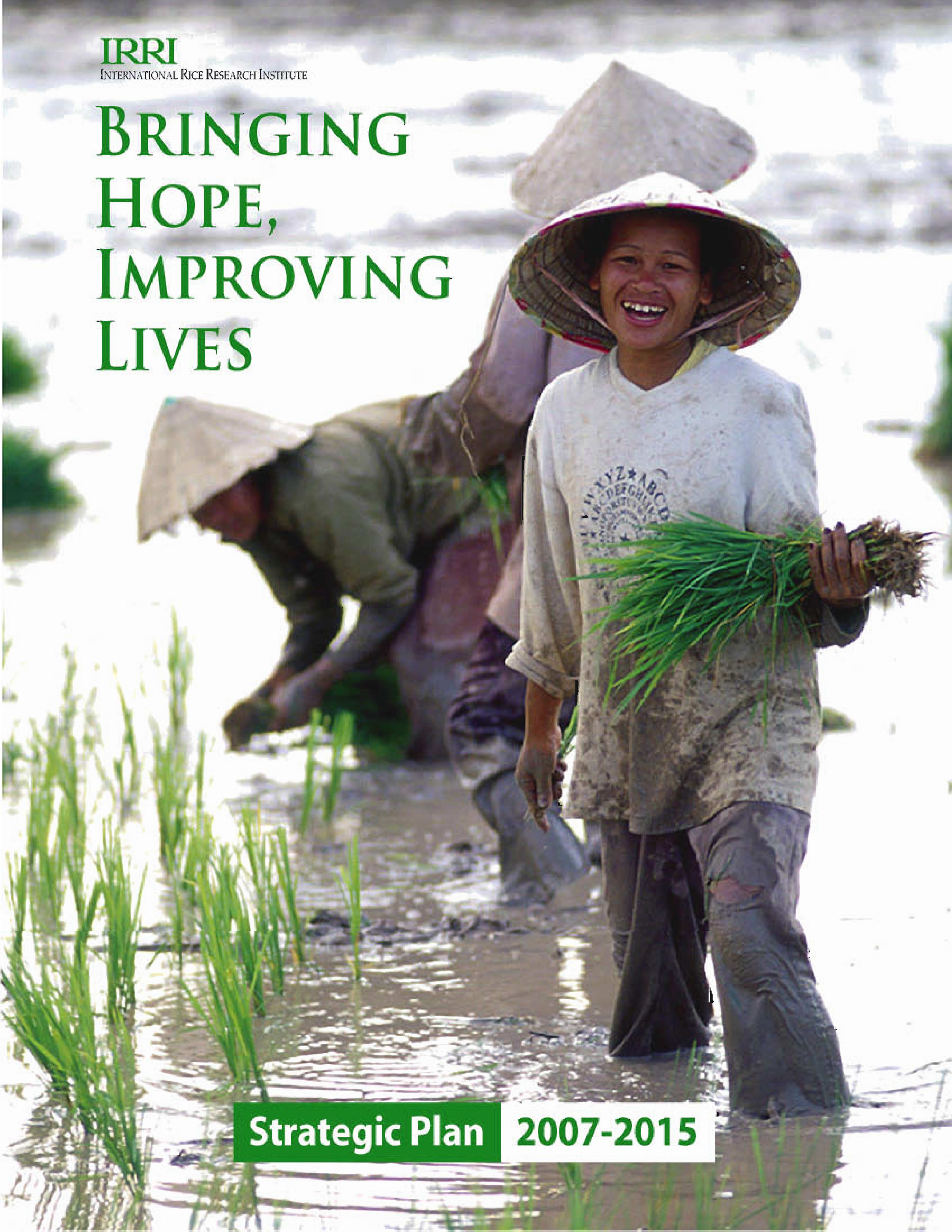
IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

Bringing Hope, Improving Lives



Strategic Plan 2007-2015

IRRI's Mission Statement

Mission

To reduce poverty and hunger, improve the health of rice farmers and consumers, and ensure environmental sustainability through collaborative research, partnerships, and strengthening of national agricultural research and extension systems.

Goals

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

Strategy

IRRI pursues its mission and goals through

- interdisciplinary thematic and system-based programs
- scientific strength in major disciplines for rice research
- anticipatory research initiatives exploring new scientific opportunities
- conservation and responsible use of natural resources, including rice genetic resources
- sharing of germplasm, technologies, and knowledge
- participation of women in research and development
- partnership with farming communities, research institutions, and other organizations that share IRRI's mission
- continued efforts in improving staff development and welfare

Values

IRRI's actions are guided by a commitment to

- excellence
- scientific integrity and accountability
- innovation and creativity
- gender consciousness
- diversity of opinion and approach
- teamwork and partnership
- service to clients
- cultural diversity
- indigenous knowledge
- environmental protection

The International Rice Research Institute (IRRI) was established in 1960 by the Ford and Rockefeller Foundations with the help and approval of the Government of the Philippines. Today, IRRI is one of the 15 nonprofit international research centers supported by the Consultative Group on International Agricultural Research (CGIAR – www.cgiar.org).

IRRI receives support from several CGIAR members, including the World Bank, European Union, Asian Development Bank, International Fund for Agricultural Development, International Development Research Centre, Rockefeller Foundation, Food and Agriculture Organization of the United Nations, and agencies of the following countries: Australia, Canada, Denmark, France, Germany, India, Iran, Japan, Netherlands, Norway, People's Republic of China, Republic of Korea, Republic of the Philippines, Sweden, Switzerland, Thailand, United Kingdom, United States, and Vietnam.

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

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Foreword

IRRI's Board of Trustees is proud to see that the Institute, in its 46th year, has withstood the test of time, growing ever more energetic with the years. Although initially set up mainly to accelerate the production of rice at a time when world food reserves were dangerously low, IRRI has transformed into an institute that has proven itself able to adapt to the changing physical, technological, and socioeconomic environment that we see today, and to continue to make all-important contributions to maintaining the world's food balance and reducing poverty and hunger.

Rice is becoming ever more significant in human nutrition. It continues to be—as a regional television channel put it—the lifeline of Asia, reliably feeding its poor. At the same time, it is rapidly growing in importance in sub-Saharan Africa. Thus, the Board endorses wholeheartedly the conclusion herein that IRRI is among the best investment instruments in the world for helping the poor and the hungry.

The Board invites all stakeholders in rice—development partners, scientists in advanced research institutes and national systems, private companies, interested members of civil society, and not least IRRI's beneficiaries—to consider this strategic plan and how you might contribute to achieving its goals for the benefit of poor rice farmers and rice eaters around the world. The rewards are great, not only in helping to end poverty, minimize the negative effects of climate change, and improve nutrition but also in achieving the stability and well-being of society when these conditions are met.

KEIJIRO OTSUKA
Chair
IRRI Board of Trustees

Preface

IRRI's previous strategic plan, entitled *IRRI Toward 2020*, ambitiously sought to carry the Institute over a 25-year period. The present plan endeavors to take the Institute over a more modest 9 years, joining the world in seeking to reach the Millennium Development Goals (MDGs) by 2015. Nonetheless, much of the work outlined here will extend beyond 2015.

We describe herein the changing world that has rendered the previous plan out-of-date because the changes are happening so fast and have by no means stopped; the world of rice in particular is in a rapid demographic, technological, and social transition (Chapter 1). We then describe the broad foundation of successful collaboration in which IRRI has continued to work with many institutions across disciplines, localities, and ecosystems (Chapter 2). This has positioned the Institute to respond with substantial optimism to both the known and as yet unknown new challenges implied by these ongoing changes toward helping achieve the MDGs, especially the three related to hunger and poverty, environmental sustainability, and nutrition and health.

The plan that we present has five strategic goals that contribute to addressing each of the MDGs. Together they represent a changed role for IRRI, perhaps one of the most significant changes in its 46-year history (Chapter 3). IRRI will shift from filling the rice bowl to filling the purse, from general crop management to environmentally sustainable management and adaptation to climate change, and with greater concern about health aspects and the nutritional value of rice. It will send our scientists more into country offices around Asia and for the first time since the late 1990s into the newly prominent rice fields of sub-Saharan Africa. IRRI will address not only rice but also ways in which farmers can diversify their crops to improve their incomes.

This shift in perspective does not mean a shift away from our core expertise and core values. Rather, it means that our targets, and how we measure the success of what we do, will be different. IRRI will continue to apply its expertise in germplasm development, natural resource management, social sciences, and information management to tackle important problems and strengthen national systems.

The plan involves some changes in our program structure (Chapter 4) and how we allocate our resources (Chapter 5). In the somewhat unsettled times within the CGIAR, we are certain that the Institute has mechanisms in place to ensure proper governance and management of its resources (Chapter 6).

We hope you will share our enthusiasm and optimism in these bold steps that we feel are required to meet the needs of IRRI's mandated beneficiaries, especially the 750 million desperately poor rice farmers and consumers in developing countries worldwide.

ROBERT S. ZEIGLER
Director General

Chapter 1

RICE RESEARCH IN A CHANGING WORLD

Roughly three-quarters of a billion of the world's poorest people depend on rice

There have been remarkable changes in the world since IRRI last crafted a strategic plan, in 1996. The Internet was in its infancy and mobile phones had yet to replace highly expensive satellite phones. The floppy disk was still the state of the art for sharing computer data. The global extent of the AIDS catastrophe was not yet appreciated. Climate change was still a matter of academic debate and uncertainty. Transgenic crops had just entered the world's food markets, and germplasm exchange was still relatively unencumbered. Identifying the location of even a single gene, let alone its function, was a major accomplishment. No plant or animal genome had been sequenced, and the human genome sequence, a reality by 2003, was not projected to be completed until 2010 at the earliest.

Over the last decade, the world has experienced three interlinked scientific and technological revolutions unlike any other the world has ever seen in such a short time span. First, the revolution in molecular biology and genetics is yielding insights, only dreamed of a decade ago, into the functioning and nature of organisms. Second is the revolution in data storage and computational power to handle the vast amounts of data these discoveries entail. Third, the communications revolution allows exchange of, access to, and distributed analysis of nearly unimaginably large and complex data sets.

These rapid advances are revolutionizing all aspects of rice science. How well the fruits of technology are used will determine to a large extent the fate of rice production—the main global agricultural undertaking.

