an additional crop for the farmers who otherwise grow no rice here. At the saline-water-irrigated sites, farmers said that Canning 7, Annapurna, and CSR4 did well under low salinity, but performed poorly under high salinity. Farmers complained that they needed varieties with good tolerance under conditions of high salinity. Researchers responded by testing new IRRI lines for highly saline conditions in the 2007 dry season. The top performer was IR72046-B-R-3-3-3-1, which yielded an average of 4.2 t ha^{-1}, while other top performers were CR 2472-1-6-2, CR 2473-9-136-1-1, and IR72596-B-19-2-3-1.

Sunflower favored as a nonrice crop

Of all the nonrice crops tested for the coastal saline area, it was farmers' favorable perceptions of sunflower that dominated the discussion. They like the fact that sunflower can be pressed for cooking oil, which saves them money on having to purchase an essential household commodity. The residue, or "cake," from the pressing process can be used for livestock/fish feed and as a cooking fuel. Although the Working Group also introduced okra, chilli, and watermelon, farmers would like to prioritize sunflower before giving attention to the other crops. They would also like to try cowpea for expanded dry-season production as they already grow it in their home gardens.

In terms of production, sunflower produced a small flower in clayey saline soils that have poor physical condition and high soil salinity. Farmers observed that the crop does better in sandy, light-textured soils. Another limitation is fungal disease. But the major constraints occur in the postharvest processing phase. Farmers identified the lack of efficient sunflower seed oil extraction facilities in the area and the high pressing cost of Rs 3–4 kg^{-1}. Farmers would also like to learn more about postharvest technologies, such as drying and storage. Researchers said there is lack of information about sunflower varieties and production practices as agricultural research centers tend to work on other crops. The research team has introduced

Farmers favorably evaluated sunflower as a dry-season crop for coastal salinity areas, as the seed can be pressed for cooking oil, which is an essential household commodity.

variety KBSH1, which is grown in other areas of Orissa. The team has so far been unable to find other sources of information about sunflower.

Testing improved crop management practices for the coastal saline ecosystem

WG3 also introduced matching crop management practices designed to enhance the salt-tolerant potential of the germplasm. Farmers can choose which component practices to adopt; however, as a package, the combination of improved germplasm and management improved yields by 91% and 75% in two years of tests compared to farmers' traditional varieties and usual management practices (Fig. 2). Briefly, these practices are

- Nutrient management in the main field using either the *Sesbania* green manuring system or the aquatic fern *Azolla* biofertilizer;
- Transplanting older (45–50 days old) seedlings at closer spacing of 15 × 10 cm in the main field; and
- Transplanting dry-season rice by mid-January compared with the usual practice of later transplanting, which allows rice to avoid the high seasonal amounts of salinity at later growth stages.

In contrast to new germplasm, crop management practices may be more difficult to introduce because farmers often do not perceive immediate, observable benefits. This was evident in the discussion of the aquatic fern *Azolla*, which was introduced as a biofertilizer. The weed control properties were more apparent than the fertility management aspects, which was the primary reason for introducing it. Furthermore, crop management practices require changes in timing of annual seasonal tasks, which can constrain their adoption. We pursued this line of reasoning for the early transplanting practices for the dry season, which revealed that farmers were convinced about this practice and were willing to establish nurseries earlier.

Nutrient management in the main field

Farmers said they saw a difference in crop performance when they used the *Sesbania* green manuring system and *Azolla* biofertilizer, both of which they can adopt with very little cost. *Sesbania*'s performance, though, is associated with the soil conditions. It does well in clayey soils with good moisture-holding capacity. However, areas such as Chaulia have light-textured soils susceptible to early drought, a serious limitation for *Sesbania*. In discussions about *Azolla*, farmers tended to stress the weed control properties of *Azolla* more than its soil nutrient benefits. In their words, *Azolla* "keeps the water cooler," which they believed inhibits weed growth. Instead of a cooling effect, the mulching or shadow effect of the *Azolla* inhibits weed growth. Scientists agreed that *Azolla* can control weeds, but they disputed farmers' explanation for the adoption preference. We suggest that farmers may be using metaphorical categories, rather than literal temperature levels, that are common in folk categorical systems (Chevalier and Sanchez 2003). Nevertheless, farmers readily recognized the weed control properties as they occurred soon after *Azolla* treatments were made to the field. However, the nutrient effects on plants take a little longer in the season to show up in the field. This point illustrates the principle that immediate results provide a positive reinforcement to adoption.

Aged seedlings and closer seedling spacing

Farmers said they were convinced that new practices of transplanting 45–50-day-old seedlings at 15 × 10 cm spacing intervals can improve crop performance. Sometimes, they had to use even older seedlings when rainfall delayed their transplanting. Their usual practice was to transplant 30–45-day-old seedlings randomly at a distance measured from hand to elbow, or roughly twice the distance of the new spacing. Farmers observed positive effects on growth in terms of better tillering by using the improved practices. They also said plants had better panicles after using these practices.

Early transplanting for dry-season rice

Farmers noticed an improvement in crop condition when they transplanted rice seedlings to the main field by mid-January because of the relatively lower salinity in January, and this also allows the rice crop to mature before salinity increases in April/May. The usual practice was to transplant about 1 month later. Farmers were preparing their nurseries in December to coordinate an early transplanting. In fact, we observed that a nursery was already sown during our late-November visit. The earlier transplanting does not interfere with field operations for the rainy-season crop. Farmers said that timely nursery establishment is important for the dry season, and they were willing to delay harvesting the rainy-season crop, as it would incur no yield penalty.

Effects of technology on food security/ livelihood enhancement

The most emphatic statement about food security was made by a man in Chaulia: "We no longer think about whether we will have enough to eat the next day." Farmers reported that participating households are now able to meet their annual rice needs, and some farmers even have a surplus to sell. This contrasts to the past when households in Kimilio village grew only enough rice for 4 to 6 months, and those in Chaulia grew enough rice for about 9 months. Farmers confirmed in their own words that the productivity improvement model promoted by the researchers had made a difference. This model sought to (1) improve yields for the wet-season crop and (2) introduce new varieties to either initiate cropping or expand the limited rice area in the dry season. Still, farmers said they needed

A nursery bed prepared in late November 2006 will allow farmers to produce seedlings for early transplanting (by 15 January) to avoid high salinity in the dry season at the coastal lowland site in Orissa, India. In adjacent fields, a mature wet-season crop awaits harvest.

good salt-tolerant varieties for the high-saline-irrigated water conditions of the dry season (which WG3 addressed by testing new materials in the next year).

In the past, farm households either borrowed rice from other villagers to make up for deficits or else males caught fish for marketing or out-migrated for work opportunities to earn money to buy food. Farmers migrated to other places in Orissa or to West Bengal for jobs such as construction. Villagers said that a few men will likely continue to migrate, but most will be able to stay to make a living on the farm. The women also said that the intensified farming system is giving them more opportunities to contribute household labor in the fields, whereas in the past they were largely confined to domestic work in the home. This is reflected by the baseline survey that reported that 81% of men's occupational category was "agriculture," while 83% of women's was "household activities" (Saha 2004). Women said that some tasks that involve them are transplanting seedlings and harvesting the crop.

Overall system productivity has been raised by the introduction of sunflower, as explained earlier in this section. Cooking oil, the product of pressing the sunflower seed, is almost as important as rice, as households need it to prepare their meals. The women in Chaulia said they use 2.5 kg of oil per month, or about 30 kg per year. Farmers said they can save considerable money by using their own oil, money that can be invested for the household. As indicated earlier, farmers' interest in sunflower was evident in that it dominated the discussion about the introduction of nonrice crops. The latter are okra, chilli, and watermelon, all of which have marketing potential, but they have a lower priority in the minds of the farmers.

The material improvements in farmers' lives became apparent when we entered the village. In Chualia, there was music resounding from a loudspeaker for a religious ceremony, even though the 1999 super cyclone disrupted electrical service that has not been restored. Yet, farmers related how they now have money for consumer goods serviced by battery, and even the women can afford cosmetics. But, more importantly, the farmers said they are investing money in their children's future. In Chaulia, farmers proudly pointed out that *all* boys and girls are attending school because they can afford books. The women there said they are encouraging their children's education so they can find remunerative employment outside of the village. Farmers in Kimilo village also reported that children were attending school, but they were less certain about their children's future opportunities outside of the village.

Evidence of technology adoption in coastal saline ecosystems

It was easy to get swept away by farmers' glowing comments about the benefits of CURE research without having concrete indicators of farmers' adopting the technologies. In many respects, farmers' comments seemed "too good to be true," as if they were telling us exactly what we wanted to hear. However, a consistent pattern of comments emerged that can be related to the social contexts of the villages. In other words, the patterns of those comments seemed to make sense from

By using CURE's improved management practices, a farmer is able to achieve a lush dry-season rice stand (above) compared to a low-productive field (left) in the coastal salinity ecosystem of eastern India.

the contexts of the villages' social conditions, and thus relate a sort of coherent, holistic story of their livelihood improvements. This sort of discourse was evident in the variations of themes that indicated that each village was affected a little differently by the technologies. For example, farmers of Kimilio, who expressed their distrust of outsiders, seemed to be more conservative, expressing that they will need more time to test the technologies before being totally convinced. The more outward-looking farmers in Chaulia, however, seemed to discuss more of the mental and material outcomes on their lives that resulted from using the technologies. One farmer said that they no longer think about whether they will have enough to eat, for example, and another said that the fact that slender grain does not give them a feeling of satiety is a moot point as they have more rice and more types of rice to eat. Of course, two factors intervene here. One is that Chaulia had participated in the project since the outset, whereas Kimilio began participating in the second year. In that respect, it would seem that an accumulation of positive results would have appeared first in Chaulia. Second, Chaulia had less severe food deficits (3 to 4 months) at the project outset than Kimilio (6 to 9 months), so it would be understandable that Chaulia would have seen more progress than Kimilio. In this way, then, farmers' outlooks about the technologies coincide with their social reality, which gives an internal validity to their discussions.

Even without such discourse analysis, there was evidence from the discussions that farmers were deeply interested in trying out the technologies, which is a key motivational factor in ultimate adoption. This was evident in their demand for seed of the new varieties. Farmers in Kimilio complained that they would prefer 5-kg seed packets compared with the 2-kg packets distributed by the team. However, the researchers explained that this was a matter of balancing the distribution of a limited seed quantity to many households against the prospects of distributing large quantities to a few households. Farmers in both villages also indicated that they are saving seed for future planting, and those in Chaulia were exchanging seeds with other farmers, who had noticed the results of the new varieties in the field.

