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**STRATEGIES FOR DEVELOPMENT AND
DISSEMINATION OF IMPROVED RICE
TECHNOLOGIES FOR THE POOR**

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DRAFT

Strategies for Development and Dissemination of Improved Rice Technologies for the Poor

1. Introduction

About half of the world's population, or more than 3 billion people, depends on rice for its staple food. Rice provides about 20% of direct human calorie intake worldwide, making it the most important food crop.¹ Rice consumption can be very high, exceeding 100 kg per capita annually in many Asian countries (10 kg is the U.S. average).

Rice is the principal food for most of the world's poorest people. Rice farming is also the main economic activity for hundreds of millions of rural poor, many of whom do not own their own land. In Asia and sub-Saharan Africa almost all rice is grown on small farms of 0.5 to 3ha. Yields range from less than 1 t/ha under very poor rainfed conditions to over 10 t/ha under intensive temperate irrigated systems. Small and in many areas shrinking farm size account for the low incomes of rice farm families.

Fully two-thirds of the world's poor live in Asia and almost all of these eat rice. Rice is also becoming a staple food in sub-Saharan Africa, where urban dwellers who only a few decades ago rarely ate rice now consume it daily. Per capita consumption has doubled since 1970 to 27 kg. In the mega-cities of Asia, the poorest of the poor may spend up to 50% of their total income on rice—not other food, but rice! So, anything that lowers the price of rice will directly benefit hundreds of millions of poor consumers and anything that increases rice-farming productivity will benefit millions of rice farmers and their families. The Green Revolution in Asia did just that and led directly to the Asian economic miracle of the last 40 years. But clearly much remains to be done.

About 50% of the rice area is grown under intensive irrigated systems. These are systems in which the water supply is assured from either surface sources (rivers and dams) or wells. Equally important, these systems have controlled drainage so that the amount of water that reaches the crop can be controlled, and it can be applied and removed for land preparation and harvest. Modern high-yielding varieties do very well under these conditions and farmers typically apply fertilizer to obtain high and reliable yields. These systems were the home of the Green Revolution in rice and lifted millions of people out of poverty. Today, about 75% of the rice produced in the world is produced in intensive irrigated systems. Thus, global food security depends upon their continued ability to sustain high yields.

The other half of global rice area is rainfed, meaning that it depends exclusively on rainfall, and in some cases unpredictable floods, for water. Rainfed rice can grow on steeply sloping lands, such as in the mountainous areas of Southeast Asia, or on the flat lands that predominate over much of the delta and coastal areas of South and Southeast Asia. But, only about 25% of the world's rice comes from rainfed systems. Because rainfall can be so variable, rice in rainfed areas typically is prone to drought and catastrophic flooding—sometimes in the same year. By far the largest rainfed areas are the “rainfed lowlands.” These are level fields in which farmers construct bunds or levees to

DRAFT

capture rainwater and maintain standing water in the field for as long as possible. Rainfed lowland rice predominates in those areas of greatest poverty: South Asia, parts of Southeast Asia, and essentially all of Africa. Because the environments are so difficult and yields so unreliable, farmers rarely apply fertilizer and tend to not grow improved varieties. Thus, yields are very low (1–2 t/ha) and farm families remain trapped in poverty. Even though these farmers are very poor, it is important to keep in mind that, for most, without rice, they would have no livelihood at all.

There are a number of worrisome signs suggesting that new challenges lie ahead. There has been a slowdown in growth in rice production as the yield gains from the adoption of the modern varieties in the irrigated areas have become almost fully exploited and the rice area is declining. Over the past five years, international rice price has doubled and price for urea tripled, the latter spurred on by the rise in oil prices. Rice stocks are at their lowest level since the 1970s. Other concerns include the rising demand for bio-fuels, the pressures that urbanization and industrialization place on land and water resources for uses other than agriculture, and the long term effects of global warming. Taken together these concerns will accelerate the demand for new technologies that can be rapidly disseminated to achieve further productivity gains and permit a continuation of low and stable rice prices.