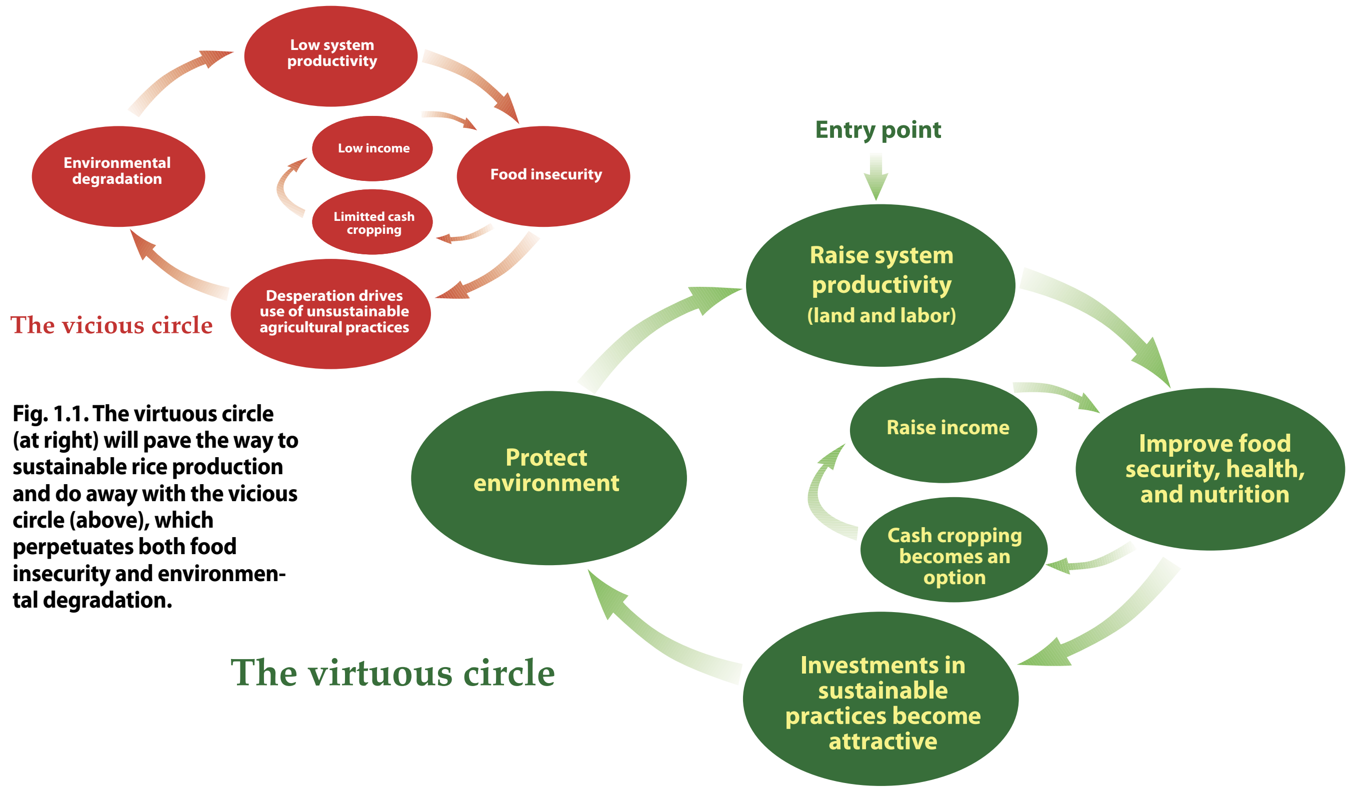


Fig. 1.1. The virtuous circle (at right) will pave the way to sustainable rice production and do away with the vicious circle (above), which perpetuates both food insecurity and environmental degradation.

Meanwhile, the physical environment—including the agroecosystems in which IRRI works—is changing. It is now realized that climate change is not some vague future problem. It is already damaging the planet at an alarming pace. Further, the institutional environment (IRRI's partners in advanced and national research institutions) and population concerns (the demography of poverty and hunger) are changing also.

Under that changing situation, agricultural policymakers in developing countries are facing three challenges simultaneously: (1) to reduce poverty and increase farm income, (2) to assure household food security, and (3) to rehabilitate and conserve the countries' natural resources. In the long run, these challenges are complementary and mutually reinforcing. However, in the term of this strategic plan, they may conflict with one another; for example, the pursuit of higher income or food security may cause a decline in or degradation of natural resources. IRRI has to find an effective combination of technologies, policies, and institutions that will create instead a virtuous circle that will pave the way to sustainable rice production (Fig. 1.1).

IRRI's new strategic plan looks at the implications for rice production of these changing environments, in the context of the Millennium Development Goals (MDGs). It embraces the scientific and technological revolutions that have made available opportunities that were unimaginable a decade ago. It also recognizes that advances in these areas alone are necessary but insufficient to solve the enormous problems and challenges that face the world today. Solving these problems requires not only creative applications of science and technology but also appropriate policies and social interventions.

The changing world

Hunger and poverty

Although the world is awash in technological miracles, some things are not changing, at least not as quickly as desirable. Masked by political and economic issues, the state of the world's food supply rarely comes into prominence. Yet, supply has been teetering

between adequacy and alarm for several decades and rice is a major factor in the food equation. In 1967, when IRRI's (and CIMMYT's[1]) new tropical semidwarf varieties were just beginning to be used in developing countries, it was forecast[2] that "Sometime between 1970 and 1985, the world will undergo vast famines—hundreds of millions of people are going to starve to death."

By the mid-1990s, the specter of imminent world famine had faded, partly because of technology that emerged from the continued strategic research by IRRI and partners. Nevertheless, rice production and productivity increases were seen to be just as vital in maintaining and improving the well-being of poor rice farmers and consumers, who make up the majority of the world's poor, and remained the focal point of IRRI's 1996 strategic plan.

In 2006, the rice situation is again worrying, reflecting new developments emanating from changes in demographics, consumption, production, and trade patterns. Globally, there has been some reduction in the proportion of people consuming less than the minimum dietary energy requirements.[3] The proportion of hungry population has declined from 20 percent in 1990-92 to 17 percent in 2000-02. On the positive side, this means that food production has kept pace with population growth—not an insignificant success. However, incidence of hunger is still at unacceptable levels for many regions: 23 percent in South Asia and 33 percent in sub-Saharan Africa. The absolute number of desperately poor and hungry people has barely declined (Table 1.1). Hunger remains a chronic feature of the landscape in both Asia and sub-Saharan Africa. Populations con-

Table 1.1. Estimates of poverty and hunger by region, 1990 to 2002.

Region	People living on less than US$1 a day (millions)			Number of undernourished people (millions)	
	1990	1996	2002	1990-92	2000-02
Asia	947	797	702	568	519
Sub-Saharan Africa	242	289	313	170	204
Middle East and North Africa	6	5	7	25	39
Latin America and the Caribbean	74	76	50	60	53
All developing countries	1,269	1,167	1,072	823	815

Sources:
World Bank. 2001. Attacking Poverty: World Development Report 2000-2001. New York: Oxford University Press.
United Nations Development Programme. 2005. Human Development Report 2005. New York: Oxford University Press.
FAO. 2004. The State of Food Insecurity in the World. Rome: FAO.

[1] International Maize and Wheat Improvement Center (Centro Internacional de Mejoramiento de Maíz y Trigo).
[2] Paddock W, Paddock P. 1967. Time of Famines. Boston: Little & Brown.
[3] FAO. 2004. The State of Food Insecurity in the World. Rome: FAO.

Sub-Saharan Africa will grow as both a rice consumer and producer.

tinue to increase. Land available for agriculture, particularly for rice farming, continues to decrease.

For hundreds of millions of the world's poorest people, rice is the only thing between them and starvation. Rice supplies must remain plentiful to provide reliable food that even the poorest can afford. Details of estimated rice needs in 2015 by country and by region are given in Annex 1.

Overall, there is an estimated global need for an additional 50 million tons of rough rice by 2015 (about 9 percent of current production) in order to meet expected consumption rates. The extra annual rice needs for South Asia by 2015 are estimated at 22 million tons, 13 percent above the present production level, and for Southeast Asia about 13 million tons (11 percent of current consumption). For East Asia (including China), where per capita income has reached high levels, the consumption is projected to decline by 5 million tons (3 percent). However, even in China, as land moves out of rice production, meeting projected demand will not be trivial.

Technological progress in rice cultivation has slowed down substantially since the early 1990s. The growth in rice yield has declined from 2.5 percent per year during the first two decades of the Green Revolution to about 1.1 percent per year since the late 1980s. Global population is still growing at 1.4 percent per year and may not reach a stationary level before 2050. The stagnation in yield growth is because yields are approaching the practical potential of the rice crop growing under favorable environments. Further increases will have to come from increased potential in rice growing under less favorable conditions—less water, less land, and probably less available labor—or new breakthroughs in increasing the yield potential of rice under favorable conditions.

Sub-Saharan Africa will continue to grow in importance both as a rice consumer and in its desire to be a rice producer. Per capita rice consumption has doubled to 27 kilograms since 1970. Although the continent will need annually approximately the same amount of extra rice during 2006-15 (10 million tons) as will Southeast Asia, this represents a huge relative increase, about 50 percent more than present African consumption levels. For some African countries, rice has become the dominant food staple as in Asia. Demand growth in Latin America and the Caribbean is likewise projected to be strong. For Central and West Asia and North Africa (CWANA), the expected increase in rice consumption is about 36 percent. Current productivity of rice farms in sub-Saharan Africa is low and the problem is exacerbated by the reduced labor force resulting from the HIV/AIDS crisis.

Of the total projected increase in rice consumption during 2006-15, Asia accounts for 58 percent and sub-Saharan Africa another 21 percent.

The demography of the poorest of the poor—rural landless, small-scale farmers, and urban laborers living on less than $1 per day—has changed during recent decades. In 1990, about 75 percent of these poor were in Asia and 19 percent in sub-Saharan Africa. The most recent data show that the proportion in Asia has lessened to 65 percent and that in Africa increased to 29 percent. But their absolute numbers have declined only marginally in this period, from 1.27 billion to 1.07 billion, and most of the decline is due to improvement in two countries only, China and India.