The qualitative analysis above was later supplemented with a quantitative survey in March 2007, which indicated that participating farmers expanded their dry-season cropping area because of varietal adoption (Saha 2007). The survey of 111 randomly selected households in 11 villages covered by CURE and a concurrent Challenge Program for Water and Food project showed that dry-season cultivation area had expanded by 20 ha between 2006 and 2007. The proportion of dry-season land accounted for 37.3 ha, or 25% of total cultivable area (wet and dry season). This contrasts to the 2004 benchmark survey that showed that 5% of the total cultivable area was in dry-season production. The report attributed the expanded area to the adoption of varieties such as Annapurna and CSR 4 and the use of techniques to harvest rainwater in ponds and ditches for irrigation. Interestingly, the researchers were able to estimate these villages' total dry-season rice area (including land cultivated by nonparticipants). They found that these villages' dry-season rice area more than doubled from 136 ha (2006) to 307 ha (2007), indicating a spillover effect for nonparticipating farmers. Only two villages showed a decline in dry-season rice area because of a lack of irrigation water or a decision to shift to nonrice crops that would require less water than rice.

As for nonrice crops, the quantitative survey showed that the households had devoted 10 ha, or 7% of total cultivable dry- and wet-season area, to such crops as sunflower, watermelon, groundnut, chilli, and okra. The report estimated that total nonrice crop coverage for these villages was 28.5 ha. This is dramatic given the paucity of freshwater irrigation and the fact that land was only rice monocropped in the dry season before 2000, if cropped at all. Whatever nonrice crops farmers were growing were entirely due to the WG3, as it was the only organization promoting these technologies for this period.

CHAPTER 5. Luang Prabang, Laos: Working Group 4 for sloping rotational upland systems

Working Group 4's key site for sloping rotational upland systems is in Luang Prabang Province of north-central Lao PDR (Fig. 5). The research collaboration engages scientists at the Northern Agriculture and Forestry Research Center (NAFReC) at Houay Khot Station about 32 km southwest of Luang Prabang City in Xieng Ngeun District. On-farm trials are conducted in villages in Luang Prabang Province and in provinces throughout northern Laos. The widespread testing allows researchers to adapt technologies to diverse upland environments. These on-farm trials also act as a vehicle to disseminate new technologies to farmers in remote areas where communication and transportation are extremely difficult. Laos lacks a well-developed seed industry, so CURE's participatory varietal selection trials are one of the few sources of new germplasm for these farmers.

Ethnic minorities populate these areas, where they grow crops in shifting cultivation plots on steep slopes and, if available, in the valley lowlands. However, shifting cultivation systems are under pressure as fields expand, and the fallow periods are severely shortened, which reduces their rate of recovery for later cropping. WG4's research follows a paradigm shift for agricultural technology development in the uplands, and the wisdom of this approach was borne out by the qualitative research. The Working Group follows a

Fig. 5. Luang Prabang Province, Laos, is the CURE key site for sloping rotational upland systems; qualitative assessments also took place in Oudomxay Province.

Table 7. Varieties tested in IFAD project, Oudomxay Province, Laos.

Variety	Type	Duration	Villages where tested
Laboun	Glutinous	Early	Nam Haeng Neua
Mak Fai	Glutinous	Early	Nam Haeng Neua
Mak Hin Soung	Glutinous	Medium	Nam Haeng Tai, Nam Haen Neua
Phae Daeng	Glutinous	Medium	Nam Haeng Tai
Chao Mad	Nonglutinous	Medium	Nam Haeng Tai
B 6144 (aerobic)	Nonglutinous	Early	Nam Haeng Tai, Nam Haeng Neua
Yunlu 52 (China)	Nonglutinous	Medium	Nam Haeng Neua

Source: Xay District DAFEO (2006).

landscape model to improve crop productivity in the various levels of the uplands, rather than just focusing on improving rice yields. In this way, technologies are being developed to improve lowland production, which will reduce pressure on the uplands, while improving upland productivity to reduce the expansion of shifting cultivation.

Testing new rice germplasm for sloping rotational uplands

The qualitative assessment of farmer acceptability of new rice varieties was conducted in the non-CURE villages of Nam Haeng Tai and Nam Hang Neua in Oudomxay Province to the north and east of Luang Prabang Province. CURE found these varieties (Table 7) to be popular with farmers at its usual PVS sites, so they were supplied to the International Fund for Agricultural Development (IFAD) loan project for scaling out at its project target sites. The IFAD loan program is administered through the Provincial Agriculture and Forestry Extension offices (PAFEO) and implemented locally through the District Agriculture and Forestry Extension offices (DAFEO), all of which represent the Lao government's agricultural outreach network to local communities. The qualitative assessment thus allowed us to elicit farmers' evaluations of these varieties outside of the usual CURE network, which would give us evidence of their acceptability to farmers in wider upland areas.

Farmers' comments on germplasm for upland conditions

Varietal diversity for upland microenvironments

We used a key informant approach because not enough farmers had grown the new rice varieties to warrant use of the focus group approach. At Nam Haeng Tai village, we interviewed a male and female farmer who had tried the new varieties in the 2006 season. We interviewed five male farmers who grew the varieties at Nam Haeng Neua village. Farmers have grown the varieties for only one season, but their comments produced interesting lines of inquiry that could be of significance for the acceptability of these varieties to farmers. The people in the two villages assessed were from the Khmu ethnic minority group. Different ethnic groups may have different criteria for judging rice varieties. The Khmu are considered to be an indigenous group, that is, among the first to settle in Laos, but through history they have been socially, politically, and economically marginalized (LeBar et al 1964:113-114).

In both villages, the discussions revealed the importance that farmers attach to varietal diversity. Farmers reported that they grew as many as 15 traditional varieties in their sloping fields, and as many as seven varieties in their lowland fields. Farmers said that the diversity in rice varieties allowed them to (1) time harvest to meet food-short periods, (2) take advantage of soil and weather microenvironments, and (3) get as high a range of yield as possible. Applying these criteria to the farming system, farmers sow early-maturing varieties on sloping uplands in order to make food available as soon as rice is harvestable. However, these varieties are lower-yielding, or "poor," as farmers put it, with a usual output of 1.0 t ha^{-1} or less. Farmers would like to shift these varieties to medium-maturing materials to avoid bird and rat damage. Longer-duration varieties are valued for their higher productivity, as they yield up to 1.2 t ha^{-1}. Households fortunate enough to have lowlands will obtain yields of about 1.2 to 1.5 t ha^{-1}, but as high as 2.0 t ha^{-1}. An ongoing project to construct irrigation facilities known as *muang fai* would also allow prospects for a dry-season rice crop. Up to now, there appears to have been virtually no dissemination of improved rice varieties for uplands in these villages although a few have been introduced through CURE-IFAD collaboration.

In general, 2006 was a poor growing season in terms of drought damage to crops in both villages. Early drought affected germination. The rains came about 1 week after sowing. The poor growing season is reflected in data that showed that the varieties in nonfertilized plots in both villages generally yielded less than the average recorded for those varieties in the 2006 PVS throughout northern Laos (Table 8). The wide range of yields observed, 0.29 to 2.45 t ha^{-1}, indicated the wide variability of environments in these two villages, which were

Table 8. Varietal performance data, IFAD villages, Oudomxay Province, Laos.

Farmer and gender[a]	Variety[a]	Yield[a] (fertilized)	Yield[a] (nonfertilized)	Yield gap[a] (fertilized–nonfertilized)	Average yields 2006 CURE PVS Northern Laos[b] (nonfertilized)
		(t ha^{-1})			
Nam Haeng Tai Village					
1. Male	Mak Hin Soung	1.80	1.17	0.63	1.63
	Phae Daeng	2.16	1.40	0.76	0.40
2. Female	B 6144 (aerobic)	2.14	1.39	0.75	1.75
	Chao Mad	2.00	1.30	0.70	NT
Nam Haeng Neua					
1. Male	Yunlu 52	3.50	2.45	1.05	NT
	Mak Hin Soung	2.16	1.40	0.76	1.63
2. Male	Laboun	0.60	0.50	0.10	1.61
	Mak Fai	0.60	0.45	0.15	NT
3. Male	B6144 (aerobic)	NT	0.86	N/A	1.75
4. Male	B6144 (aerobic)	NT	0.29	N/A	1.75
5. Male	B6144 (aerobic)	NT	0.15	N/A	1.75

Sources: [a]Xay District DAFEO (2006). [b]Songnoukhai et al (2006).

located 2 km from each other (see Donner 1978 for discussion about the dynamics of microenvironments in a similar ecosystem in northern Thailand).

The discussions were a good exercise in comparing farmers' perceptions to the quantitative yield data reported by researchers. Although the yield data showed that farmers could achieve a 1.0 t ha^{-1} yield increase by using fertilizers, over what they would get with their traditional varieties (reported to be 1.0 t ha^{-1} or less), the discussion revealed socioeconomic constraints that would affect farmers' ability to achieve those results. The highest yields were achieved in fertilized plots. However, farmers said they could not afford to buy fertilizers. Consequently, there was a yield gap range of 0.10 to 1.05 t ha^{-1} between fertilized and nonfertilized plots. This points to a serious socioeconomic constraint that might possibly be addressed at the policy level in terms of subsidies. As one farmer put it, "If the project can supply fertilizer, then we can use it. If not, we can't use it because it is too expensive."

The high-yielder Yunlu 52 (3.50 t ha^{-1} fertilized, 2.45 t ha^{-1} nonfertilized) is problematic because its yields were achieved on half of the plot, whereas the other half died for an unknown reason. We did not ascertain whether this was a problem with the variety or the environment. The farmer also complained that Yunlu 52 has to be sickle-harvested, whereas Khmu usually hand-strip the crop, leaving stems in the field. The Khmu do not use straw for livestock, leaving another problem in disposing of the straw after harvest. Yunlu 52 is nonglutinous, which could further constrain adoption as the Khmu prefer glutinous rice for household consumption. That is not to say that it cannot be processed for noodles for marketing to non-Khmu (although the farmer who grew it did not have the household technology for noodle-making).

Many upland groups, such as the Khmu, prefer glutinous rice for household consumption, but our discussion revealed that nonglutinous varieties may have a marketing niche here. The woman who grew the nonglutinous entries, Chao Mad and the aerobic B6144, reported that she can process the rice for making noodles, which are sold to non-Khmu people in the area. She had a high opinion of Chao Mad both for its agronomic characteristics and its seed type for noodle-making. The Chao Mad seed is suitable for making noodles because of its large size compared with the smaller grain type of B6144. She also said that selling noodles can be more profitable than selling rice. She reported that 1 kg of rice can be processed into 3 kg of noodles, which are then sold at 5,000 Lao kip kg^{-1}. Thus, 1 kg of rice can yield a potential income of 15,000 kip. Given that farmers can sell 1 kg of rice for 3,000 kip, the woman said that she could earn more money by making noodles than by selling rice.