2. A pro-poor strategy for technology development

In much of Asia, given the pervasiveness of the rice crop and the place of rice as a staple in the diet, the first step has been to increase rice productivity. Increasing rice productivity provides the entry point for science and technology. Adoption of new technologies can provide the stepping stone to enable farm families to diversify their incomes through both farm and non-farm activities, including the out-migration of labor from agriculture. For many farm households this is becoming the pathway out of poverty.

IRRI has developed five strategic goals that address the problems of poverty and related issues as follows:

- Reduce poverty through improved and diversified rice-based systems
- Improve nutrition and health of the poor rice consumers and rice farmers.
- Insure that rice production is sustainable and stable, and has minimal negative environmental impacts, and can cope with climate change.
- Provide equitable access to information and knowledge on rice and help develop the next generation of rice scientists.
- Provide rice scientists and producers with genetic information and material they need to develop and improve technologies and enhance rice production.

These strategic goals are very much in keeping with the Millennium Development Goals - reducing extreme poverty and hunger, promoting gender equality and empowering women, ensuring environmental sustainability – in short, addressing issues of poverty in the present and sustaining rice production in the future.

DRAFT

2.1 Addressing issues of poverty

Technology development to reduce poverty calls for a two-pronged approach.

- Ensure adequate and affordable food supplies for poor rice consumers through further increases in productivity and profitability on irrigated land.
- Enhance household food security and income in rainfed areas of Asia through improved varieties and management that can double yield and reduce yield variability under stress conditions such as a drought or flood.

Irrigated rice. The first approach, development of new technologies for the irrigated systems must take into account that the rice-based systems are changing rapidly. Along with this there is a change in demand for technologies. Rising incomes and urbanization lead to a change in demand patterns for agricultural products. As consumers are diversifying their diets so also must the farm economy diversify to meet the changing consumer demands. Research on varietal improvement is focused on increasing the biological yield potential of rice. Development of improved management practices are designed to reduce the gap between the yield potential of improved varieties and the farm level yield and/or lower the unit cost of production.

There are currently three technologies in the formative stage of development designed to raise the yield ceiling in the tropics. These include adapting hybrid rice to the tropics, development of a new plant type which will raise the grain to straw ratio, and converting rice from a C3 to a C4 plant type to increase the photosynthetic rate. What these projects emphasize is the often long time duration required for development even using modern biotechnology techniques. Projects such as the development of a C4 rice or a rice with tolerance to global warming are referred to as *frontier projects* which will have a long gestation period.

Meanwhile researchers are promoting improved crop management practices through the simultaneous reduction of multiple farm constraints. The farmer demand for crop management technologies is changing with the changes in the farm economy. For example, there is a growing demand for technologies which are labor saving, which address the problems of water scarcity, or which reflect increased women's participation in the labor force. At the same time there management practices such as improving seed quality and health, reducing pesticide use, and site-specific nutrient management which provide the opportunity for increasing yields and/or lowering the unit cost of production.

Rainfed rice The second approach is to significantly increase the productivity of rainfed lowland rice where research thus far has been less successful... However, advances in genomics and molecular biology of rice, enabled by the sequencing of its genome (the first of the crop species) and improved analytical approaches, have allowed rice scientists—breeders, geneticists, and physiologists—to make dramatic progress in developing rice lines that tolerate complete submergence, drought, and salinity. There is now an unprecedented opportunity to make massive

DRAFT

contributions to the well-being of farmers and the landless in rainfed systems. The incorporation of major tolerance of complete submergence into varieties already grown on millions of hectares is concrete proof that this opportunity can be translated into reality.

Increasing nutrition and health. A major research undertaking to improve the health of rice consumers involves the biofortification of rice or the development of nutritionally improved rice. This includes high-pro-vitamin A, high-iron, and high-zinc rice. These nutritional traits can be incorporated into varieties that farmers wish to grow. For example, combining these traits with stress tolerance is one important way to increase the likelihood that farmers and the rural poor will adopt and consume nutritious rice. High pro-vitamin A is already being combined with submergence tolerance in widely grown varieties from South Asia.