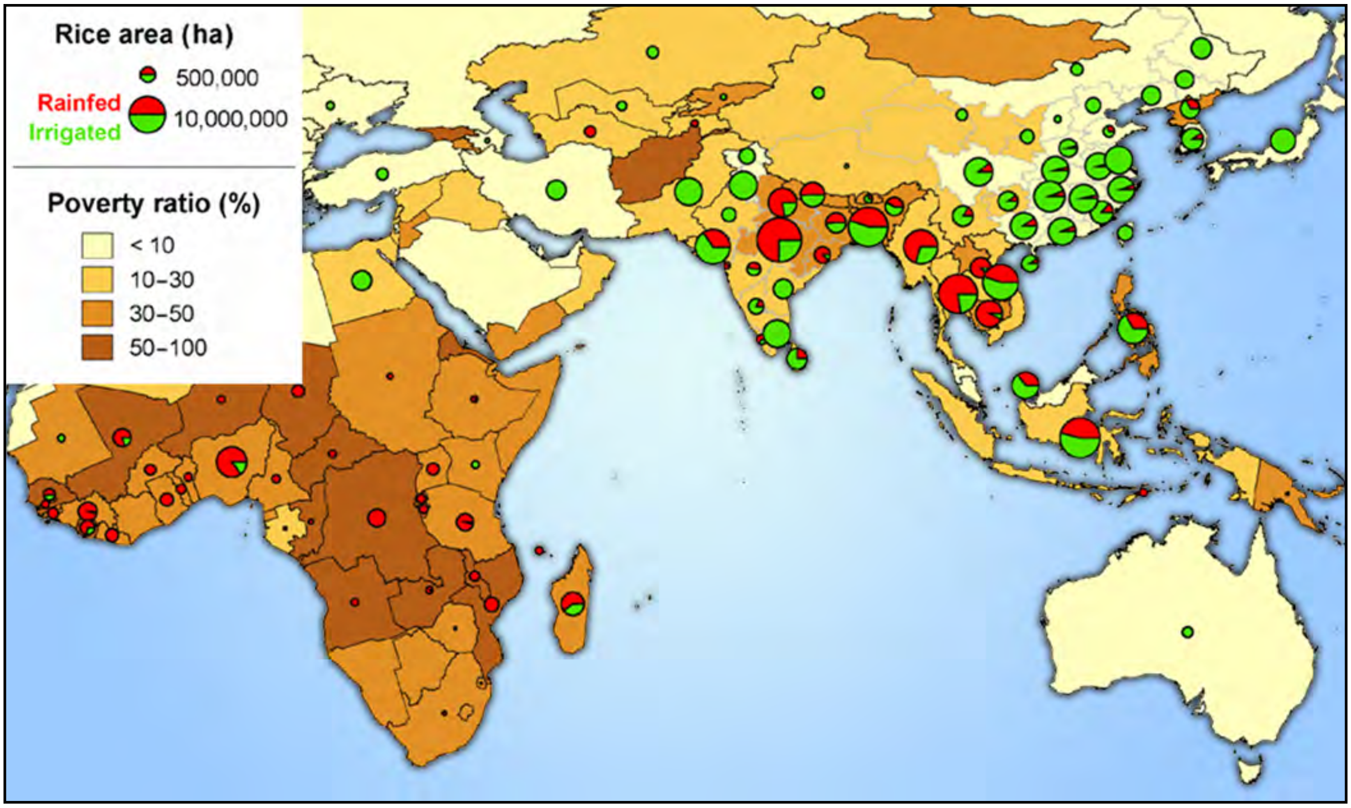


Fig. 1.2. Poverty and rice distribution and irrigation by country, and subdivisions for China and India. The size of the pie diagram is scaled (not linear) to the total rice area in a country. There is a clear relationship between the prevalence of rainfed rice and the level of poverty.

Although progress is expected in the aggregate, within Asia, poverty remains pervasive in vast areas, even in parts of India and China. The "poverty islands" are large indeed, and Africa is virtually a "poverty continent." In terms of rice production, these areas are mainly rainfed systems characterized by low yields and plagued by drought, flooding, and soil salinity. The co-occurrence of extreme poverty and predominantly rainfed rice is striking indeed, as shown in Figure 1.2.

Among the poor, rice producers and consumers of rice as a staple—the target groups for IRRI's research and capacity-building endeavors—make up a large proportion, totaling perhaps 340 million in South Asia and 140 million each in Southeast Asia and sub-Saharan Africa.[4] Roughly three-quarters of a billion of the world's poorest people depend on rice.

Health and nutrition

Malnutrition manifests itself in many ways throughout the developing world. In Asia, several major nutrition problems continue to confound human development.[5,6] Apart from undernutrition per se, iron deficiency anemia affects 88 percent of pregnant women in South Asia, contributing to maternal mortality and to impaired mental development in vast numbers of children, and vitamin A deficiency affects 169 million preschool

[4] Estimated using the 2002 poverty ratio in countries that are significant rice producers and/or with annual per capita rice consumption of more than 20 kilograms of milled rice.
[5] FAO. 2004. The State of Food Insecurity in the World. Rome: FAO.
[6] United Nations. 2004. Fifth Report on the World Nutrition Situation. New York: United Nations System Standing Committee on Nutrition.

Hidden hunger: vitamin and mineral deficiencies from inadequate diets rob the poor of productive lives. The number of affected poor in Asia dwarfs that of any other region of the world.

children in South and Southeast Asia (33 percent of all preschool children) and 104 million (32 percent) in Africa. Malnutrition also exacerbates the severity of HIV/AIDS and reduces the effectiveness of therapeutic drugs.

Zinc is an essential micronutrient, involved in many functions in the body. Deficiency of zinc in the diet can have serious direct health consequences and on the severity of a number of diseases, including common childhood infections. It is estimated that 60 to 70 percent of the population in Asia and sub-Saharan Africa could be at risk of low zinc intake; in absolute numbers, this translates into about 2 billion and about 400 million people at risk, respectively.

Malnutrition in many developing countries has in recent years become a double burden: levels of undernutrition have remained high, while life-style diseases (such as diabetes and heart disease) associated with overnutrition are increasing significantly. In China, the prevalence of obesity tripled in men and doubled in women during 1989-97. At the same time, growing awareness of the need for improved diets is leading to emphasis on foods that are healthy, rich in micronutrients and disease-preventing agents, and devoid of harmful contaminants. There is increasing concern over contamination of soil and water with toxic metals or metalloids, such as arsenic and cadmium.

In addition, poor health of rice farmers and farm workers can result from chronic and infectious diseases from water-borne sources and from such vectors as rodents and mosquitoes, including leptospirosis, schistosomiasis, helminth infections, arboviruses, malaria, and dengue. In sub-Saharan Africa, some of these problems will increase in prominence as rice lands and areas of standing water increase.

Pesticide poisoning from improper application is another risk that rice farmers and laborers face. Reliable data on the incidence of pesticide poisoning are sparse, mainly because many cases never reach the health system.

Environment

Rice-growing areas are among the world's most enduring, environmentally sound, and productive agroecosystems. Lowland rice provides more than 75 percent of the world's annual rice supply and it is the only major food crop that can be grown continuously, without the need for rotation, and can produce three harvests a year. In many respects, lowland rice poses fewer threats to the environment or sustainability than many upland production systems, and provides a rich array of ecosystem services (Table 1.2).

The water retained in bunded lowlands reduces flooding downstream and increases groundwater recharge. Soil erosion is negligible in most lowland rice systems, whereas it

Table 1.2. Ecosystem services* of lowland rice.

Provisioning Products obtained from ecosystems	**Regulating** Benefits obtained from regulation of ecosystem processes	**Cultural** Nonmaterial benefits obtained from ecosystems
In most lowland systems		
• Nitrogen fixation • Food production, rice	• Water regulation – *flood storage* – *groundwater recharge* • Climate regulation – *raises local humidity* – *anaerobic soils store carbon*	• Spiritual and religious values of many cultures • Cultural heritage
Lowland systems under specific management		
• Food production, nonrice crop and fish • Wood and straw for fuel • Genetic resources, wild rice	• Water regulation – *soil salinity management* • Climate regulation • Purification of polluted water • Soil organic matter maintenance • Biological control to reduce crop pest and disease outbreaks	• Aesthetic • Inspirational • Educational • Recreation and ecotourism for local and foreign tourists
Supporting services *Services necessary for the production of all other ecosystem services include soil formation, nutrient cycling, and primary production. These services depend heavily on connectivity/flows between rice fields and surrounding ecosystems.*		

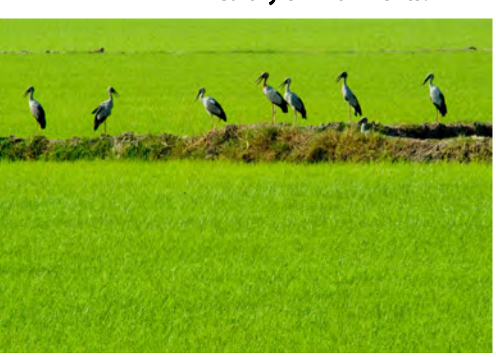
* The benefits people obtain from ecosystems. These include provisioning, regulating, and cultural services that directly affect people and the supporting services needed to maintain other services.

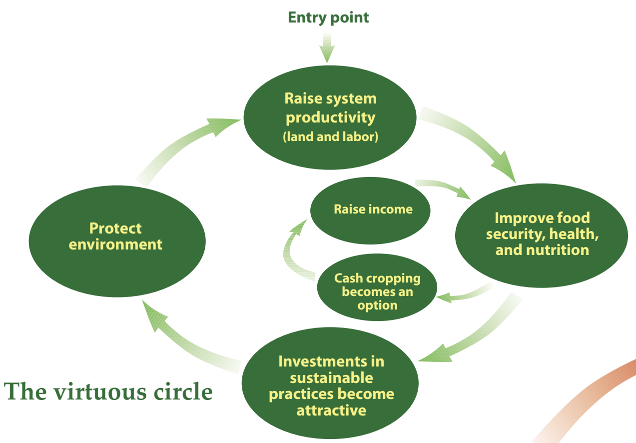
is a major threat to sustainability elsewhere. Irrigation may be a cause of soil salinity; however, rice cropping is often a component of measures to reclaim saline and alkaline soils. Risks of water pollution caused by inorganic fertilizer are minimized by the particular conditions of flooded rice, even in the most intensive systems, whereas contamination of groundwater and surface water is a concern when flooded rice is rotated with other crops such as wheat and maize.

Rice farming and changes in farming practices are affecting the environment in several ways. Some areas face concerns about the effects of agricultural activity on environmental sustainability and farmers' health. Crop diversification, changes in cropping patterns (alternating flooded and aerobic crops), and changes in crop management are likely results of market pressure and declining water availability, yet, these changes may jeopardize the sustainability of systems because of deterioration in soil health and pest buildup.

In the "poverty islands" in rural areas, agroecosystems tend to have poor soils and difficult terrain, with low resilience to drought, natural disasters, and changes in climate. As a result, farmers can be trapped in a vicious circle of poverty (Fig. 1.3). Such areas are extensive. For instance, it is thought that up to 10 million hectares of land could be affected by salinity. The tens of millions of hectares of rainfed lowlands of South and Southeast Asia and Africa are characterized by drought and, almost paradoxically, flooding and submergence. The uplands in Asia, where rice is the major food crop, extend for about 15 million hectares, with about 50 million people directly dependent on them.

Healthy lowland rice systems promote healthy environments.





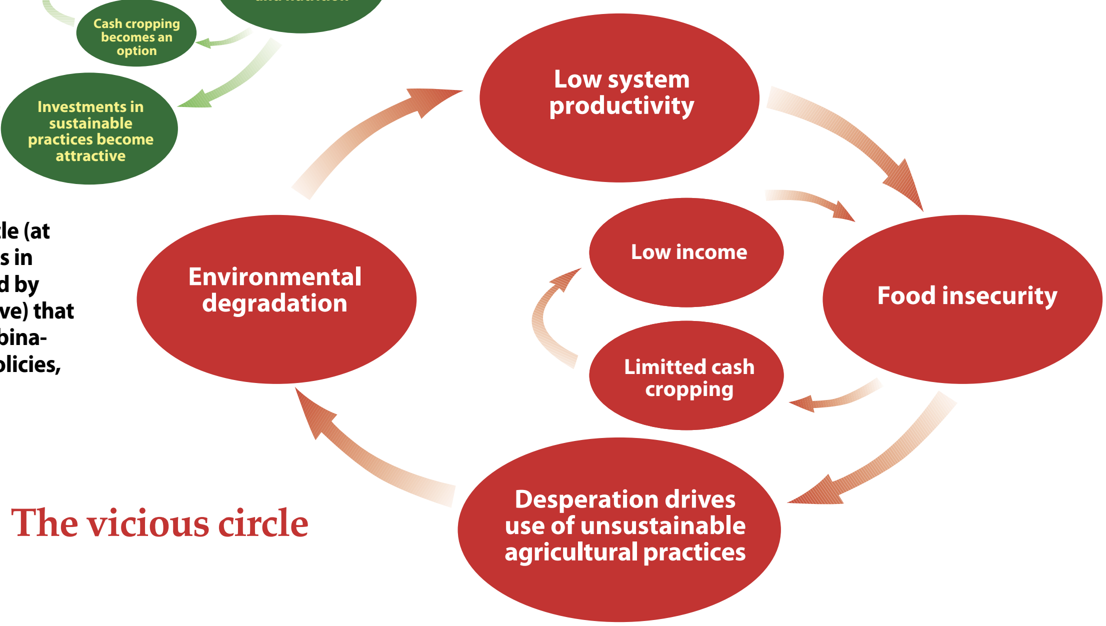


Fig. 1.3. The vicious circle (at right) that traps farmers in poverty will be replaced by the virtuous circle (above) that provides the right combination of technologies, policies, and institutions.