Aerobic rice is being tested in various environments throughout Asia where water is a limiting factor in rice production. Variability was wide in aerobic rice yields between the two villages. At Nam Haeng Tai, the one plot planted to B6144 yielded 1.39 t ha^{-1} (nonfertilized) compared with 0.15–0.86 t ha^{-1} in three plots at Nam Haeng Neua. A one-year test would not be indicative of a long-term trend in varietal performance, as the environments and farmers' management would differ by site. There still seemed to be an interest in B6144 as four farmers requested seed for 2007 plantings, and others saved seed to try it in the next year. A main constraint, though, is the

Table 9. Seed requests for 2007 sowing, two villages, Oudomxay Province, Laos.

Variety	No. of farmers requesting	Amount (kg)
Mak Hin Soung (glutinous)	6	60
Non (glutinous)	5	20
B6144 (aerobic, nonglutinous)	4	40

Source: Vongphutone (2006).

fact that B6144 is nonglutinous, and households would have to alter their consumption preference away from glutinous rice. Even the woman who grew it for making noodles said that a larger grain type is preferable for processing.

Although the discussions winnowed out the unacceptable traits of the varieties, there seemed to be an emerging consensus in favor of nonglutinous Mak Hin Soung (Table 9). In the unfertilized trials, it yielded reasonably well (1.17 and 1.40 t ha^{-1}). Farmers gave favorable comments on grain type, agronomic characteristics, and eating quality. Farmers also liked the fact that it could be harvested by hand-stripping using the traditional Khmu method. The demand for Mak Hin Soung was indicated by the fact that six farmers ordered seed from researchers for the next year's planting. The other glutinous varieties tested tended to receive unfavorable comments regarding seed type and field performance. Phae Daeng was the second highest yielder (1.40 t ha^{-1}, nonfertilized), but farmers complained about the small and "hairy" or "itchy" grain, and that it did not produce full panicles. Laboun and Mak Fai yielded 0.50 t or less per hectare in nonfertilized fields because of soil termites and poor soil conditions. These latter varieties were also damaged by rats and birds because of their early duration, according to farmers.

Achieving food security in the face of shortened fallows

Of the seven farmers interviewed, only one indicated that her household was food secure year-round. Other farmers said they lacked food for 3 to 6 months. This also seems to be supported by official village reports that indicate that food shortages may last up to 6 months and, in some cases, even more. Farmers often discussed the microenvironmental factors of climate and soil quality, and biotic stresses that affect their productivity.

It was also clear from the discussions that farmers rely on sloping uplands for food security and that production has been declining because of short fallows that farmers associate with population pressure. The population increase may be the result of a natural increase, but another factor may be the government policy of consolidating upland villages to locations closer to roads. Five villages were moved to the Nam Haeng Tai site in 2000, whereas nine villages had been moved to Nam Haeng Neua in the mid-1980s. The concentration of households in a specific area could conceivably pressure the local resource base, whereas villages were more widely distributed across the landscape in the past.

Farmers recalled that, in their lifetimes, the fallow periods of upland plots have been halved to 4 years from 8 to 9 years, which they said resulted from population pressure. Of interest is that ethnographers in the 1960s considered an 8–9-year fallow as critically short of the optimum time needed to regenerate fallow plots (LeBar et al 1964:114). It is obvious that the fallow situation in the sloping uplands has surpassed the critical state and can be more accurately described as a state of crisis.

In terms of new germplasm, it becomes clear that rice yield is a necessary, but not sufficient, condition for farmer acceptability. Just as important are the agronomic characteristics and grain and eating quality of new varieties. In some cases, the variety must meet the latter criteria before yield will be a factor for varietal preference. The most favorable comments

Shifting cultivation is a main cropping practice for sloping uplands in northern Laos. A field is burned (left) in preparation for sowing. Transportation infrastructure (right) is poor in these areas, and many other places are still accessible only by narrow mountain trails or by rivers through the mountain canyons.

were made on the glutinous variety Mak Hin Soung because of its yielding characteristics plus its field performance, grain and panicle characteristics, and the fact that it can be hand-strip-harvested. It also meets households' cooking and taste preferences. It seems to have passed farmers' rigorous criteria as a suitable variety. Farmers would likely adopt new varieties in the context of their usual diversification strategy, and CURE's PVS program seems to be the best approach to let farmers decide what varieties are suitable for their highly localized conditions.

A project that is opening new paddy lands is a welcome development in these villages, and it seems to generate a lot of interest in these villages. The newly opened paddy holds potential for stabilizing rice productivity under irrigated conditions for some households. It has implications for sloping uplands, as increased lowland productivity could take the pressure off expanding shifting cultivation fields, which in some areas are also benefiting from higher productivity through new varieties. The qualitative evidence thus supports the landscape paradigm promoted by CURE as a viable approach to achieving food security and enhanced livelihoods that are consistent with the ecological constraints of upland communities.

Indigenous knowledge as a proxy variable

We also found some observations from farmers that can be regarded as proxy indicators of deeper underlying constraints to crop productivity. One is that farmers associated gall midge occurrence with soil types in sloping upland fields where non-glutinous varieties grew. The association of a biotic stress with soil type might be worth exploring as to whether a proximate cause could be related to gall midge damage where farmers observe it. One hypothesis could be that these sorts of soils might favor alternate plant hosts for gall midge (B. Samson, personal communication 2007).

Second, in lowland fields, farmers described "fog" as a constraint to seedling growth. It is unclear whether "fog" has been precisely translated from the local language. Farmers may be referring to low-temperature stress that occurs when fog lingers close to the ground during December and January (B. Samson, personal communication 2007). Cooler temperatures shut down the metabolic processes of rice, which causes yellowing and high mortality rates. The frequency and degree of severity that "fog" has for crop production would have to be investigated to determine whether there are any implications for new technologies that are being introduced to this area.

These Khmu children are among the many ethnic minority groups of upland Laos. Understanding each ethnic group's indigenous knowledge system can be valuable for developing culturally acceptable technologies.

Testing rice–pigeon pea intercrop to improve upland livehlihoods

Upland communities have been traditionally integrated into upland-lowland trading networks for products such as nontimber forest products, opium, and other upland crops (Halpern 1963). However, high-value products that can be marketed to generate better incomes have eluded upland rural households. CURE has been investigating sticklac production in a rice–pigeon pea system for purposes of achieving an economic return on a marketable crop as well as a way to use a leguminous species to renew the soil during short fallows. Pigeon pea would be an advantage over other leguminous cover crops that promote soil fertility but do not provide an economic return for farmers' labor in establishing those crops. In Laos, private traders have already aroused farmers' interest by providing pigeon pea seed and the inoculum, *Laccifer lacca*, used for extracting the sticklac resin from the pigeon pea tree. The CURE activity would allow farmers to assure a supply of rice, although at what appears to be some yield penalty, while the intercropped pigeon pea reaches maturity for sticklac harvest in the following year. In 2006, CURE scaled up this system to farmers in Houay Hia Village, a Khmu community about 13 km from Luang Prabang.

A local marketing firm, Va Yo, was working with a few of the farmers there for two years, and CURE's work expanded on that effort. The assessment involved interviews with several farmers, and the analysis was limited as they had yet to harvest the first batch of sticklac.

Houay Hia Village provided a good case study because it has good access on a sealed road about 30 minutes from Luang Prabang. Farmers' interest was driven by four community members who are growing pigeon pea for Va Yo. CURE scaled up the rice–pigeon pea intercrop to seven households. We had wanted to do a focus group discussion with these farmers, but, upon our arrival, we were informed that there was an oversight in informing the farmers. Instead, we interviewed the village head, his deputy, and another male farmer who were participants in the rice–pigeon pea up-scaling.

Food security is relatively less serious at Houay Hia than in other villages visited for this impact assessment. About half the village's households were food secure, whereas the other half had enough food for 8 months. New rice varieties introduced through participatory varietal selection yielded 1.2 to 1.3 t ha^{-1} compared with 0.8 to 0.9 t ha^{-1} for the 10 traditional varieties that are usually planted. Farmers had adopted several new varieties through CURE, among which Laboun earned farmers' favor. A constraint here was seed availability, as seed multiplication had lagged behind demand, farmers said.

In this upland system, farmers could sow pigeon pea in June, about 10 to 21 days after establishing upland rice. Rice would be harvested in September, while the pigeon pea continued to grow. The pigeon pea was inoculated with the *Laccifer lacca* parasite in November for the harvest of the first batch of sticklac in the following April. The next month, the pods would be harvested, and the pigeon pea would be inoculated in June for extracting sticklac in November.

Farmers liked the intercropping concept as the weeding of rice also benefits the pigeon pea; therefore, labor could be applied to both crops at the same time. The interactions of a dual cropping system were also beneficial in that pigeon pea canopy shaded weeds somewhat, and the legume improved soil conditions for the following rice crop. However, there was some rice yield penalty for growing two crops in the same field.

In terms of pigeon pea performance, farmers were pleased with the crop. However, farmers indicated that dry weather in November affected the inoculation of plants with the *Laccifer lacca* parasite. They thought a second inoculation in June would be more favorable due to wetter conditions expected with the advent of the monsoon season.

As for the pigeon pea pod, farmers said it had been promoted as a livestock feed, but they would more likely use it for household consumption. The young pods can be boiled and the mature pods are eaten for the seed. Farmers also mentioned that the leaf could be used as a local remedy for skin rashes, whereas the sticklac could be used as an adhesive for repairs around the farm.

Our visit occurred in late February, so the first sticklac batch had yet to be harvested, which would be about 2 months away. So, neither yield data nor current pricing information were available. Farmers provided us with sticklac pricing data based on marketing to Va Yo. The company paid 2,000 kip kg^{-1}. A reasonable yield would be 800–1,000 kg ha^{-1}, and the size of a typical household plot would be 0.5–0.8 ha, or a projected sticklac harvest of 400–800 kg ha^{-1} per household. Given these assumptions, a potential gross income would be 800,000–1.6 million kip ha^{-1} per household, depending on plot size. As one farmer put it, "Pigeon pea grown in rice can increase our income. If, in the future, the market is good, we would like to plant pigeon pea for sticklac and sell it."

However, this scenario has several constraints:

- *Availability of seed and inoculum:* So far, the sources are either Va Yo or CURE. Once project support ends, it is unclear how the CURE participants will obtain these resources to continue the project, unless Va Yo includes these farmers in its program.
- *Marketing uncertainties:* In addition to the usual boom and bust cycles of the market, farmers would be beholden to Va Yo as the only marketing outlet. Some sort of coordination is needed so that farmers can be aware of the company's pricing structure.

At the time of the visit, 3 ha were planted to pigeon pea and farmers said they would be willing to expand threefold if the market were favorable for sticklac and if they could obtain inoculum. At this point, those were the two main issues that could affect the adoption and sustainability of this technology. It appears that all of the right conditions are in place for this technology to succeed, but sustaining it would depend on the availability of materials to continue it and access to markets.