2.2 Sustaining rice production in the future

Technology development and dissemination is a never ending process. Sustaining rice production requires initiation of activities now that lay a foundation for development and dissemination of technologies that address the challenges of the future.

Research to address issues of sustainability. A number of research projects now underway can be referred to as *frontier projects*. The gestation period is long and the future success unpredictable. These include the earlier mentioned converting rice from a C3 to a C4 plant type, developing varieties with tolerance to global warming and to drought tolerance. On the management side there is what some describe as the looming water crisis.

One of the most pressing environmental concerns in Asia today is the growing water scarcity and overexploitation of water resources. As industrial and municipal demand for water grows, there will be less water for agriculture in the future. Ways are being sought to develop and disseminate water saving technologies and increase water productivity. These include alternate wetting and drying of paddy fields now widely practiced in China, encourage the development of farm ponds, make use of low-lift pumps for development and distribution of water and introduce low-cost drip irrigation. Institutional factors, for example presence or absence of farmer irrigation associations, play a major role in either inhibiting or facilitating water use efficiency. The way we manage our water resources will require major changes in the future.

Capacity building and knowledge sharing. One of the successes of the past was in the degree and/or short term training of thousands of NARES scientists who contributed to the success of the Green Revolution. Now the research-development network has broadened to include laboratories in advanced countries on the one hand and NGOs on the other. There is also a growth in farmer participatory research. New information and communication technologies help to tie this network together and close the communication gap. However, incentives need to be in place to attract and encourage the development of the next generation of rice scientists.

3. Promoting Rapid Dissemination

The traditional linear ‘transfer-of-technology’ approach which was designed to provide technology packages developed in research centers to farmers is clearly inappropriate in the current dynamic context of farming. As opposed to ‘blanket recommendations’, farmers increasingly need recommendations targeted to specific environmental conditions. Because these conditions can vary within even a small area depending on soil type, rainfall pattern, management regimes, methods and approaches that can take into account these conditions simultaneously are needed to conduct adaptive research and develop conditional recommendations. Such recommendations can be complex and can not be effectively transmitted through the traditional extension approach. It is important that technology delivery approach is able to impart knowledge to farmers to enable them monitor crop conditions and make appropriate adjustments in crop management. This is especially applicable to intensive irrigated areas where farmers are more market-oriented and the economic viability of rice production depends on their ability to reduce the unit cost of production through the use of ‘knowledge-intensive’ technologies.

In rainfed areas which suffer from several constraints including poor institutional support to agriculture, limited availability of improved seeds is an important constraint. The supply of seeds from the usual institutional source is weak and the private sector is poorly developed to serve as an alternative supplier. Farmers depend mainly on their own farm-kept seeds and limited exchange of seeds among themselves. The seed replacement ratio is less than 15% in most cases. As a result, improved seeds spread very slowly and the spread is often highly localized. Even where farmers have used improved seeds, productivity gains have been low and highly variable as complementary crop management practices are poorly adopted. The problem in rainfed areas is compounded by other constraints such as very small and fragmented farms, poorly developed infrastructure and poor supply of public services in general, and limited ability of farmers to access and effectively utilize information.

Against this backdrop, five essential elements of IRRI’s strategy for promoting rapid technology dissemination are:

1. Farmer participatory approaches to technology development and validation

This is to ensure that technologies are consistent with farmers’ needs/constraints and that farmers have early access to technologies/information through their involvement in technology development/validation processes. Farmer participatory approaches to varietal selection are now accepted in several countries and are becoming increasingly institutionalized. Early access to information and technologies during participatory validation helps partly get around the institutional seed supply bottleneck. IRRI, in partnership with national agencies, is now increasingly working in this participatory mode for accelerating technology dissemination.