Direct seeding is one of many dramatic changes that will affect agriculture-environment interactions.

Changes in farming practices, driven by water and labor shortages, are affecting the agricultural resource base. In rainfed areas, farmers' attempts to ensure food security can result in agricultural activities that risk accelerating soil degradation and nutrient leaching that contribute to poor soil health and falling productivity—which forces farmers into greater poverty. Or, because of unreliable rainfall and stress-susceptible, nonresponsive traditional varieties, farmers are unable or unwilling to apply inputs that could increase productivity.

And, the physical environment is changing. There is less available water, less and less arable land for cultivation, more carbon dioxide in the air, and atmospheric temperatures appear to be rising. Climate change will affect rice crops: higher temperatures will reduce yields, flooding will increase exposure to lethal submergence, and drought may well increase in frequency in critical areas. In Asia, 80 percent of freshwater withdrawal is used in agriculture and nearly 80 percent of the water in agriculture is used in rice cultivation. Water is becoming scarcer and more valuable; for example, more than 12 million hectares of irrigated rice lands in South Asia alone are likely to face severe water shortage within 20 years.[7] Indeed, continuous rice cultivation is losing its attraction to governments and farmers where higher-value crops can be grown using less water. The long-term impact of these changes on soil quality, organic matter, and greenhouse gas emissions will be large

[7] Tuong TP, Bouman BAM. 2002. Rice production in water scarce environments. In: Kijne JW, Barker R, Molden D, editors. Water Productivity in Agriculture: Limits and Opportunities for Improvement. The Comprehensive Assessment of Water Management in Agriculture Series, Volume 1, CABI Publishing, Wallingford, UK. p 13-42.

and, disturbingly, its full extent is unknown. Despite the considerable cost of land conversion, a shift of rice farming to less favorable areas has already begun in some areas in eastern India, Indonesia, and the Philippines.

The changing drivers of research

Millennium Development Goals

International interest in agricultural research for development began with grave concerns over the ability of Asia to feed itself—so rice was an obvious priority. But, once the euphoria of the Green Revolution had passed, research funding became stagnant and even declined. And attention turned to the serious problems facing sub-Saharan Africa.

Elaboration of the MDGs in 2000 represented a major shift in the emphasis of all forms of assistance to developing countries and set the global research and development agenda to 2015. The mission of IRRI and of the CGIAR—to improve the livelihoods of low-income people in developing countries—fits with the intent of the MDGs (Fig. 1.4); the MDGs offer time-bound targets related to specific goals to which most countries have subscribed. These are reflected in the research priorities of the CGIAR for 2005-15:

- sustaining biodiversity for current and future generations;
- producing more and better food at lower costs through genetic improvements;
- reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products;
- alleviating poverty and sustainably managing water, land, and forest resources; and
- improving policies and facilitating institutional innovation to support a sustainable reduction of poverty and hunger.

The MDGs also set the scene for greater intersectoral collaboration. Poverty cannot be eradicated on a sectoral basis, but depends on general rural development to a large extent, indicating the need for research also to become more multisectoral, more people oriented.

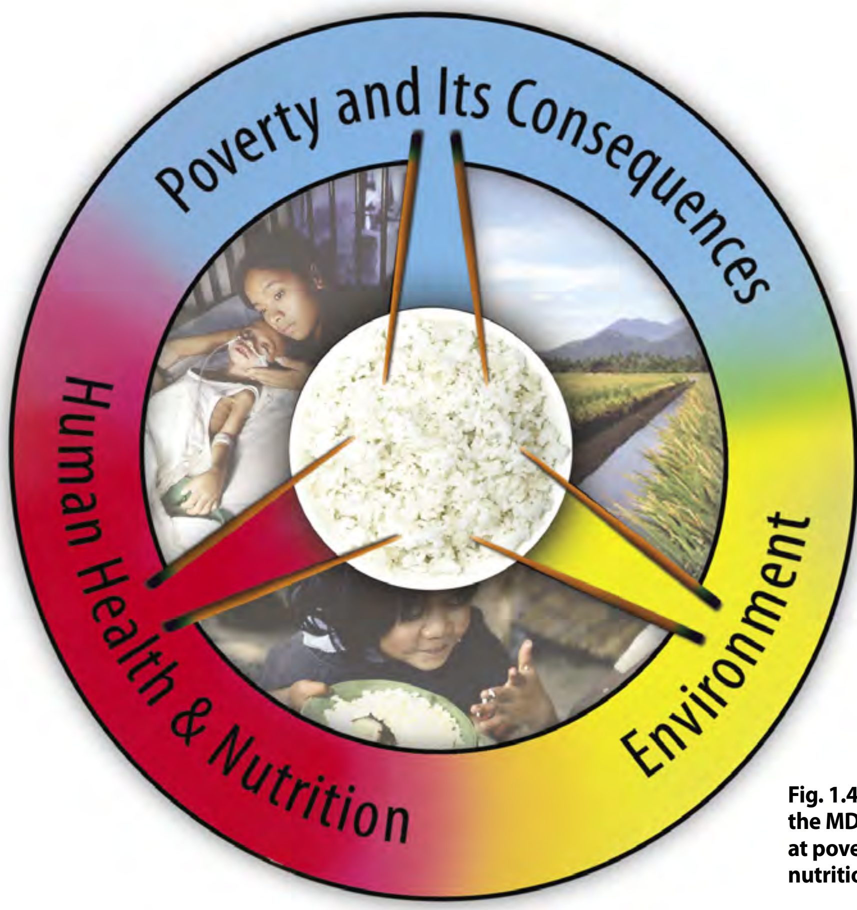


Fig. 1.4. Rice is central to achieving the MDGs, particularly those aimed at poverty, human health and nutrition, and the environment.

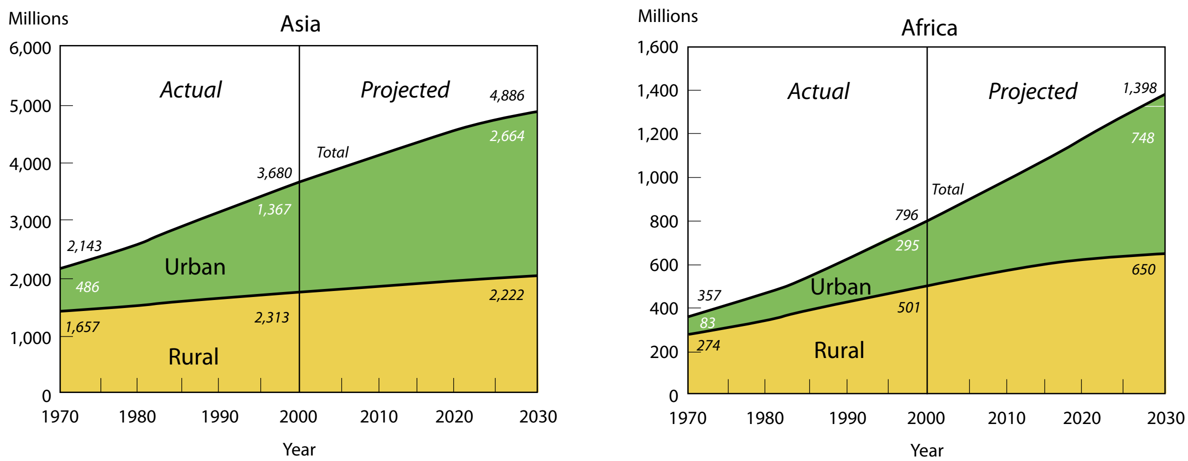


Fig. 1.5. Urbanization will continue to grow rapidly in both Asia and Africa.

Urbanization and the feminization of agriculture

Asia and Africa are the least urbanized continents in the world, with only about a third of the population currently living in urban areas. Urbanization is proceeding rapidly; within the next 25 years, nearly 55 percent of the population in Asia and 53 percent in Africa will be located in urban areas (Fig. 1.5). Poverty will be increasingly concentrated in urban areas with the migration of relatively poor people from rural areas. Urban poor need adequate food at affordable prices to meet other basic needs. Rice for poor consumers in Asian and African cities will continue to come from increased production and productivity in irrigated rice systems that account for over 70 percent of total rice production. A further increase in productivity in the irrigated systems is needed for maintaining the balance in rice supply and demand, to keep prices affordable for the urban and rural poor.

An important implication of growing urbanization is the diversion of fertile rice lands to meet the demand for housing, factories, and roads; and to grow vegetables, fruits, and fodder, which have stronger markets. The process of shrinking rice land is already under way. Growing urbanization and industrialization also mean that water indispensable for intensive irrigated rice cultivation is becoming scarce and a more valuable resource. Increased water scarcity and contamination of fresh water have already posed a serious threat to sustainable agricultural development. Increasingly, rainfed lowlands will be called upon to meet the demand for abundant inexpensive rice. With rural-urban migration and the movement of labor from agriculture to rural nonfarm activities, the agricultural labor market is becoming tight and the wage rate has been increasing. Thus, additional rice production to meet the growing demand must come from less land, less water, and less labor.

Labor out-migration has been changing women's role in agriculture and rice farming. Empirical evidence from IRRI's studies on labor out-migration revealed that rural-to-urban migration is prevalent in rainfed rice-producing communities in developing countries. Migrants are away on a seasonal or circulatory and long-term basis. Men migrate more than women in search of more remunerative nonfarm employment. Men take advantage of the growing job market in the rural nonfarm economy, leaving the agricultural work to women. In this situation, the women's role in agriculture changes from unpaid labor to farm manager. Women's decision-making authority in farm-related matters increases in the absence of men. Thus, among nuclear households, female de facto heads of households increase with male out-migration. The feminization of agriculture is already occurring and will likely increase in the future with rapid urbanization and out-migration of men. Poor and illiterate women continue to be immersed in agriculture and bear a heavy burden of farming tasks, with less access to nonfarm work than men. The comparable data for the rural sector over the decade in India show an increase in the share of main female workers to male workers. Women, particularly from the poorest and lowest social strata of the society, are likely to be employed in agricultural activities such as farming (rice, wheat, and nonrice crops), livestock, fishery, and forestry rather than in nonfarm activities.

The changing face of agriculture

The continuing slow decline in the real price of rice since the 1960s has been offset for poor producers by increasing productivity and lower costs, allowing producers to increase their income. Progress in poverty reduction requires, among other things, a continuing increase in the productivity of land, water, and labor. At the same time, rural labor is leaving agriculture for more remunerative activities. Future rice production faces an increasing scarcity of all three essential elements: labor, land, and water. But, given the inadequacy of investment in further public agricultural research and development, increases in rice production will slow down, unless trends are reversed. The real price of rice is likely to bottom out and may rise modestly through 2025. This is alarming news for poor rice consumers, but, how can a balance be found between the needs of consumers for low-cost rice and the needs of farmers for a decent income?