CHAPTER 6. Hazaribag, India: Working Group 5 for drought-prone plateau uplands

CURE's Working Group for drought-prone plateau uplands is a collaboration with the Central Rainfed Upland Rice Research Station (CRURRS), Hazaribag, India. CRURRS is at the heart of the undulating landscape of the Gangetic Basin of eastern India (Fig. 6). To the untrained eye, the uplands are not discernible from other levels of the plateau landscape, although farmers are well aware that the slight elevations in topography make a big difference in crop productivity. Here, it is common to hear farmers complain that "rains come late," and, combined with the uneven rainfall distribution throughout the growing season, it is a precarious situation for household food security.[10] Although improved varieties and, more recently, commercially promoted hybrids are cultivated in lowlands, it is the uplands where rice productivity is most unstable. Farm households may (1) sow low-yielding traditional rice varieties, using little or no fertilizer; (2) convert these lands to nonrice crop production; or (3) abandon these lands from crop production during the wet season. Farmers were interested in growing improved varieties for uplands, but they lacked sources of information about new varieties, or else the ones available were poorly

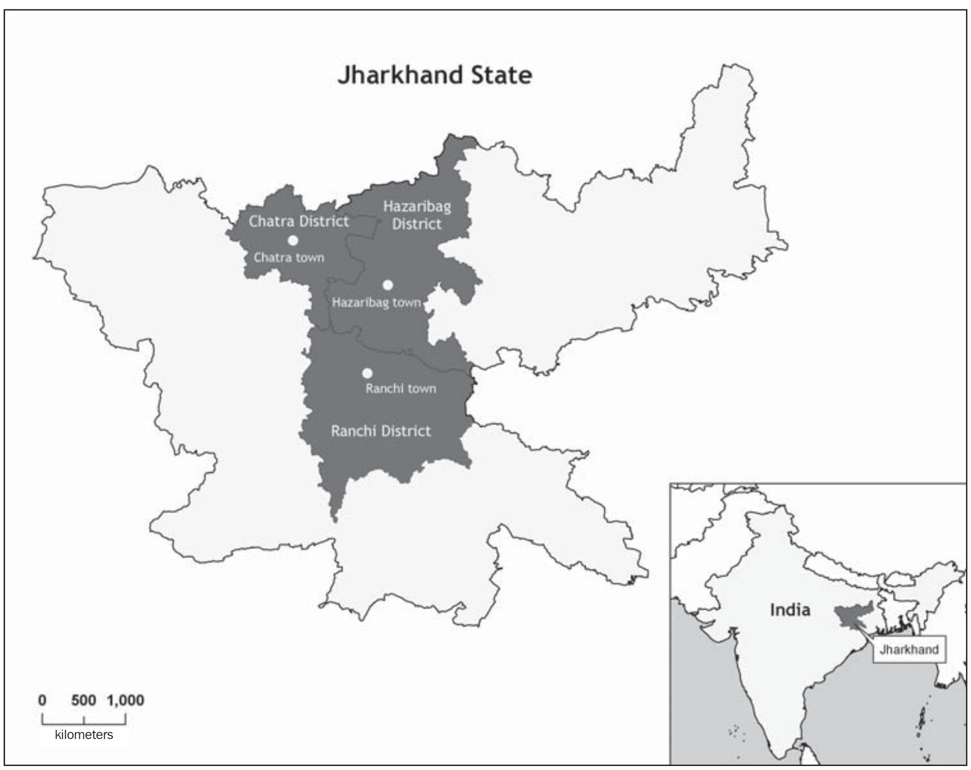


Fig. 6. Jharkhand State, eastern India, CURE key site for drought-prone plateau uplands.

[10] Actually, the last two growing seasons (2006 and 2007) of the ADB-RETA 6136 Project deviated from the usual patterns in that rains were timely and well distributed.

Farmers in Amin village who sowed short-duration Anjali had harvested by mid-October 2006 and were busy sowing a sequence chickpea crop in early November. Meanwhile, a nearby farmer's field sown in a lower-yielding traditional variety (inset) was about 2 weeks away from harvest, which would be too late for timely chickpea sowing.

adapted to local conditions. Consequently, low productivity led to an untenable food situation that was a "push" factor for off-season male out-migration toward wage-earning opportunities in urban localities. WG5's objective was to raise upland rice productivity by introducing new germplasm and crop establishment methods that would allow for earlier sowing, higher rice productivity, better weed control, and a subsequent earlier rice harvest in order to better time a postharvest nonrice crop that would diversify the overall system.

Testing blast-resistant Anjali for the drought-prone ecosystem

Working Group 5 promoted two short-duration (90–95 days) varieties for the upland conditions of Jharkhand State. Products of the CRURRS breeding program, the varieties were drought-tolerant Vandana and medium-drought-tolerant Anjali. These varieties have yield potential of 3.5 t ha^{-1} vis-à-vis traditional Brown Gora, which yields about 1.0 t ha^{-1}. Despite Anjali's lesser drought tolerance, it caught the favor of farmers during the drought-stressed growing seasons in 2004 and 2005. Anjali tended to outperform Vandana due to its better blast resistance during disease outbreaks. This was apparent during a 2005 visit when we observed healthy fields of Anjali adjacent to plots of diseased Vandana. Anjali certainly demonstrated its blast resistance, but blast pathogens are known to quickly adapt to new germplasm after its continued and widespread use. Plant breeders will have to continue their efforts to develop varieties that are resistant to the long-term shifts of blast populations in this ecosystem.

Because of the positive results in on-farm trials, WG5 scaled up Anjali and new establishment practices in 2006 through 20 NGOs working in districts across the 440-km border of northern Jharkhand. The NGOs were to give CURE-developed technologies a longer reach, as the Working Group has limited human resources for dissemination and follow-up guidance. This was particularly important for the more remote areas where public security was vulnerable to a long-running insurgency movement. The NGOs would be able to work in areas that were poorly accessible to governmental organizations.

Farmers' indicate that Anjali gains a foothold

The fields in CURE's villages were a bustle of activity when we visited Hazaribag for the qualitative impact assessment in early November 2006. Farmers had harvested Anjali 2 weeks earlier (mid-October) and now they were sowing chickpea in bunded uplands as the sequence crop. Meanwhile, neighboring stands of traditional varieties and other usual varieties were still 2 weeks away (about mid-November) from harvest. In field discussions, farmers said they liked Anjali's yielding ability compared with Brown Gora, and favorably assessed its disease resistance. Farmers also appreciated Anjali's short duration, which avoided late-season drought and gave them the opportunity to sow a postrice chickpea crop in the same field in bunded uplands. Anjali is harvested early when no other rice variety is ready, so rice is available during the otherwise food-scarce months prior to the main harvest. Women also indicated that the short duration allows them to better distribute household labor over the harvesting season. If all fields were sown with late-maturing varieties, they would have to hire labor to harvest all the fields at the same time (S. Haefele, personal communication 2007). In summary, farmers said that Anjali could improve their overall livelihood as they had a suitable variety for a staple food crop in the uplands. As one farmer put it, "We will use Anjali next year. Of course, if there are any newly introduced varieties from the government, we will try them again. Our main consideration is yield."

Farmers' comments varied about Anjali's taste and cooking quality. In some villages, farmers said they preferred a more slender grain than Anjali's coarser grain type. But, in Kuchu Village, farmers said that Anjali's white grain color favorably distinguished it from the reddish Brown Gora traditional variety. In summary, though, farmers said that the variety's taste and eating quality were acceptable enough for them to consider it for household consumption.

Evidence of Anjali adoption

The CURE villages in Jharkhand are strategically located in remote areas, but are on well-traveled sealed roads where farmer-participants' crops are visible to passers-by. At these sites, we often came across farmers from non-CURE villages who inquired about how to obtain Anjali seed. As one farmer said, "Other farmers have seen our fields, and they want seed from us." A case in point occurred in Lupung Village, where a farmer expressed regret that he and a group of co-agriculturalists had opted out of the 2006 sowing. Their nearby upland rice crop was still weeks away from harvest, while the participating farmers were busy sowing chickpea. A tomato producer there was also interested because he wanted to diversify into rice and needed suitable varieties for his upland fields. At other villages, farmers who had obtained seed from NGOs also indicated that nonparticipating farmers were requesting seed from them. For example, two farmers from Sangrhi Village, who were interviewed at an NGO training center in Chatra town, said that 10 to 15 farmers requested seed from them. Another village, Pawo, had not been involved in seed distribution, but its farmers requested the NGO to provide seed for 2007 plantings as they had observed Anjali growing in neighboring fields.

While all the above may be considered anecdotal, the WG5 team did document that Kuchu Village farmers sold about 500 kg of Anjali seed to farmers in nearby villages. If all of the seed were sown, it would account for 5 ha of coverage, in addition to 10 ha sown by Kuchu farmers. In Amin Village, farmers doubled the area sown with Anjali from 2005 to 2006. This amounted to a total of 6 ha sown in 2006. In the third CURE village, Lupung, farmers indicated they wanted to increase Anjali's coverage in the next year. As Lupung was a new village added to CURE, 2006 was its first year of experience with Anjali.

As for farmers' enthusiasm for the sowing of a postrice sequence crop in bunded uplands, there are questions about sustainability as the project provided high-quality chickpea seed. It is a truism that farmers participate in crop diversification trials to get good-quality seed that they would not otherwise be able to afford or to which they would not have access. This was evident in comments given by some farmers who were sowing chickpea at the Hazaribag key site. The sustainability of sequence cropping will depend on whether farmers will invest in new seed once current stocks start to deteriorate. Conceivably, this might depend on improved system productivity that could lead to a more secure financial situation, possibly motivating farmers to continue investing in this system. Regardless of outcome, chickpea is a versatile option for bunded uplands. They can harvest it for leafy biomass for salads, and it provides an end-crop of garbanzo beans. There is also some flexibility in that farmers can market it when prices are favorable or consume it at home when they are not, thus enhancing overall food security.

The other crop used in diversification trials, pigeon pea, was intercropped with rice in unbunded uplands, and it got a good stand in two villages. As a deep-rooted crop, pigeon pea is better able to access lower reserves of soil moisture in this drought-prone ecosystem. However, continuous cropping is susceptible to *Fusarium* leaf wilt, which is a subject that needs to be addressed to make this system sustainable. By coincidence, the usual cropping system for unbunded uplands in Amin village alleviated this prospect. For 2007, these farmers planned to rotate the rice–pigeon pea intercrop to a field that had been sown with maize in 2006 and, vice-versa, they would plant maize in the field where the rice–pigeon pea was intercropped in 2006. Villages with this sort of rotational pattern would be able to immediately benefit from the rice–pigeon pea intercrop in unbunded uplands. For villages without this option, CRURRS was testing *Fusarium*-resistant varieties provided by the International Crops Research Institute for the Semi-Arid Tropics. The downside was that testing would take a few years before suitable varieties could be confirmed for Jharkhand conditions.

Is two months' food security improvement enough?