Recently, stress-tolerant genes such as Sub1 for submergence, Saltol1 for salinity and genes for drought are incorporated into popular rice varieties Swarna and IR 64 which are intolerant of

DRAFT

stresses or are low yielding. Improved varieties tolerant to abiotic stresses are included in PVS trials conducted on-station and on farmers' fields. Farmer/community participatory approaches are being used to validate and evaluate improved crop and resource management technologies – for example, zero-reduced tillage in rice-wheat systems of the Indo-Gangetic Plain, alternate wetting and drying water management, site-specific nutrient management, ecologically-based rodent management and hermetic grain storage to reduce post harvest losses and maintain grain quality.

2. *Close partnership with NGOs, farmer and community organizations for promoting technology dissemination*

Mobilization of NGOs, farmer and community organizations is a potent strategy for initiating and sustaining developmental changes, including dissemination of agricultural technologies, in rural areas. These organizations have strong grass-roots base and are better able to respond rapidly to local needs than the more formal line agencies. Close partnerships with these local organizations is becoming increasingly a part of IRRI's mode of operation. Technologies that are found to be successful in one location are being rapidly validated/disseminated in several other locations simultaneously by mobilizing the national network of these NGOs and farmer organizations. The role of this kind of partnership is illustrated well by a project in Bangladesh where such national/regional networks were mobilized to facilitate production and distribution of improved seeds to farmers (Samsuzzaman and van Mele 2005).

Village/community-based seed production systems that are linked with institutional sources of new seeds were similarly established through the help of these organizations to meet the local needs.

3. *Rice Knowledge Bank and ICT platform for rapid dissemination of information*

RKB together with ICT serves as an important platform and a mechanism for providing and integrating knowledge/information regarding improved technologies and markets. IRRI is developing and using these information platforms increasingly to provide rapid access to recent technical and other information about rice to various stakeholders. For promoting easy access, country chapters of RKB have included locally-adapted information I written in local languages.

4. *Mass communication:*

Use of mass media such as print, radio, television and other means of mass communication can be an effective way of transmitting technology information packaged as simple messages. This is demonstrated by the successful use of mass media for promoting “three-reductions and three gains” campaigns which involved reductions in seed rate, fertilizers and pesticides in rice production Vietnam. An important challenge in this approach is to translate the complex scientific information into simple and easily understood messages (such as “no early sprays”) that can be effectively transmitted through mass media.

DRAFT

5. *Training:*

Development of training materials and provision of training on rice technologies to NARES partners has remained a major strength of IRRI for development of local capacity for research and technology delivery. Modern approaches of training are being brought in to further augment this capacity while clearly identifying the areas of IRRI's comparative advantage in the context of improving local capacity and forging closer linkages with other providers of training.

IRRI is deploying all of these components as a part of an overall strategy for promoting rapid delivery and dissemination of improved technologies.

4. Conclusions

As the growth in productivity in the irrigated area slows and the growth potential in the rainfed areas remains unrealized, new approaches are being adopted by IRRI scientists to speed the process of technology development and dissemination with the goal of reducing poverty and sustaining rice production in the long run.

A two pronged approach to poverty reduction involves the development of technologies to raise productivity and maintain low and stable rice prices in the irrigated areas, and technologies to maintain higher and more stable yields in the rainfed environments.

The setting of priorities, development and validation of technologies, and dissemination of proven technologies requires a close interaction among scientists and stakeholders. Farmer participation with scientists at each stage is becoming widely accepted.

The most difficulty is found in scaling up technologies particularly in the rainfed areas where, for example, often new and improved seeds are simply not available. The widespread adoption of improved technologies is best achieved through a close partnership with strong grass-roots based organizations such as NGOs, farmer, and community organizations. Information technologies are providing an improved awareness of technologies and markets. IRRI scientists are involved in a range of approaches for technology dissemination as part of an overall strategy for pro-poor technology delivery.