Improved productivity of farms through diversification into additional and high-value crops, and livestock, is probably the only way poor rice farmers can be taken out of poverty and remain farmers. More profitable agriculture—still rice-based—will increase the value of land and enhance the rural investment climate—making finance available for further development. The employment benefits through development of new markets and infrastructure can be large and would offset much poor urban migration, replacing it by migration of more prosperous people.

However, the existence of small farms, even in Asia, is uncertain in the face of supermarket expansion throughout the developing world, the increasing use of public and private standards and grades, privatization of agricultural knowledge and delivery, and growing demand for rice types that have particular quality and taste.

Continued population growth accompanied by increasing rural-urban migration throughout most of Asia, where 90 percent of the world's rice is farmed and eaten, means that, within the next 25 years, nearly 55 percent of the population will be urban-based, compared with one-third at present. More land will be needed for housing, factories, and roads as well as for other crops, such as vegetables, fruits, and fodder, which have stronger markets. There will be less land for rice. And, the land lost will be almost exclusively among the best and most productive agricultural land in the world.

Crop diversification should raise farm income, yet will also raise challenges for sustainability and environmental impact.

Science, computation, and communication

The biological sciences have experienced an unprecedented revolution. Rice science has been a major beneficiary, since rice was adopted by the plant sciences community as a "model species." This means that it is at the forefront of genetic analysis, the study of gene function, and physiology. For this reason, rice is ideally positioned for a frontal assault on problems that plague poor rice farmers and that have previously defied solution. Developing tolerance of drought and submergence and changing the nutritional value of rice are now real possibilities, not just dreams.

The data storage, computation, and communication revolutions allow scientists to manipulate and exchange enormous data sets that permit complex analysis of problems from molecular biology and gene function to the impact of potential agricultural changes on the world's climate. Furthermore, the Internet gives the ability to access globally distributed data sets as if they were in a single archive. It is now possible to imagine all of the world's rice information being made available to anyone with access to the Internet anywhere, and at any time. The enormous growth in and plummeting costs of hand-held wireless communication tools suggest that over the lifetime of this strategic plan the Internet will be accessible by even the poorest rice farmers and their children.

Evolution of national systems

Many national agricultural research and extension systems (NARES) have evolved to become strong partners of IRRI. China, for instance, has become a leader in hybrid rice development, is working on a super rice of its own, and is ready to train other NARES in such fields as genomics. At its headquarters in Los Baños, IRRI itself has trained almost 10,000 national scientists to date, including more than 1,300 scientists who received degree-level training; many thousands more have been trained through courses provided in-country by IRRI and NARES partners. Most Asian NARES now undertake their own rice breeding programs and research. Nonetheless, demand for training from IRRI in specific areas remains strong, even from China and India.

There remain research areas for which many NARES seek IRRI support. A stakeholder survey undertaken for this strategic planning indicated strong support for IRRI to lead or continue research in partnership with them on the following[8]:

- understanding the mechanisms of abiotic stress tolerance and enabling marker-assisted breeding for abiotic stress tolerance,
- water management, especially in water-scarce regions,*
- crop protection,
- molecular characterization and analysis of rice genetic resources,*
- genetic engineering for yield advancement and improving nutritional quality (including nutrient-dense rice germplasm),*
- bioinformatics to facilitate comparative biology across crops,
- using transformations to verify gene functions,*
- identification of gene variation or allele mining,*

[8] Topics with asterisks are those in which NARES want IRRI to lead the research.

Labor will be increasingly scarce in the agricultural sector.

- assessing civil society perceptions regarding genetically modified organisms,
- ecosystem and environmental characterization,
- assessing the effect of climate change on rice production,*
- analyzing the impact of global development on the rice economy,* and
- developing and sharing databases for the rice sector.

The private sector and advanced research institutes

The private sector is taking an increasing role in seed development and delivery, especially in favorable environments where lack of water is not a main stress. Hybrid rice, which already occupies a significant share of rice lands in China and Vietnam, is a natural focus for the sector. Although seed costs are double or more, profits are substantially higher due to 16–20 percent yield gains over normal (inbred) varieties. The private sector also has more efficient and effective delivery mechanisms than does the public sector. The stakeholder survey indicated that NARES research leaders expected the private sector to make a significant investment in quality improvement, improving hybrids, mechanization and postharvest processing, and weed management, but not much in other areas. There are opportunities for partnerships with the private sector to share its knowledge for developing products that target the unfavorable environments where poor farmers predominate and where the sector is unlikely to have market interest.

Advanced research institutes now have significant and increasing investments in rice science, albeit often with little practical orientation. Partnerships with these institutions can provide IRRI with access to vast scientific resources and multiply the impact of research and capacity-building efforts.

Implications

Poverty

- Most of the world's poor are rice eaters and the world's poorest regions depend on rainfed rice. Any effort to reduce poverty—and the consequences of poverty—must address the productivity and profitability of rice, especially rainfed rice.
- Several persistent human nutrient deficiencies that continue to be severe throughout the developing world can be addressed by improving the nutritional value of the principal food staples of the poor, especially rice.
- Out-migration and the feminization of agriculture mean that technology and its communication must be gender sensitive. Increasingly, all farm activities and management responsibilities fall exclusively on women.
- Rice figures prominently in virtually all dimensions of attaining the MDGs in the world's poorest regions. Thus, the role of rice serving society's multiple needs must be viewed beyond that of a simple food staple.

Rice production and consumption

- In Asia, to meet expected future demand, ever more rice will need to be produced from a shrinking land area, with less water, with less cost, and probably with less available labor.
- In Africa, the need for additional rice over the next decade is nearly as great as for Asia.
- The increasing attractiveness of high-value crops and the increasing demand for more nutritious food suggest there will be demand for more diverse products from rice-based systems and for more nutritious rice.
- Harmful contaminants of rice need closer attention to ensure health of consumers.
- Failure to meet future needs for rice could once again raise the specter of famine and starvation on a global basis.

Inexpensive rice for poor consumers versus a living wage for farmers is a constant tension.

- Urbanization, and associated changes in food quality requirements, means that farms must become more labor efficient, and be able to reliably deliver products of standard quality.
- The scourge of HIV/AIDS, particularly in sub-Saharan Africa, will require more labor-efficient production.

Research on rice systems

- In Asia, there is a need not only to continue to improve rice productivity through germplasm and resource management research but also to protect past yield gains.
- Yields in Asian unfavorable rainfed rice lands urgently need to be improved to compensate for shrinking favorable irrigated areas and to improve incomes in the unfavorable areas.
- Rice systems must diversify where possible to increase incomes and help reduce poverty—a high priority for policy, socioeconomic, and crop management research.
- The great need and scope to improve rice productivity and production in sub-Saharan Africa can be met by adapting successful Asian research approaches to the very different circumstances there.
- Early attention to diversification of rice-based systems in sub-Saharan Africa offers the exciting possibility of simultaneously increasing rice production and significantly reducing poverty.
- In all rice-growing areas, environmental concerns remain serious, demanding research investments in soil health, water quality and availability, and greenhouse gas emissions.
- Near-term impacts of climate change demand that rice cope with higher temperature and extreme weather events. Changes in rice production practices must, at a minimum, be greenhouse-gas-emission neutral.

Capturing and sharing global rice knowledge

- Improving the livelihoods of the poorest rice consumers and producers involves the moral imperative to make exchange of information equitable and free to all: a global public good.
- Although NARES have increased their capacity, a shrinking cadre of rice scientists overall means that a new generation of rice scientists is needed.

An eye to the future

- Rice improvement is a moving target. Changing growing conditions and consumer preferences will certainly place unforeseeable demands on rice varieties. Access to the full range of rice genetic resources is intrinsic to the development and deployment of improved germplasm for future generations.

IRRI holds in trust the world's largest collection of rice genetic resources.

As described earlier, IRRI is far from alone in facing the above issues and problems. The past decade has seen increasing rice research capacity and activity of advanced research institutes, NARES, and the private sector. However, IRRI has an ongoing solid record of success and retains many comparative advantages, described in the next chapter, that continue to make the Institute a natural—and preferred— research partner in tropical and subtropical rice systems for the benefit of poor rice producers and consumers.

Thai students hold a press conference at the Bangkok airport after spending a week at IRRI participating in a rice camp with Filipino counterparts.

Chapter 2

SCIENTIFIC EXCELLENCE AND PARTNERSHIPS:

BUILDING ON A FOUNDATION OF SUCCESS

IRRI learned early on that success depends on scientific excellence and broad, enduring, and visionary partnerships focused on clear objectives

Today, well over half of the rice consumed worldwide is from varieties derived at least in part from parents developed at IRRI. Nutrient, pest, and water management practices used by hundreds of millions of rice farmers around the world can trace their origins to IRRI's collaborative research. As a consequence, millions of people have been lifted out of poverty and go to bed without hunger pangs because rice is now a dependable and affordable staple food. This success not only increased farmer incomes but also generated rural employment, laying the foundation for the Asian economic miracle. Some 50 million hectares of forest and grasslands, which otherwise would have been turned under the plow, remain in their natural state because of increases in rice production as a result of the Green Revolution. This remarkable situation was seen as an almost unattainable dream by the founders of IRRI and was realized in partnership with national rice scientists, many trained by IRRI.

IRRI learned early on that success depends on scientific excellence and broad, enduring, and visionary partnerships focused on clear objectives. It is useful to explain here the dimensions of excellent science targeting development issues, IRRI's global collaborators, and its array of institutional assets. These form a credible platform from which to launch this forward-looking strategic plan.

Scientific excellence in a development context

"Conventional" breeding

The development of adaptive, high-yielding rice varieties, such as those used in the Green Revolution, is widely recognized as a key contribution of IRRI's research programs. Such breeding programs are often considered "conventional." However, they require multidisciplinary scientific collaboration. The research includes germplasm exchange, systematic multiple trait evaluation, and testing in a variety of locations, involving many disciplines and several countries. The end result is a constant stream of advanced germplasm freely available to any rice improvement program in the world.

The spectacular increases in yield using the early modern varieties were not without side effects. Along with their higher yields, these varieties introduced a new set of challenges for farmers. Early varieties became susceptible to some insect pests and diseases that formerly caused little yield loss in already low-yielding traditional varieties. Rice scientists entered into a decades-long program—work that continues today—to introduce into the rice plant broad-spectrum and durable resistance to pests and diseases, as well as tolerance of abiotic stresses. Considerable success has been achieved in managing major rice diseases (e.g., bacterial blight, blast, and tungro) through genetic means over large areas of tropical irrigated rice lands. That relatively few disease outbreaks have occurred in the past 15 years is a result of collaborative research starting from basic investigation of host-pathogen interactions to the deployment of effective genes in farmers' fields. IRRI's role in the integration of genetics, pathology research, and breeding (including hybrid rice) has been crucial in achieving and sustaining these gains. Likewise, combining resistance to insect pests with ecologically based crop management principles has greatly reduced the incidence and impact of pest outbreaks.