Given farmers' enthusiastic acceptance of Anjali, it might seem to be disappointing for readers to know that farmers thought it would improve food security by only 1 or 2 months. This might not seem like much improvement over the 6- to 8-month annual food shortages that they attributed to low system productivity, and population pressure combined with inheritance patterns that reduced field sizes for succeeding generations. On the other hand, farmers' assessment was based on their first few years of trials on smaller plots that they intended to increase in coming years. Furthermore, a few additional months of rice production would ease their financial burden somewhat from having to purchase rice for the household. A female farmer estimated that the additional rice could save about Rs 2,000–2,500 that they could invest in their two sons' education.

To make up for food deficits, male householders migrate to urban areas, such as the state administrative center, Ranchi, or even as far as India's major urban areas, such as Kolkata, New Delhi, and Mumbai. In the cities, they are able to obtain unskilled jobs as rickshaw pullers or construction work. The daily urban wage rates are Rs 70, which are more than double what they would earn in agricultural employment. Whatever way they can accomplish it, the farmers said they would prefer to stay and make a living on the farm rather than have to migrate for work. That was their rationale for wanting to learn the new technologies. "When we are able to fill our bellies, why would we leave the village?" one farmer said. "If we can grow enough food, why would we need to leave the village?"

Testing dry line-seeding establishment systems for drought-prone uplands

New germplasm was only part of the equation for improving upland productivity in Jharkhand. The other part of the formula was improved rice establishment practices compared with farmers' traditional establishment system known as *tiwai*. This practice involves broadcast sowing of rice with high seeding rates followed 3 days later by a plowing of the field. The practice loosens the upper crust to promote faster rice emergence, and it arrests early-germinating weed seeds. As the practice can also reduce the rice plant population, farmers sow at a higher seeding rate to compensate for this loss.

After testing several line-sown crop establishment practices with farmers, WG5 settled on two methods: (1) seeding behind a plow and (2) broadcasting in furrows followed by planking. Although CURE research showed seeding behind a plow to be more effective, farmers tended to prefer broadcasting in furrows as it required less labor. WG5 research showed that either practice eased the weeding task because of the establishment of defined rows compared with a scattered stand from broadcasting in a nonfurrowed field. A plow pass at 15–20 days after sowing in light- and medium-textured soils uprooted early weeds with about one-tenth of the labor used in handweeding, and the crop needed only a light hand weeding later, which also used less labor. The less labor is appreciated because upland crop establishment must be coordinated with transplanting in the lowlands and, furthermore, women found handweeding easier to do in fields with defined crop rows. The plow pass also promotes *in situ* moisture conservation, allows sunlight penetration, and allows farmers to topdress nitrogen to get a better response from modern varieties, according to the WG5 research.

Three years of data showed that the new line-sown practices achieved yields in drought-stressed years comparable to what the *tiwai* could achieve only under conditions of favorable moisture (Table 10). *Tiwai* exceeded 2.0 t ha^{-1} only in the favorable-moisture season of 2006, whereas line sowing achieved those levels even in the unfavorable seasons. The results showed that yields of line-sown crops were 81% and 60% higher than those established by *tiwai* for the two drought years, and had a substantial increase even in the favorable year. The WG5 data suggest that new establishment practices could potentially stabilize rice yields over the range of erratic climatic conditions expected in this ecosystem.

Table 10. Three years of data on crop establishment practices, Jharkhand, India.

Establishment practice	Average yield (t ha^{-1})		
	2004 (drought)	2005 (drought)	2006 (favorable moisture)
Tiwai	1.17	1.43	2.27
Line sowing	2.21	2.29	2.87
Difference (%)	81	60	42

Source: Variar (2006).

Establishment systems still waiting to take hold

We admit that we were swept up with farmers' enthusiasm for Anjali and the sequence cropping, and that it overshadowed an investigation of the improved line-sowing establishment practices introduced to the CURE villages. This demonstrates the need for tight discipline when conducting farmer discussion groups, as their open-ended nature can veer the discussion away from equally important topics. This is especially critical as the research plan was designed to raise system productivity through the introduction of new germplasm in the context of better establishment practices.

We had the most detailed discussion in Lupung Village, where farmers were already using line sowing for other crops, so they were more willing to test it for rice. These farmers mentioned three advantages of sowing behind the plow: (1) it avoids seed decay that occurs when broadcasting is done under puddled conditions, (2) the covered seeds are protected from preying birds, and (3) covered seeds have better germination than uncovered ones. Farmers also observed that better tillering and higher yield occur as a result of the more efficient seeding rates required by seeding behind a plow. Using this method also requires better plow control to achieve a seed depth of 5 cm and for even row spacing at 20 cm, which is easier done using traditional plows. The newer plows in common use cut 8–10-cm furrows, which are too deep for Anjali. Farmers like the fact that straight rows make it easier to handweed the crop, which was a comment also made by women in focus group discussions in other villages in 2005.

Farmers in the other villages were more convinced that broadcast sowing and the higher seeding rates gave better weed suppression. They contended that seeding behind the plow "wastes space," and it reduces rice's weed competitiveness. Researchers argued, however, that line sowing uses seed more efficiently and results in better tillering because of a less dense stand. The best that could be said is that farmers were still experimenting with these practices under the supervision of the WG5 field assistant. Many of these farmers were younger, so it appeared they would be more open to changing practices if they experienced an advantage over the usual practices. On the positive side, farmers said the availability of a short-duration variety, such as Anjali, is an incentive for trying a new establishment practice. This may be a pathway for farmer adoption of improved establishment practices. We foresee a scenario whereby farmers will want to fine-tune their management with the new establishment practices once Anjali reaches its full potential under farmers' usual techniques.

CHAPTER 7. Arakan Valley, Philippines: Working Group 6 for intensive systems with a long growing season

CURE's key site for intensive systems with long growing seasons is in Arakan Valley, Philippines, the upland "rice belt" of North Cotabato Province on Mindanao Island (Fig. 7). Here, CURE collaborates with researchers at the University of Southern Mindanao (USM) and the Municipal Agricultural Office (MAO) who have been working to raise the productivity of a traditional variety, Dinorado, and to reduce rural households' vulnerability to food insecurity. Identified by its pinkish grain, Dinorado is known for its aroma and good eating quality. Dinorado fetches a good price because of its demand for weddings, fiestas, and as a menu item at specialty restaurants. However, farmers have been sowing Dinorado for 30 years and the genetic purity of their seed stocks has declined. Up to the implementation of this Project, good-quality Dinorado seed was scarce. Farmers also lacked access to better-yielding modern varieties for the uplands. Consequently, upland rice area declined sevenfold from 1994 to 2002 (Table 11). The local government's figures showed that upland rice area dropped from 2,753 to 377 ha during that period. Furthermore, upland rice yields averaged only 1.58 t ha^{-1} and rural households annually produced enough rice for only 4 to 6 months, depending on the availability of lowland paddy (Villanueva et al 2004:21). Because of rice seed scarcity, upland fields were converted to maize, which farmers sold in order to have money to buy food.

Fig.7. Arakan Valley, North Cotabato Province, southern Philippines, CURE key site for intensive upland systems with a long growing season.

Table 11. Rice planting area, Arakan Valley, North Cotabato Province, Philippines.

Year	Area (ha)	
	Lowland (irrigated & rainfed)	Upland
1994	731	2,753
1995	680	2,000
1996	804	398
1997	1,041	1,590
1998	1,452	550
1999	694	950
2000	603	1,050
2001	1,094	539
2002	1,035	377
2003	677	2,969
2004	500	2,218
2005	600	2,958
2006	641	2,960

Source: Municipal Agricultural Office, Arakan Valley, as quoted in Villanueva (2004:20).

Results were dramatic after CURE, USM, and the MAO joined forces to enhance agricultural productivity. In the years after 2003, rice area not only rebounded to mid-1990 levels, but was trending toward the 3,000-ha mark (Villanueva et al 2004:20). In discussions about qualitative impact assessment, farmers said that rice yields doubled to 4.0-plus t ha^{-1}, but, more importantly, the hungry months have been reduced to just June and July. Now, the municipal agricultural officer, Mr. Edgar Araña, has a vision that the remote district of Arakan Valley will revive its once-widespread reputation as a producer of high-quality Dinorado seed.

The WG6 team was able to achieve its aims by applying social science methodologies and technical expertise. Through sensitive interaction with the farmers, the team employed participatory methods that built rapport to understand the farmers' cultural and socioeconomic context in order to adapt the technologies to the local situation. The dynamics of this relationship were apparent during the FGDs and on-farm visits, in which farmers actively engaged with researchers to discuss the constraints and positive aspects of the technologies.

The community seed bank: organizing farmers for better seed health management

The WG6-Arakan Valley team was guided by the principle that rice seed scarcity = food insecurity. Following that principle, the team set its objective to improve seed health/quality and the availability of modern varieties for Arakan Valley's rural households. The primary mechanism was the establishment of a network of seed producers who agreed to follow proper seed health management practices. This network is known as a community seed bank (CSB). An IRRI seed health consultant trained farmers in proper seed health practices, and on-farm seed health was monitored during the project duration. The CSB cooperators also hosted farm walks during which neighboring farmers could discuss their crops and management practices. Although the team intended the CSB to be an informal organization of seed producers, farmers observed positive results, and they institutionalized the organization in order to sustain its benefits in the eventuality of project termination. In 2006, farmers inaugurated the network as the Arakan Community Seed Bank Organization (ACSBO). In addition, the MAO used the CSB model to revive a similar traditional practice in the nearby Manobos indigenous community. WG6's sister site at Lampung, Indonesia, established a CSB based on the Arakan Valley model.

Community seed bank achieves farmers' favor

Farmers related a "before" and "after" scenario regarding the effect of the community seed bank in rural household rice production. The "before" part of the story refers to the scarcity of Dinorado seed, the lack of improved varieties, and chronically low yields. The "after" part involves two principal ideas. One is that farmers learned the practices for producing good-quality seed, which has improved the supply of Dinorado seed. Not only did they employ the practices but they also observed field results that have raised their consciousness about how seed purity can improve rice production. In other words, they are convinced about the efficacy of the practices. The second idea involves better yields due to the introduction of new varieties of upland rice. This refers to modern varieties such as UPL Ri5 that has more stable and better yield than Dinorado. The better yields have reduced the food-short months from about 6 to 8 months to only 2 months.

In addition, participating farmers distinguished themselves from the nonparticipants in terms of the latter's continuing vulnerability to food insecurity. When asked which households were most likely to be affected by poor seed quality, the responses were

- "Households without access to seeds are most affected."
- "They don't have seeds."
- "Others said they no longer have seeds because they consumed them."
- "They don't have seeds because they consume them all."
- "Those who were not able to access information."

These comments support the research team's wisdom in adopting the seed scarcity = food insecurity model to address rice productivity problems in the Arakan Valley. It has been the practice for food-insecure households to eat their stored seeds during food-short months, which further exacerbates their food shortages. If the comments above are true, the farmers who have not taken advantage of seed health management techniques continue to follow this practice, which threatens their seed supply for growing the succeeding season's crop.