Toward precision breeding

New genetic tools and knowledge have greatly improved the ability to increase the tolerance of plants of multiple biotic and abiotic stresses. Taking advantage of available rice genome information, the nature of some disease resistance is being dissected genetically to reveal networks of controlling genes. Recent IRRI experiments have narrowed down the chromosomal regions containing genes for resistance to brown planthopper, a pest that remains a serious threat to rice throughout Asia.

Molecular sequencing and use of a gene (*Sub1*) that confers submergence tolerance for large tracts of flood-prone rice land required cutting-edge knowledge of plant physiology, biochemistry, and genetics that eventually led to deployment of the gene via breeding it into local varieties. A submergence-tolerant variety has been recently released as Varshadhan in Orissa, eastern India, bringing hope for increased productivity in a submergence-prone area. In collaboration with scientists in Japan, IRRI scientists are also on the verge of locating the gene that allows plants to perform well in phosphorus-deficient soils, an extremely important trait considering the finite nature of phosphorus reserves. Waiting in the wings is the application of new knowledge, hard won by IRRI over the years, that superior rice performance under drought stress is a heritable trait.

Using an entertainment-education (EE) approach to motivate rice farmers to reduce pesticide use in the Mekong Basin

Farmers' decisions to spray pesticides are due more to loss aversion attitudes, biased beliefs, and local peer pressure. Mass media can be effective in modifying the learning behavior in decision-making and practicing change. EE can effectively be applied to cultivate a new societal norm with regard to pesticide use by communicating integrated pest management (IPM) principles. In addition, it can potentially be extended to other issues, such as health education (e.g., HIV/AIDS) and resource and environment management.

***My Homeland,* a radio soap opera broadcast by the Voice of Ho Chi Minh, is an excellent example of the EE approach.**

Recent multidisciplinary work at IRRI in partnership with the HarvestPlus Challenge Program[1] and others aims to improve the provitamin A and iron content of rice grain. IRRI produced a high-iron rice line. Testing this rice line as a means to reduce incidence of anemia in women was the result of a scientific alliance with plant scientists, nutritionists, and health specialists. Demonstrating the possibility of improving the nutritional status of at-risk populations through iron-rich rice varieties is a milestone in the effort to form alliances between agricultural and other sectors to deliver long-term, sustainable solutions to problems of human nutrition.

Efficient use of natural resources

The promise of higher yields from modern varieties came with the need to apply more fertilizer to realize their potential. This led to a second-generation problem: excessive fertilizer application. "If 100 kilograms of nitrogen is good, then 200 kilograms must be better," was a mode of thinking encouraged by the availability of very cheap nitrogen fertilizer. IRRI and collaborating scientists have shown clearly that high yields can be achieved with modest fertilizer application rates. These practices are based on decades of research by IRRI and its partners on the ecology of tropical rice fields and agroecosystems. Programs to communicate simple rules for appropriate fertilizer application based on IRRI's research are spreading throughout Asia.

Although most modern varieties released in the past 15 years have broad resistance to the key pests and insects, many farmers still spray excessive and unnecessary pesticides. IRRI has launched integrated pest management practices that have reduced insecticide use and the likelihood of deleterious effects on humans and the environment as a result of improved knowledge of pest and predator relations. Site-specific nutrient management,

[1] A CGIAR Challenge Program (CP) is a time-bound, independently governed program of high-impact research that targets CGIAR goals in relation to complex issues of overwhelming global and/or regional significance, and requires partnerships among a wide range of institutions in order to deliver its products.

the product of an early "New Frontier Project" that has involved years of research into soil fertility and crop management practices by IRRI and partners, has resulted in guidelines and practices to improve the efficiency of fertilizer use.

Similar stories of how IRRI has responded to the changing world of rice production can be told about farming systems, women in rice, harvest residue management, water management, soil management, seedling establishment, seed health, biodiversity, and climate change. New conventional and hybrid rice lines promise to raise yield potential significantly. And they all retain in their genes the lessons learned during nearly half a century of development.

Effective collaboration

All the examples of IRRI's research successes above feature some form of collaboration, alliance, or partnership. Without them, the research could not have been done or made available to farmers. Such collaboration now largely defines the Institute's research—through networks, consortia, formal collaborative research, conferences, and symposia. A high-level council, the Council for Partnerships on Rice Research in Asia (CORRA), establishes a broad framework for collaborative programs and provides oversight by senior NARES leaders on IRRI's activities in Asia.

Partnerships with NARES enable IRRI to "take the research to the problem," and allow a broad thematic and geographical scope. An enduring example of the power of partnerships is the International Rice Testing Network, now the International Network for Genetic Evaluation of Rice (INGER). For the past 30 years, national and international rice breeders have been exchanging and testing promising rice breeding lines through this network and submitting their own material for region-wide testing. IRRI's sister institutions in Africa and Latin America have developed "branches" of INGER in response to its success in Asia. Almost half of the rice varieties released for farming in the developing world today have been the result of this collaboration.

Increasing farmer awareness of the importance of healthy seed is an example of IRRI-NARES-NGO collaboration.

IRRI's ground-breaking consortium model for partnership with NARES was founded on the premise of equal intellectual contribution by all partners. The Consortium for Unfavorable Rice Environments (CURE) coordinates strategic research collaboration between IRRI and national systems on the participatory development and testing of technologies in rainfed environments in partnership with farmers, and it promotes resource-sharing and information exchange across national programs. Parallel to CURE, the Irrigated Rice Research Consortium (IRRC) is active in all major irrigated rice countries in Asia, consisting of national systems of Bangladesh, China, India, Indonesia, Malaysia, the Philippines, and Vietnam. The IRRC seeks to identify and meet regional research needs in irrigated rice, and promote research collaboration and integration. In both CURE and the IRRC, research agendas are developed in close coordination with the Challenge Program for Water and Food (CPWF). Similarly, IRRI is a convening member of the Rice-Wheat Consortium. Technology delivery is ensured through a series of work groups composed of interdisciplinary teams of research and extension workers at sites in three or more countries that tackle specific problems.

The rice-wheat rotation is one of the intensive systems being studied in the IRRI-CIMMYT Alliance programs.

Genetic improvement is a central element in IRRI's research and new science will play a key role in building the foundation for future needs. Currently, only a small fraction of the conserved germplasm and wild species has been used in genetic improvement. Biological evaluation of these materials, guided by a clear picture of their genetic constitution (through advances in genomics), offers enormous potential for tapping into underused genetic resources. IRRI has positioned itself to channel advances in plant genomics to applications in rice through formation and coordination of the International Rice Functional Genomics Consortium, and participation in the Generation Challenge Program (GCP). The Consortium aims at determining the basic function of all rice genes, with an emphasis on knowing the critical genes and gene networks important to agricultural improvement.

IRRI and the International Maize and Wheat Improvement Center (CIMMYT) are developing three Alliance Programs with common oversight and management, and unified program budgets and program leaders that will bring enhanced research capacity and broadened partnerships. These Alliance Programs—Crop Research Informatics Laboratory (CRIL), Intensive Rice-Based Systems in Asia, and Development of a Cereal Knowledge Bank—will be integral components of the IRRI programs. IRRI looks to greatly strengthen its relationship with the Africa Rice Center (WARDA) as it increases its investments in Africa.

IRRI's accumulated strengths and assets

IRRI's research and related endeavors with its collaborators have also resulted in less visible, but most important, benefits to the Institute. These are its accumulated assets and advantages for contributing to food security and poverty reduction. These assets and advantages listed below largely define the actions that IRRI can take to solve the next generation of rice research problems:

- Focused mandate to eliminate hunger and poverty through rice research, training, and communication.
- Proven technology development and delivery platform.
- Rice genetic resources held in trust for the global community.
- Center of excellence for unlocking the potential of rice genetic resources.
- Integrator of research across disciplines and across levels from basic through strategic and applied to adaptive research.
- Trusted coordinator of international networks and consortia for discovery, development, and dissemination of rice-related information and technologies.

- A repository of freely available rice information and knowledge.
- A critical mass of scientists from different disciplines.
- Close association with agricultural universities in Asia and other advanced research institutes.
- A builder of bridges among advanced institutions, national systems, and nongovernment organizations, and among countries at different levels of development and with different political inclinations.
- A credible and neutral voice in influencing the agenda for rice research of relevance to pressing problems.
- A sensor of the global trends affecting the rice economy via its unique sets of rice-related databases.
- A willingness and ability to work with nations that have suffered decades of war or other calamities.

Preparing for the future

To ensure future success, IRRI must invest these assets wisely. In particular, IRRI must continue to nurture its scientific credibility—which in turn reflects the quality standards by which it conducts research—and its global relevance. Credibility is attained through concrete and objective achievements. Relevance means that this credibility (these achievements) translate into solving the important problems that the Institute is mandated to address—how to improve the well-being of poor rice producers and consumers. IRRI's continued credibility and relevance create unique strengths for tackling problems in difficult working environments that are unlikely to be solved by other institutions.

IRRI's special role in linking advances in science with the real-world problems of poor rice farmers and consumers means that scientists doing cutting-edge research in advanced laboratories look to IRRI as the link for translating and applying their technologies to achieve development impact, while scientists and development experts in the NARES look to IRRI as a provider of appropriate technology for solving intractable agricultural problems. IRRI benefits from a dynamic balance among disciplines and from strength in both upstream and downstream research.

Frontier Projects

IRRI has a 46-year history of investing in visionary research, research that, if successful, could revolutionize agriculture. The original Frontier Project was none other than the incorporation of semidwarf genes to create the modern high-yielding varieties. In the late 1980s and early 1990s, IRRI began developing a set of Frontier Projects. A new plant type and a "mega-project" on yield decline have since yielded novel varieties for farmers and site-specific nutrient management, respectively. Projects on apomixis (a type of seed-set that allows farmers to save seed for hybrids without losing the yield advantage) and biological nitrogen fixation are showing promise after more than a decade of work, and will continue. As in any set of high-risk ventures, some, such as a perennial upland rice and self-generated herbicides (allelopathy), did not make adequate progress and were dropped.

Reducing the impact of drought in rainfed lowland rice is a great scientific challenge with huge potential payoff.

Recent rapid advances in science and technology present a myriad of exciting possibilities in different scientific disciplines that could revolutionize rice farming. IRRI's strong financial reserves place it in a position to launch another round of visionary projects. Such challenges with high potential payoffs also carry a degree of risk, and thus are not necessarily attainable, especially within the term of a strategic plan. So they will almost certainly continue beyond the life of this plan. IRRI has identified research activities with probability of major development impact and where good science and collaboration can make a difference, in three areas—improving the photosynthetic efficiency of the rice plant, identifying and deploying drought tolerance genes, and designing rice farming management systems that do not contribute excessively to greenhouse gas emissions, based on new rice varieties bred to withstand expected future environments.

Each of the Frontier Projects will be carefully planned by teams of experts, and be evaluated periodically for acceptable progress.

IRRI's new role

The remaining problems facing poor rice farmers and consumers are becoming even more complex and less tractable. Solutions require more extensive and multidisciplinary research; more access to genetic resources; more and stronger partnerships with national systems, advanced research institutions, nongovernment organizations, and private industry; and more information about both farmers and consumers.

IRRI must change markedly to meet these challenges and, to do so effectively, it will need new expertise. Given its limited resources, far less in real terms than in preceding decades, the Institute will have to sharpen the focus of its research lens to make a strong contribution to attaining the Millennium Development Goals. Some areas in which IRRI has invested heavily in the past such as conventional breeding for irrigated rice, site-specific nutrient management, integrated pest management, and small-scale agricultural machinery are now mature technologies in which NARES have significant expertise. IRRI will reduce its investments in these areas as suggested by the stakeholder survey. However, this shift in resource allocation will be carried out over a transition period so as not to jeopardize the advances made.

A sharp focus on poverty reduction takes the Institute beyond its "historical" focal areas in rice production (increasing productivity or "filling the rice bowl"), which required a major focus on favorable irrigated areas, to "filling the purse," a major effort to improve farmers' incomes in unfavorable rainfed areas. This also means relatively less research emphasis in irrigated areas, while acknowledging that they must continue to receive research attention in order to protect the yield gains already made.

The new needs and research opportunities to increase rice production in sub-Saharan Africa are compelling reasons for IRRI to form partnerships there to make use of its accumulated experience in increasing farm productivity; yet, the Institute cannot afford to lessen its overall work in Asia, where most rice is grown and eaten.

The reality of global climate change demands attention from IRRI because rice farming itself is changing, as well as being a potential agent of change. Managing these changes can also mitigate the effects of climate change. IRRI will have to shift its focus from general farming system and environmental concerns to those most closely associated with rice diversification and climate change in order to maintain the sustainability of rice-based systems.

New concerns and knowledge about health and nutrition have also now given IRRI the imperative to help make rice more nutritious and to minimize health problems in some areas associated with consuming and growing rice.

The research opportunities for IRRI to meet these new challenges could hardly be more compelling and exciting. Increasing farmers' incomes and consumers' food security by improving and stabilizing crop yields in rainfed areas (Fig. 2.1) and bringing Asian rice research experience to bear in sub-Saharan Africa amount to spawning new green revolutions in these vast areas. IRRI can now accelerate the development of new varieties and cropping systems—both to maximize opportunities for diversification to stimulate the rural economy and to adapt to changing physical environments—by drawing on the new scientific and technological advances. At the same time, these advances can be used to find ways to mitigate the effects of rice farming on the environment.

The fundamental assets that underpin IRRI's research—the world's largest rice germplasm collection and databases of tropical rice information and knowledge—are also finding additional important roles: germplasm can be characterized in fine detail and readied for future application, and information can be shared, discussed, and disseminated in new ways to reach the greatest number of people directly, including, for the first time, poor farmers themselves.

The following chapter translates these challenges, opportunities, and expectations into a set of goals and attainable objectives. Frontier Projects are included, in boxes, to highlight their potential contribution to the goals.

Global climate change is a reality and will affect rice farmers for decades to come.

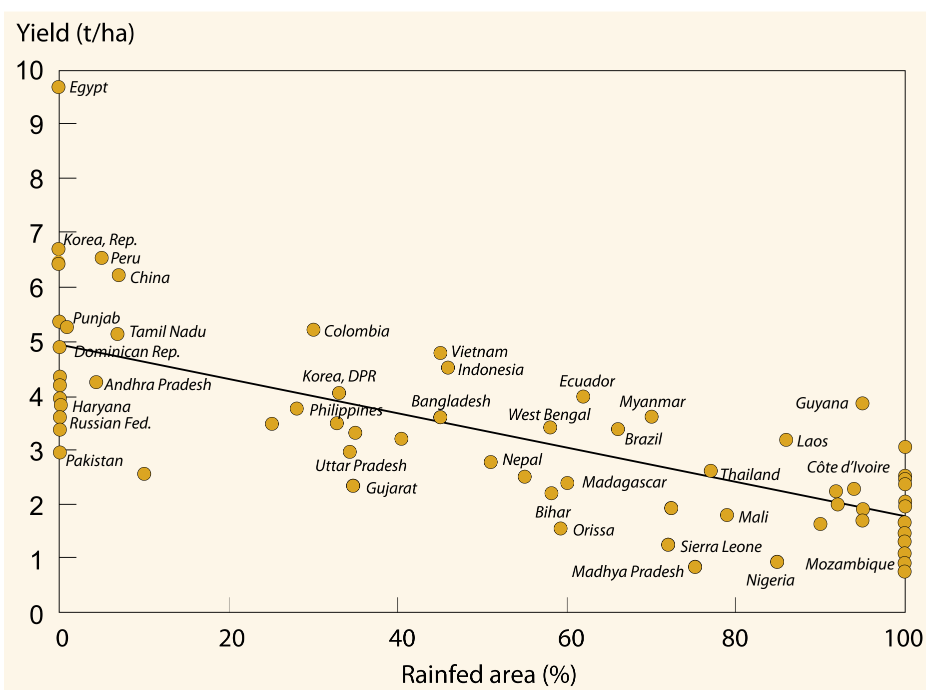


Fig. 2.1. Association of rice yield (t/ha) with rainfed area (%), for 61 developing countries and 16 Indian states with rice area greater than 20,000 ha. 2002.

Chapter 3

GOALS, OBJECTIVES, AND TARGETS TO 2015

Only with clearly articulated goals and objectives can IRRI chart a path to impact

For this strategic plan, IRRI has developed a set of strategic goals for focusing its research and related activities over the next decade. These goals were derived through an extensive planning process (Annex 2) that analyzed the needs and sources for rice-related research over the next decade; the changing social, institutional, physical, and research environment in which IRRI operates; and the roles that stakeholders and staff felt would best be filled by the Institute. The background and analysis for the development of the goals are summarized in Chapters 1 and 2.

It was concluded that the Millennium Development Goals (MDGs) related to hunger, poverty, environmental sustainability, and nutrition and health formed a sound basis and direction for IRRI's future activities. Among the research and delivery themes in the Institute's research agenda, guided by the Consultative Group on International Agricultural Research (CGIAR) system priorities, IRRI will give particular attention to addressing these MDGs by

- contributing to **poverty reduction** of poor farmers, particularly women, in rainfed areas, through development of stress-tolerant rice varieties for unfavorable conditions, and through improvement of rice varieties and rice-based diversified cropping systems in Asia and sub-Saharan Africa that generate additional on-farm income while maintaining low production costs and prices for the urban and landless rural poor;

- contributing to maintaining the **sustainability** of rice-based systems, especially intensive irrigated systems, in the face of growing land and water shortages, a dynamic labor profile, and changing environmental conditions; and
- improving the **nutrition and health** status of rice consumers and producers, especially women and children, by improving the nutrient content of rice, minimizing harmful contaminants, and reducing the incidence of water-related diseases on rice farms.

To assist it in these efforts, IRRI will

- exploit the new **information and communication** technology to create a global, equitable forum for knowledge creation and sharing, and capacity building; and
- enhance its capacity to respond to **germplasm needs** arising from changing and uncertain future environments.

Sets of objectives toward meeting each goal were generated. For each objective, targets were identified that will enable progress to be monitored. These will be refined continuously through the rolling medium-term plan process and specifics of the impact regions defined within the first two years of this plan. The baseline for assessing programs toward targets is the year 2000. Thus, by developing activities that address the targets and assigning resources to these activities, the mechanism is in place to develop a business plan that is directly linked to the execution of the strategic plan. The CGIAR system priorities developed by the Science Council form a logical and inclusive framework by which implementation of IRRI's activities can be assessed. The relationships between IRRI's goals, the MDGs, and CGIAR system priorities are shown in Tables 3.1 and 3.2 on pages 38-39.

IRRI's Goals

Goal 1
Reduce poverty through improved and diversified rice-based systems

Goal 2
Ensure that rice production is sustainable and stable, has minimal negative environmental impact, and can cope with climate change

Goal 3
Improve the nutrition and health of poor rice consumers and rice farmers

Goal 4
Provide equitable access to information and knowledge on rice and help develop the next generation of rice scientists

Goal 5
Provide rice scientists and producers with the genetic information and material they need to develop improved technologies and enhance rice production

GOAL 1

Reduce poverty through improved and diversified rice-based systems

Rationale

Adopting the MDG on eliminating extreme hunger and poverty opens profound new opportunities for IRRI to improve the economic and social well-being of poor rice consumers and farmers who increasingly are female. Rainfed areas coincide to a large extent with regions of severe and extensive poverty where rice is the principal source of staple food, employment, and income for the rural population (see Fig. 1.2 on page 5). Poor people in these areas lack the capacity to acquire food, even at low prices, because of low yields and limited employment opportunities elsewhere. Climatic conditions are such that rice is the only crop that can survive during the main growing season. The poor have no choice but to grow and consume rice.

In both Asia and rice-producing areas of sub-Saharan Africa, farmers face low and very unstable yields and high risks of harvest failure from drought, flood, and other stresses. Reliable and high yields can be achieved only by growing varieties that tolerate these stresses. New genetic knowledge technologies now permit rapid breeding and deployment of improved varieties tolerant of environmental stresses. Reliable, high yields alone will not lift rainfed rice farmers from poverty. But, they will provide the financial opportunities and security for farmers to diversify and seek other sources of income.

The rural landless and urban poor spend most of their income on rice. To keep the rice price affordable, rice

supply must match growth in demand. For the medium term, the favorable irrigated ecosystem will remain the major source of rice supply for urban markets. In irrigated systems, yields have plateaued at high levels, but will require research to maintain them. Yields can be further increased through hybrid rice development and major changes in plant physiology. Crop management and postharvest technologies are needed to reduce the unit cost of production, which helps maintain profits for farmers and keep the price affordable to poor consumers.

The experience of economic development in East Asia demonstrates that improving productivity in staple food production builds the foundation for agricultural diversification into high-value crops and expansion of nonfarm activities. IRRI's research with sister CGIAR centers and other partners will include developing an understanding of current livelihood systems, constraints to and opportunities for agricultural diversification, and pathways to reduce poverty; and research to identify rice technologies that will best match identified diversification targets, whether in other crops, fish, or livestock.

FRONTIER PROJECT

Drought and productivity in unfavorable rice environments

Recent IRRI research has shown that the drought tolerance trait is strongly influenced by genes and gene networks with large effects. The project will scale up their detection, analysis, and delivery for use in marker-aided breeding. By incorporating genes for this trait from rice and other species into widely grown or "mega" rice varieties, technologies can be developed with national systems and provided to farmers to enhance and stabilize their rice yields and income. Broad and new partnerships will be necessary to take the genetic findings from the laboratory to farmers' fields in a wide variety of rainfed conditions.

Objectives

1.1 Enhance household food security and income in rainfed areas of Asia through improved varieties and management practices that can double yield and reduce yield variability under stress conditions

2015 Targets

- Develop elite disease- and pest-resistant lines and management practices that can double current rice yield in drought-prone, submergence-prone, and salt-affected areas, and demonstrate the potential with farmer participatory research at selected sites.
- Increase yield at a regional level by at least 25 percent and reduce its temporal variation by half for the rainfed systems in selected regions of South Asia and the Mekong Delta countries.
- Demonstrate in at least five regions of South Asia and the Mekong Delta countries with high incidence of poverty the potential of increasing farmers' income by 50 percent through gender-sensitive crop diversification and integration of other agricultural activities.