An interesting finding was that seven of the nine CSB participants in the discussion group were actually tenant farmers. The 2004 benchmark survey indicated that about 28% of rural households farmed under tenancy arrangements (Villanueva et al 2004:10). This would seem to indicate that CSB technologies can be exploited by land-poor households. The farmers also explained that many are tenants who farm land owned by relatives, which results in a familiar, stable sort of landlord-tenant relationship.

Transportation infrastructure was a problem in Arakan Valley, which constrained farmers' participation in these activities. For example, it was noted that farmers had problems crossing a certain river lacking a bridge. Even though boat access was available, they were afraid of the dangerously rough waters. Of the cooperators who dropped out of the project, it was said that the road situation discouraged them from attending the various activities, such as the farm walks. There also seemed to be poor communication in spreading information about the Project to rural households, which could be a function of poor roads. However, farmers were able to use their informal communication networks to spread some of the technologies to nonparticipants. Farmers said that they taught new practices to laborers who work in their fields, as well as to other farmers in the area. In fact, on a windshield tour of the district, the research team was able to point out fields of nonparticipants who had adopted the technologies.

The CSB affects farmers' understanding of seed health practices

Farmers' comments indicated that they not only learned the seed health practices but that they also understood the principles that informed the techniques. Abstract principles can become highly relevant if they can be applied to real-life experiences. In this case, farmers could explain how a crop performed when it was sown with good-quality seed versus a crop sown with poor-quality seed. For example, seed producers described fields with a "flat top," or rice plants with uniform height, as an indication that pure seeds had been sown there. In contrast, fields sown with seed mixtures had a ragged appearance. Farmers also mentioned that, by following good seed health practices, they observed that the seeds matched the ideal morphological characteristics associated with the variety/line. For example, pure Dinorado seed had pink coloration, whereas a seed mixture tended toward white coloration. Seed size and shape were also criteria that farmers used to judge the purity of the lot.

Thus, the evidence from the discussion showed that farmers had learned that "seeing is believing." This is significant because, in a focus group discussion, farmers could easily recite what researchers wanted to hear. In this case, they were relating actual field conditions they had observed to support their statements. Other examples of these comments follow:

- "The crop stand of rice is uniform because we now know how to purify (seeds)."
- "If there is a mixture, or off-type (seeds), the rice will not mature uniformly because the panicles did not come out at the same time."
- "Pure seeds have better tillering than the impure seeds we used before."
- "With seed mixtures, the crop matures earlier, and it attracts birds and insects. The mixtures ripen ahead and can attract diseases and pests."
- "The seed mixture or presence of off-types will reduce yield."
- "We are more conscious of proper seed quality practices."

This deeper understanding of the "why" of seed health management is likely to go a long way toward sustaining these practices, as it has changed farmers' thinking about crop management. It is one thing to *use* a new technique but it is another thing to *understand* its overall ramifications and to experience positive effects of behavior modification. This approach is also supported by educational theory that states that interactive, hands-on learning is an effective approach because learners can relate new knowledge to the conditions of their everyday experiences (Freire 1970, Kolb 1984). In other words, learners are empowered to change their lives.

CSB success: the proof is in the yield

This statement in the local language sums up farmers' opinions of the yield performance of new lines/varieties accessed through the Project: "*Nag improve gid ha*!" translated as "It really improved!"

Through the project's participatory trials, farmers were able to obtain new lines of Dinorado and related traditional materials of Azucena through IRRI's gene bank, as well as improved varieties (Table 12). Farmers reported that yields as much as doubled from 20–30 *cavans* (sacks) per hectare to 60 *cavans* per hectare. A *cavan* is the local unit of measurement roughly equivalent to 17–18 kg. Using the farmer-generated data, yields would have increased from 1.2–2.1 t ha^{-1} to 2.4–4.2 t ha^{-1}, a considerable increase given that the project benchmark survey reported an average upland rice yield of 1.58 t ha^{-1} (Villanueva et al 2004:21-22). Furthermore, for the 10 years prior to the project (1994-2003), upland yields ranged from 0.80 to 2.0 t ha^{-1}. As one farmer said, "One hectare before produced only 30 *cavans*; now, with the new varieties, we can harvest more than 60 *cavans* per hectare."

It also appeared that better yields have resulted in a production increase as farmers also reported fewer food-short months. Farmers said that the food-short months were reduced

Table 12. Upland varieties/lines used at the CURE WG6 Arakan Valley site, 2007.

Traditional	Improved varieties
Dinorado[a]	UPL Ri-5[a]
Azucena[a]	PSB Rc-9[a]
Guyod	NSIC Rc-9 (Apo[a])
Handurawan	Dilion Rice[a] (DR90/Lorsbar, IR72768-8-1-1)
Palawenya	PR 23813-2-53[a] (PR 53)
Davao Rice	UPL Ri-7[a]

[a]Introduced through the project; traditional materials would include new lines obtained through IRRI's Genetic Resources Center (the gene bank).

to just 2 months, June and July, which is right before harvest. This is an improvement over former times when food shortages occurred from January to August, depending on the extent of land the household held in lowland areas (Villanueva et al 2004:30). Better production has had social effects that have strengthened the participants' families and community ties, which will be discussed later.

As farmers' described it, there is a dynamic relationship about how they use traditional and improved varieties and to what ends. Farmers prize Dinorado for its economic value, as it is sold to meet the demand of niche markets, but they also keep a small amount for their own consumption when they miss the taste for it. These comments correlate to the benchmark survey that described a "savings" function for Dinorado, in that it was set aside for buying food in lean months (Villanueva 2004:18). As one farmer said, "It is easier to save *palay* (unmilled rice) than to save money." Also, farmers said that it is easier to save rice because stored maize is susceptible to insect damage. The higher-yielding UPL Ri-5 provides some flexibility in terms of household livelihood. It can be kept for household consumption, but, if prices are high, it can also be sold to earn money to buy cheaper imported rice, as Vietnamese rice is now available in the local market. The availability of rice as a food staple is in stark contrast to the situation described in the benchmark survey. In that report, farmers saved Dinorado for selling it to earn money to buy cheap maize for the lean months. Now, they have rice available for household consumption because of the improved productivity of the improved varieties, which can also be sold to buy cheaper rice. Farmers reported that households may still consume maize during the lean months, but the number of lean months has been reduced to 2, which reduces the amount of time in which they consume maize.

The CSB affects rural households' livelihoods

Farmer-to-farmer seed exchange indicates that the seed supply has improved because farmers have sufficient seeds to share with other farmers. Not only do they have seeds for their household needs but they also have a sufficient quantity for sharing with relatives, neighbors, and friends. Farmers did not exchange seeds that much before, because "we didn't even have enough seeds for ourselves." Seed exchanges also indicate that a particular line/variety approximates farmers' performance criteria as they seek out seeds to try in their own fields. Thus, the availability of these lines/varieties for testing stimulates this sort of demand, which is a credit to the PVS program and to the research managers who identified appropriate materials to test in participatory trials.

Farmers mentioned that they are gaining a reputation as good seed producers, which has generated demand for their seed. As ACSBO President Mr. Nestor Nombreda said, "We hardly have seeds for ourselves because of the strong demand." One NGO has recognized his good-quality seed by contracting to grow organic Dinorado for 500 Philippine pesos per *cavan*, whereas the usual Dinorado price is 425–450 pesos per *cavan*. Another farmer said that he has exchanged seeds as far away as Alamada Municipality in the far northwest corner of North Cotabato Province (Arakan is in the northeast corner).

Our CURE collaborators at USM were quick to point out that seed exchanges are more than a transfer of useful products from one party to another. These exchanges are a form of social capital that is reciprocal in nature and can build community relationships. The community is strengthened because rural households can draw on their relatives, friends, and neighbors in times of need, and vice-versa. Comments from farmers bear this out:

- "We (our household) don't sell seeds, but we are happier now because we are able to share seeds with our children so they can also plant."
- "We are able to share seeds with neighbors. I am able to share seeds with our children so that if they have a good harvest, and mine is a failure, I can get seeds from them."

Social scientists' interest in the theoretical aspects of exchange can be traced back to Marel Mauss' seminal work *The gift: forms and functions of exchange in archaic societies* (1970), which was a springboard for further analytical refinements of exchange theory in traditional societies (Sahlins 1974). One political scientist, James C. Scott (1976), even theorized that the breakdown of traditional institutions that guarantee a minimal level of food security can lead to widespread social unrest, resulting in peasant rebellion against government authority.

So far, the seed traders have been reluctant to reward the better seed producers with higher prices. The USM team has been working at raising stakeholders' consciousness of seed quality through a "value chain" concept. Stakeholders along this chain strive for a good-quality product once they realize each's contribution to creating the value of it. Once that awareness is achieved, each works together to harmonize his efforts that result in a good-quality product. WG6-Arakan Valley has conducted rice sensory tests involving farmers, traders, and consumers to start a dialogue on the quality traits demanded by the market. The team is working to keep quality consciousness foremost in farmers' minds in the long-run hope that traders will become aware that their livelihood is closely linked to farmers' productive capacity.

Testing mixed cropping as a buffer against crop failure

Taking one step more, the Working Group sought to buffer rural households against crop failure by diversifying the upland rice-based cropping system. Should rice fail, farmers could fall back on nonrice crops, which are also remunerative because of marketing potential. Farmers had already diversified their cropping systems with sporadic maize plots aside from the main upland rice crop. But this sort of diversification reflected a retreat from the lower-producing rice cropping, rather than a strengthening of the overall system. The Working Group expanded upon the farmers' nonrice cropping choices by testing legumes, which are good sources of protein and can fix nitrogen to improve soil fertility. The experimental setup involved strip plots of rice with groundnut, mungbean, or maize in the same field. A postseason cropping analysis showed that rice + mungbean gave the highest production advantage, followed by rice + groundnut and rice + maize. A rice monocrop of an improved variety planted with Dinorado gave the least production advantage (Somera et al 2005). WG6-Arakan Valley's data also showed that cooperating farmers shared mungbean and groundnut seeds with other farmers, which indicated a wider interest in these crops. When given a choice of crop combination in the Project's third year (2006), farmers tended to choose rice + mungbean because of its earlier harvest (1 month before rice), a desire for household consumption, soil conditioning properties, and investors' expressed interest (Table 13).

Farmers viewed the mixed cropping of rice and nonrice crops as a way to buffer themselves against food insecurity. If the rice fails, they could fall back on the nonrice crop, and vice-versa. In the discussion, farmers mostly discussed mungbean, which probably reflects the composition of the participants in the discussion. They said that mungbean is harvested right before the rice harvest, so it is a buffer against food shortages at that time. Farmers also appreciated the legume's effect on soil conditions.

The multiple benefits of mungbean are reflected in the following comments:

- "If our rice fails, we still have mungbean."
- "While waiting for rice to be harvested, we have mungbean because it matures earlier than rice. Mungbean also helps in restoring the fertility of the soil; besides, it can help feed my family."

Farmers were pleased to have access to the higher-yielding Pagasa-7 mungbean variety, which has better cooking and taste quality than the usual variety, Australian 124. Farmers also reported success at selling mungbean seeds both within and outside of North Cotabato Province. These areas include

Table 13. Farmers' and researcher-managed yields, CURE mixed-cropping trials, Arakan Valley, Philippines, 2006.

Crop	No. of farmers choosing	On-farm yield range ($t\ ha^{-1}$)	CURE site yield
Mungbean	7	0.20–2.53	0.63
Groundnut	4	0.24–0.71	0.36
Maize	4	2.9–5.90	5.18
Rice			
Dinorado	12	0.54–2.33	1.67
UPL Ri-5	12	1.75–3.93	3.27

Source: CURE Working Group 6-Arakan Valley (2006).

Alamada and Mlang, North Cotabato; Surrallah, South Cotabato; and Tacurong City, Sultan Kudara Province. The distances concerned are significant as road infrastructure is poor, which is a constraint to exchanging these materials in far-away areas.

The mixed cropping system, as proposed by CURE, poses constraints to adoption. Farmers said that the row widths for crops, as suggested by the researchers, consumed time and labor at sowing and harvest. They said that the women and children were "confused" when they were involved in sowing and harvesting operations. "It is time-consuming and labor-consuming, and difficult to harvest," as one farmer said. However, farmers seemed to be able to adjust the field layout to their farms' circumstances.

Another constraint mentioned was land tenancy, as some farmers do not necessarily have the final say-so on the kinds of crops that can be cultivated in the landowners' fields. One farmer-tenant said that he is able to plant mixed crops, but, for others, this depends upon the landlord's permission. In some cases, a landowner might allow the tenant to grow only rice. This could be a setback, especially as these technologies are promoted to help resource-poor farmers, and land could be one of the resources they are lacking. To be sure, the tenancy situation may not be so onerous as many farmers said that the landowners are usually relatives, which results in a familiar land-use agreement. Still, this issue was important enough for the farmers to bring it up in the focus group discussion, and ultimately it reveals that farmers are beholden to landowners for implementing this technology.

Two are better than one: testing rice genetic diversity for improved household food security

WG6-Arakan Valley's third technology for improving food security was to introduce a concept of planting two different rice varieties in specified row ratios in the same field. Researchers have promoted rice genetic diversity as a practice to reduce the occurrence of disease, but it was also introduced in Arakan Valley as a buffer against food shortages, as one variety would

CURE has introduced two sorts of crop diversification practices to Arakan Valley. At left, a farmer stands between two varieties sown in strips, which is an adaptation of the research design's row interplantings. At right, a farmer and his son are in a field mixed-cropped with rice and mungbean.

likely produce a crop when another incurred losses. In addition, it was thought that farmers who grew several varieties would be better able to meet their household needs and consumers' demand. The experimental setup involved two rows of Dinorado interplanted with four rows of the improved variety UPL Ri-5. The latter variety has characteristics similar to those of Dinorado, but it is higher yielding.

The interplanting of traditional and improved rice varieties in the same field proved to be the most problematic of the new technologies introduced to Arakan Valley. Farmers did understand the ecological benefits for crops. Throughout the discussion, they understood the higher yields from using the practice and that the shorter variety, UPL Ri-5, tended to keep Dinorado from lodging in the event of high winds. However, farmers expressed difficulty in following the research design that called for a ratio of two rows of Dinorado to four rows of UPL Ri-5. Family members had a hard time keeping track of the varietal ratios at planting, and especially the children needed supervision. At harvest, the family members had problems keeping seeds separated by variety, which reflects their seed health training to avoid mixtures. If anything, this demonstrates that they were able to use their seed knowledge to critically analyze a new technology that contradicted it. In that way, there is an internal validity to their discussion, as they gave consistent answers that demonstrated what they had learned in their training. Some comments were

- "It's confusing and very laborious."
- "If you would ask me to plant (rice genetic diversification), I will still plant it. But if it will be my decision, I think it would be better if I do not continue because the design is really confusing."
- "Children provide labor for planting. When they plant, they get confused on the design. They must be supervised at all times so the seeds will not be mixed."
- "There are instances when the harvesters mixed the Dinorado and UPL seeds while harvesting because they got confused."

Recognizing that rice genetic diversity may serve a useful purpose in their cropping system, farmers reported that they were adjusting the research design to make it easier to manage. They were planting the varieties as different sections in a field rather than using the row ratio technique prescribed by researchers. It is uncertain whether the modified version gives the same effects on crop performance as the original design. But the farmers' search for a suitable method demonstrates that they are engaged in a process of discovery just as are researchers steeped in the methodological canons of science. This is a classic example of farmer experimentation that has been documented throughout the developing world (Chambers 1983:91-92).

PART 3
What have we learned from qualitative assessments?

CHAPTER 8. Pathways to impact: lessons learned from CURE qualititative assessments

CURE's model for pro-poor technology development

Throughout this publication, we have described an array of environmental conditions and stresses that affect rainfed rice-based system productivity in the countries served by the CURE network. Given their diversity, these ecosystems can present perplexing challenges to agricultural scientists used to a narrowly defined discipline-focused approach to research. At another level, some social and cultural factors outside the purview of the natural scientific disciplines need to be considered for making progress in unfavorable environments. It is here that CURE shows its strengths, as the work is holistic and it brings to bear that "critical mass" of scientific expertise for generating, developing, and validating technologies for these stress-prone environments (Bennett 2005). Combining scientific knowledge with farmers' experience of making a living in these difficult environments, the developed technologies are more likely to make a difference in resource-poor rural households' livelihoods. This is important for effectively contributing to achieving Goal 1 of IRRI's 2007-2015 strategic plan, which states:

Reduce poverty through improved and diversified rice-based systems

This is also aligned with the United Nations Millennium Development Goals (MDG) that aim to make substantial progress in improving the living standards of the world's poor by 2015 (www.un.org/millenniumgoals/). Further, IRRI's Goal 1 operationalizes the first MDG ("Eradicate extreme poverty and hunger") for the unfavorable environments where many of the world's rural poor live. Not only does CURE attempt to improve rice production, but many of those improvements, such as earlier rice establishment systems, aim toward diversification into nonrice crops. In this way, CURE uses rice research as the entry point into rural households' livelihood system for raising overall system productivity.

Organized five years before development of the IRRI strategic plan, CURE and its use of farmer participatory methodologies strategically positions it to do the kind of pro-poor work mandated by IRRI and the UN's MDGs. We say "strategically positioned" because effective farmer participatory research is still a work in progress for CURE. As the case studies showed, some sites are better than others, and much more capacity building is needed. Our observation has been that sites get the best results when scientists commit themselves to the painstaking application of farmer participatory methods. Despite the range of skills in the network, it is clear that the institutionalization of farmer participatory methods in the CURE paradigm offers a corrective to what development critic Robert Chambers (1983:10) coined the "rural development tourism" syndrome. This syndrome is characterized by six biases that render the poor invisible to the research process. These are worth repeating here because they are a reminder of why we do farmer participatory research (Chambers 1983:13-23):

1. *Spatial biases:* In some research projects, there is a tendency to situate the experimental sites where they are easily accessible for the convenience of researchers and visitors. Although CURE's key sites are necessarily positioned at host institutions, the farmer participatory research occurs in villages located in distant locales and often accessible only on poor roads. A balance is struck here between being distant enough to capture rural households' livelihood systems, but visible enough to showcase the technologies to familiarize the area's farmers with these technologies.
2. *Project bias:* These are "showpiece" and "nicely groomed pet project or model" villages that receive a preponderance of project support at the expense of poorer areas. The CURE village is only a showpiece to the extent that it gives visibility to technologies to catch the interest of nonparticipants. CURE's goal is not to concentrate technologies at one ideal location, but rather it is to work with farmers to test technologies so they can be scaled out over a wider area.
3. *Person biases:* It is common for researchers to want to work with the so-called better-off "progressive farmers" who can bear the risk of adopting new technologies. To some extent, CURE's experience shows that it is difficult to reach the "invisible" poor. However, CURE strives to incorporate poorer farmers

by offering a basket of technologies that can be suited to a household's socioeconomic status. For example, the qualitative assessments revealed that landless households were able to use the new technologies. Furthermore, CURE considers women's perspectives through activities such as PVS, and researchers continually assess the impacts of technologies on "women's work."

4. *Dry-season bias:* Project evaluators may limit their trips to research sites when the weather is favorable for travel. In CURE's work, researchers work in villages throughout the growing season, and not just when conditions favor easier travel. This interaction is necessary to introduce the new technology, observe how farmers adapt new technologies, and provide any backstopping support.
5. *Diplomatic biases:* Project workers may insulate visitors from poor areas so as not to offend their sensibilities. By its nature, farmer participatory research makes the CURE village an "open book," which raises researchers' consciousness of the socioeconomic categories in the community.
6. *Professional biases:* Researchers may tend to conduct research within narrowly defined disciplinary boundaries without regard to the implications for the overall farming system. CURE's Working Group structure integrates knowledge of various disciplines to achieve a technological product. Good examples are the establishment systems that integrate new germplasm with crop management practices, which also take into account the social and economic circumstances of the rural household.

CURE is not perfect; many of these biases persist to a certain degree, just as they do in any research program. But a good start has been made upon which further progress can build. CURE's downstream approach means that agricultural research extends beyond the highly controlled research station or outside the confines of a well-supported showpiece village. Instead, scientists collaborate with farmers to solve real-world problems in real-world conditions of the unfavorable ecosystems.

CURE's achievements under ADB-RETA 6136

Through support from the Asian Development Bank, CURE was able to conduct adaptive research to validate new technologies, which were then scaled out during the one-year project extension in 2007. As indicated by the qualitative data, some of these technologies can have considerable impact on farmers' livelihood systems, while constraints were identified that would hinder their uptake. Here, we discuss these achievements, how the farmer participatory approach contributed to their development, and shortcomings that need to be addressed to continue progress in technology development in the unfavorable rice ecosystems.

Suitable germplasm identified for the surveyed sites

Through participatory varietal selection and in demonstrations under on-farm conditions, CURE was able to identify germplasm that achieved farmer acceptability beyond farmers' traditional varieties. This was evident at Cuttack (salt-affected lowlands), Hazaribag (drought-prone lowlands), and Arakan Valley (intensive upland systems with a long growing season), where new varieties could yield at least 1 t ha^{-1} (or at least double) more than traditional varieties. At Hazaribag and Rangpur (flood-prone lowlands), farmers also valued the earlier-maturing varieties because these allowed farmers to intensify the rice-based system with better timing of a post-rice crop. The iterative process of varietal testing in farmers' fields was able to identify germplasm suitable for the stresses of these ecosystems. In Cuttack, these were older-developed varieties that could perform well under coastal saline conditions. At Hazaribag, it was the blast-resistant Anjali that earned farmers' favor despite its lesser drought tolerance for this drought-prone ecosystem. In Arakan Valley, new accessions of Dinorado reinvigorated the production of a valued traditional variety, while researchers also introduced improved varieties with similar characteristics for improving overall food security. At Rangpur, the early-maturing BRRI dhan 33 was distributed to a limited extent, but there appeared to be demand as neighboring farmers observed its performance in participating farmers' fields.

Although yield was an important factor, other considerations became apparent, especially at the coastal salinity site of Cuttack. Here, farmers appreciated multistress tolerance of the germplasm. The introduced salt-tolerant varieties survived a wet-season flood because of elongation ability. This may be important information for plant breeders to widen the search for traits that can improve varietal performance under a range of conditions in unfavorable ecosystems. For the dry season, farmers were interested in varieties with high tolerance of saline water irrigation, to which researchers responded for the 2007 on-farm tests.

The two Oudomxay Province villages assessed in Laos present a different set of circumstances, as 2006 was their first exposure to the new varieties. The discussion that ensued reflected how farmers sort out the advantages and disadvantages of new germplasm, especially for the microenvironmental conditions of the sloping uplands. It is here that cultural factors come into play because the ethnic minorities each may have differing criteria for evaluating germplasm. This surfaced in regard to the acceptability of nonglutinous varieties for the Khmu, who prefer glutinous rice for household consumption. Some households may be able to use nonglutinous entries for making noodles for marketing, or else they would have to change their cultural preferences to the consumption of nonglutinous rice. Also, rice varieties that can be harvested through the Khmu traditional hand-stripping method may be more preferable than those requiring sickle-harvest. The Khmu do not raise bovine species, so the straw is not necessary for their livestock. This also begs the question about the disposition of straw if they adopt varieties that must be sickle-harvested. That cultural factors are important in agriculture is not to say that these cultural preferences will never change. The anthropological literature is copious on culture change, although bereft of any widely applicable models of it. However, innovations that fit as unobtrusively as possible into a culture are probably more easily adopted in a development context as they require minimal adjustments in the social and cultural system. We believe that the Khmu will adopt the most favored of the new varieties as an addition to the many varieties that they already grow, rather than a wholesale replacement as occurs in the adoption of mega-varieties in the lowlands. The Khmu discussion also revealed that inputs could give dramatic yield results, but, under current policies, the cost would make them inaccessible to resource-poor households. In this case, any immediate yield gains will be incremental as fertilizers are too expensive for farmers to adopt.

All the above discussion points to the exchange of information between farmers and scientists to find the kinds of varieties suitable for these quite diverse ecosystems. This illustrates the strength of the farmer participatory approach used in varietal introduction. Although yield is an important consideration, farmers choose among various agronomic, plant type, and cultural criteria in finally deciding to choose a variety. Involving farmers in the process of germplasm introduction thus improves the chances of adoption and the realization of the research investment in developing these new varieties. The dialogue fostered also gives scientists valuable information on the sorts of farmer-preferred criteria that need to be considered in the future development of new varieties for these difficult ecosystems.

Viable crop and natural resource management practices to raise system productivity

Although rice breeding is a core mission of IRRI and many collaborating NARES institutes, the new varieties must be situated in an ecosystem context in order to have the greatest impact on a livelihood system. Improved rice production can reduce hunger and also improve households' financial situation as it reduces the need to have to buy rice. However, rice scientists in CURE have also gone a step further by developing ways in which rice-based systems can be diversified into nonrice crops. This is an integrated approach, and farmers appreciated the opportunity for ways to diversify their production systems, either for improving food security or for having an additional crop to market. One theme is to establish rice earlier, which gives an opportunity for better timing for a postrice crop. This may involve the introduction of early-duration varieties and/or new direct-seeding crop practices for early rice establishment, both for the purpose of advancing the harvest, which allows earlier timing of a postrice nonrice crop. At Hazaribag, this involved direct-seeding the early-maturing Anjali, which could either be intercropped with pigeon pea or followed after harvest with sowing of a chickpea sequence crop. At Rangpur, the strategy to mitigate *monga* involved the introduction of direct-seeding by a drum seeder or lithao, which had multiple effects on the cropping and social system. Early establishment not only advanced the rice harvest to reduce hunger and to provide job opportunities to agricultural workers, it also provided better timing for potato sowing. The better timing for potato likewise had multiple effects in providing jobs to the rural poor and in reducing inputs for controlling biotic stresses. Farmers were also interested in an early-maturing rice variety that could be introduced to this system. At Arakan Valley, new rice varieties were integrated into a mixed cropping system that could buffer households against rice losses, but they also provided sources of protein for the family's diet. The mixed-cropped legumes also improved soil conditions for subsequent crops. Another practice, rice genetic diversity, was less favorable because farmers found the design too confusing for family members to implement.

Another theme is that crop management practices can improve the genetic potential of stress-tolerant traits bred into new germplasm. This was shown at Cuttack, where a basket of technologies—nutrient management, aged seedlings, and closer seedling spacing in transplanting—raised the performance of newly introduced rice. For the dry season, earlier nursery establishment and transplanting before mid-January were optimal for avoiding the seasonal higher salinity levels. At Hazaribag, on-farm results consistently showed that new direct-seeding practices could stabilize rice production between years of favorable and unfavorable moisture.

What emerges from the above research is that new crop management practices have to fit into the social and economic systems of rural households in order to be acceptable. Crop management practices are more complicated to develop because they require farmers to change long-practiced patterns of household labor allocation and timing of seasonal tasks. Rangpur'*s monga* mitigation practices are a classic case, as they introduced new technologies at a time of year when labor was available due to a slack seasonal employment period right before the usual rice harvest. The new system was able to mobilize unused labor not only for rice harvesting but also for field preparation for the sequenced potato crop. In the meantime, the effects of these technologies radiated throughout the social system, which benefited both medium-landholding farmers and landless agricultural workers. This system also had some effect on improving relationships between large-landholding farmers and their poorer relatives, who could borrow rice at needy times. At the other sites, Hazaribag and Cuttack, farmers seemed to be motivated by the prospect of being able to grow remunerative nonrice crops to avoid their seasonal off-farm migration for wage-laboring jobs.

The largest constraint in these new systems is the availability and affordability of good-quality nonrice seed. It is common to hear farmers say that they are participating "to get seed," indicating that it might not be easily available from any source except the researchers. To make a difference in the livelihood system, researchers must be able to anticipate how farmers can continue with these technologies once project support ends. That is the ultimate test for adoption. This may require entering the policy arena to advocate government support for seeds. There may be a role for extension services or NGOs here to make good-quality nonrice seed available. This was evident at Rangpur, where some farmers indicated that NGOs marketed good-quality potato seed. In this way, the research program needs to be better integrated with the distribution sources of nonrice seed.

Community organizing for improved seed health management

Arakan Valley's development of a community seed bank model would seem to extend CURE's role from purely technology development to organizing an effective mechanism for technology delivery. It is through the CSB that seed health practices and new varieties are disseminated to farmers, and through which follow-up monitoring is conducted. This may appear to blur the boundaries of IRRI's and NARES partners' missions away from a strict function of research for technology development. However, we propose that the CSB is a technology in itself, if one considers a broader definition of that concept to include "the use of tools, the pattern of work, the information or knowledge employed, and the organization of resources for productive activity" (Seymour-Smith 1986:276). Furthermore, the social science literature shows that linking technology to a social organization is a people-centered approach that is likely to sustain technologies introduced by a project (Cernea 1991, Kottak 1991).

Just as other technologies may be diffused to other areas, we found that the CSB model is portable, as it was implemented in a nearby Manobos indigenous community, as well as at the WG6-Arakan Valley's sister site in Lampung, Indonesia. At those sites, farm communities can adapt it to their particular circumstances. It would seem inconceivable that a CSB could be developed without a farmer participatory approach, as it requires a sustained scientist-farmer partnership to teach new seed health management practices, and the follow-through to ascertain that farmers are properly using these practices. The WG6 team sensitively accomplished this with field schools, farm walks, and on-farm monitoring, in addition to raising farmers' and traders' awareness of their supporting links in the value chain of seed production. The farmers have responded by instituting the CSB into a formal organizational structure, the Arakan Valley Community Seed Bank Organization. This assures that a formal network is in place that can sustain and build upon the gains already achieved through CURE's seed health management program.

Progress in household food security has been made but in varying degrees

The evidence from the qualitative assessments indicates that progress has been made toward improving household food security at most of these CURE sites. The amount of progress ranges from villages that indicated they are growing surpluses (Cuttack) to other sites where annual food shortages have been reduced to about 2 months (Arakan Valley) or to where only a 2-month annual improvement (Hazaribag) occurred. In each of these cases, farmers reported that food shortages had ranged from 3 to 9 months. Although progress was made, we must take into account that farmers are still testing the varieties and management practices on a small scale. Further gains can likely occur once they continue to build their confidence in the technologies and expand the area of adoption. They may need to test these technologies over the range of conditions that frequent these unfavorable ecosystems. After all, unfavorable rice environments are characterized by the erratic nature of the stresses that confront crop production. Drought and flooding can occur at various points of a single growing season, whereas problem soils, such as saline soils, add another layer of complexity. Achieving stable rice production in these ecosystems needs to take into account this variability.

The Lao site in Oudomxay Province is more problematic because 2006 was the first year for the selected village to test the varieties for sloping upland conditions, which CURE was able to introduce through an IFAD development project. However, the qualitative research was able to elicit the sorts of cultural and agronomic criteria that a specific ethnic group, the Khmu, uses to evaluate new cultivars. This underscores the strength of the farmer participatory approach, as "one size doesn't fit all" when introducing technologies to unfavorable environments. This approach is particularly apt for the sloping uplands, where farmers have to take into account highly localized microenvironmental factors in choosing new rice varieties. By giving farmers a choice in varietal selection, CURE is able to mobilize farmers' own knowledge and expertise in cultivating rice in this ecosystem.

Partnering with farmers to achieve impact

Whether or not a research project employs farmer participatory approaches, it is the farmers who will always have the final say in whether they will adopt or not adopt a new technology. CURE's experience shows that partnering with them in the technology development process can bring about favorable outcomes as it allows researchers to apply scientific knowledge to farmers' realities in the unfavorable environments. This is the essence of what former World Bank sociologist Michael Cernea (1991:7) calls "putting people first" by marrying technical requirements to social realities to achieve progress in agricultural research. The concept of farmer participatory research may appeal to our philosophical sense of benevolence and goodwill toward the beneficiaries of new technologies. But, Cernea pointed out that a people-centered approach has very important ramifications for the *effectiveness* of programs that are intended to bring about positive change in the developing world. The accomplishments documented in this report tell that story at several CURE key sites.

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