1.2 Ensure adequate and affordable food supplies for poor rice consumers through further increases in productivity and profitability in irrigated rice systems

2015 Targets

- Reduce the gap between the yield potential of improved varieties and farm-level yield by 25 percent in selected regions.
- Demonstrate technologies and management options that can reduce the unit cost of rice production for the irrigated ecosystem in selected regions by 20 percent and be adopted by women farmers.
- Increase lowland rice yield by 15 percent in areas where the commonly used varieties yield below 5 tons per hectare in farmers' fields.

In South Asia, the landless poor will sometimes excavate burrows to recover rice taken by rats.

1.3 Improve food security and farmers' income in rice-growing countries in East and southern Africa through improved rice varieties and cropping systems

2015 Targets

- Demonstrate in at least three countries improved varieties with yield of at least 4 tons per hectare and crop management practices that are compatible with the needs of women farmers.
- Increase farm-level yield for the lowland ecosystem in the region by 20 percent.

1.4 Develop new rice genotypes that can potentially double yield under drought stress in rainfed environments (*Frontier Project*)

2015 Targets

- Identify key traits and mechanisms controlling rice drought tolerance, and develop relevant screening techniques.
- Tag alleles that increase rice productivity under drought stress for marker-aided breeding, validate them in farmers' fields, and use them widely in NARES breeding programs.
- Develop improved rice varieties and hybrids that increase average yield under drought by 1 ton per hectare in lowland conditions and 0.5 ton per hectare in upland conditions relative to current widely grown varieties in drought years, without constraining productivity in favorable years.
- At least 10 million rice farmers adopt varieties with increased drought tolerance in the drought-prone rainfed zones of Asia and sub-Saharan Africa.

GOAL 2 Ensure that rice production is sustainable and stable, has minimal negative environmental impact, and can cope with climate change

Rationale

It is critical that the stability and productivity of rice agroecosystems not be taken for granted and that their use by future generations not be jeopardized. Strategies are urgently needed to preserve the natural resource base while improving productivity in rice agroecosystems in the face of changing physical and socioeconomic environments. IRRI will focus on land management, biodiversity, water availability and productivity, and the impact of climate change to develop and promote technologies and options to sustain rice-producing environments. Adopting a landscape approach, IRRI will seek to optimize land-use patterns and practices to promote overall resource productivity, livelihood security, and social well-being, while maintaining the integrity of the natural resource base. Understanding the complex relations among users and components of the agroecosystems will be a critical step in developing these options.

Biodiversity plays a vital role in the provision of ecosystem services, the sustainability and resilience of rice ecosystems to environmental stresses (especially drought and floods), and biological pest control. Understanding how such interventions as cropping practices, rotations, tillage, fallow, flooding regimes, and habitat management interact at the landscape level is essential to maintaining biodiversity.

FRONTIER PROJECT

Climate change and sustainability

Climate change brings new problems for the sustainability of rice production. Further, changes in air quality and composition, acid rain, and Asian "brown" clouds will produce a new bio-climate for food production systems. Rice cultivation is often viewed as a contributor to climate change through the production of greenhouse gases. Given the essential role of rice in the food system, solutions must be sought that not only minimize the impact of rice production on the environment but also change the "balance sheet" such that productivity and environmental quality can be sustained. Strong science will be brought to bear to decipher the causes and effects involved and to improve germplasm adaptation to expected future climatic conditions, and mitigate the negative effect of agriculture on climate.

There are continuing grave concerns about misuse of pesticide and chemical fertilizer, especially in intensive production systems. The former can seriously disrupt the functioning of natural biodiversity and the latter can seriously contaminate surface water and groundwater. Both can adversely affect farmers' health and income.

Water scarcity and the need to reduce water inputs will affect many aspects of crop management, variety choice, soil quality and organic matter, pest populations, productivity, and the environmental impact of rice-based systems. Strategies for coping with water scarcity are needed to ensure the sustainability of lowland rice systems. Water supplies are further threatened by contamination from industrial, urban, and agricultural sources, while options for water saving and conservation are already needed in many rice-growing areas.

Climate change and global warming are likely to be accompanied by weather extremes that pose significant threats to food production. Given the importance of rice production to global food security, cropping systems and germplasm will have to be adapted to cope with the effects of climate change. It is also necessary to develop genetic technology and management practices to mitigate the negative effects of agricultural activities on climate.

The IRRI-CIMMYT Alliance Program on Intensive Rice-Based Systems in Asia will be an important implementation mechanism to achieve this goal.

Objectives

2.1 Develop natural resource management options to ensure sustainability of rice agroecosystems

2015 Targets

- Quantify the key processes contributing to unsustainability in the major rice-based systems and validate improved resource management options that raise productivity by 10–25 percent while maintaining the resource base and improving environmental quality in three Asian countries.
- Demonstrate land management strategies—adoptable by women—based on improved knowledge of land use and landscape interactions that enhance ecosystem sustainability and raise overall productivity by 10 percent at key sites in three Asian countries, and derive options relevant to East and southern Africa.

2.2 Improve agroecosystem resilience through enhanced biodiversity

2015 Targets

- Identify practices and policy options that enhance biodiversity and ecosystem function, as measured against quantitative indicators, in selected agroecosystems and in three countries.
- Evaluate and demonstrate improved sensitive management options based on ecological approaches to pests that reduce losses in selected affected areas by 20–50 percent.

2.3 Develop management options to combat scarcity of freshwater resources and deterioration in water quality

2015 Targets

- Quantify the role of paddies in the hydrological cycle and develop water management options to maintain ecosystem services in three target areas.
- Combat the threat of water unavailability to rice production by developing water-saving technologies that improve water-use efficiency by 25 percent in selected areas.
- Determine the extent and level of deterioration in water quality in rice-based systems of two Asian countries, and develop management and policy options for the efficient use of water resources in these systems that recognize the growing role of women in agriculture.

2.4 Identify interventions to mitigate the effects of climate change and rising sea level, and minimize greenhouse gas emissions (Frontier Project)

2015 Targets

- Develop predictive models of the effects of climate change on rice production.
- Identify cropping systems options, including germplasm and management, for three major affected areas to adapt to future climates, particularly higher temperatures, and rising sea level.
- Determine changes in soil carbon and greenhouse gas emissions caused by changing land-use practices and crop diversification, and identify practices that minimize greenhouse gas emissions in selected rice-based systems.

GOAL 3 Improve the nutrition and health of poor rice consumers and rice farmers

Rationale

Nutritional deficiencies, especially in women and children, often go hand in hand with extreme poverty because poverty is a major factor limiting access to diversity in the diet. Reliance on a single staple, such as polished rice, does not provide the suite of minerals and vitamins necessary for healthy growth and development and leads to widespread nutritional deficiency in poor rice consumers. Solutions are (1) more diverse diets, (2) large-scale fortification or supplementation programs, (3) eating nutritionally improved unpolished rice, (4) increasing the amount of bioavailable vitamins and minerals in polished rice, and (5) maximizing the calorie potential of rice when both freshly cooked and stored.

IRRI's strengths and comparative advantage are in (3), (4), and (5), and its participation in crop systems diversification can contribute to (1). The bran layers of rice contain such micronutrients as iron, zinc, and many other minerals and vitamins, but persuading people to eat unpolished rice requires solving problems of cooking expense and rancidity.

Transgenic and germplasm screening approaches can be used to raise the amount of bioavailable micronutrients. Rice with greatly increased levels of provitamin A (Golden Rice) has been produced and IRRI is developing agronomically acceptable lines in partnership with NARES. Likewise, IRRI's work has shown that iron from high-iron rice lines is absorbed by iron-deficient women.

The structure of the starch and protein in the grain determines the calories that can be derived from either freshly cooked or stored rice; in the latter, its digestibility, and thus calorie potential, often decreases. Rice starch with a low glycemic index can have a favorable impact on the prevalence of diabetes in rice-dependent countries.

The health of rice consumers is at risk if they eat rice contaminated with metal and metalloid toxins (arsenic, lead, and cadmium), which can arise when it is grown on contaminated soils, or when contaminated water is used to irrigate plants or to cook rice, and microbial toxins (mycotoxins), which can occur in grains if the crop is incorrectly handled during grain filling, harvest, or storage. Contamination of grains from irrigation water or soil can be decreased by capitalizing on known genetic variability and breeding. Mycotoxin contamination can be decreased by changing postharvest handling and processing practices.

The health of rice farmers, laborers, and their families is also threatened by the occupational hazards of pesticide use, and by a number of water-borne and zoonotic diseases, such as schistosomiasis, leptospirosis, malaria, and dengue. Further, commonly known and emerging diseases pose a potential barrier to innovative rice-based cropping systems being developed by IRRI, especially in Africa.

Objectives

3.1 Improve the nutritional status and health of rice consumers by increasing the content and bioavailability of nutrients in polished and unpolished rice, and creating consumer awareness of the benefits

2015 Targets

- Enhance the nutrient content of 20 percent of the rice produced in targeted areas of endemic poverty.
- Reduce the prevalence of mineral (iron and zinc) and vitamin A deficiencies in women and children in targeted areas of endemic poverty through consumption of more nutritious rice.
- Brown or underpolished rice occupies 10 percent of the market in three target areas.

Irrigation water from tube wells polluted with arsenic can contaminate rice grains in the field.

3.2 Ensure the health of rice consumers by reducing the presence or toxicity of contaminants in rice grains

2015 Targets

- Develop and deploy in 50 percent of the rice grown in contaminated areas germplasm that accumulates a particular contaminant in the grains to a significantly lower extent than currently grown varieties.
- Develop improved production and postharvest management strategies that minimize mycotoxin contamination and demonstrate their implementation by NARES in identified areas with mycotoxin problems.

3.3 Ensure the health of rice farmers by contributing to the development of management and policy intervention options to mitigate human disease and occupational hazards associated with rice farming

2015 Targets

- Develop and promote policies for the management of pesticides and application technologies in rice-producing countries.
- Develop methods for assessing disease risk in rice-growing areas used in all IRRI's research.
- Develop mitigation options to decrease the incidence of water-borne human diseases associated with rice farming.

GOAL 4 Provide equitable access to information and knowledge on rice and help develop the next generation of rice scientists

Rationale

The availability and affordability of new information and communication technology, such as the Internet, mobile phones, and powerful computers, are increasing rapidly. This situation has created important opportunities to allow people with common interests to form communities, communicate, and collaborate. It has also raised new obligations for IRRI to curate, exchange, and share not only its own body of information, data, and experience but also that of the world's knowledge about rice in all its forms.

In parallel, biology in general and rice science in particular are becoming more dependent on data mining and analysis of large, integrated information resources. The publication of the rice genome sequence and the emergence of rice as a model crop for cereal biology have precipitated considerable investment and involvement by IRRI in bioinformatics, with a focus on relevant traits and comparative biology aimed at leveraging information between crops. The joint activities on crop informatics of the IRRI-CIMMYT Alliance Program will play an important role in this respect.

IRRI's solid record of information management, publication, training, and capacity building combined with its existing wealth of electronic information and databases provide a unique opportunity to exploit new technologies to create a global information hub that can be used by all to improve knowledge sharing and capacity building for poverty reduction, environmental sustainability, and human health and nutrition.

In capacity building, the thousands of NARES scientists who have received degree and/or short-term training at IRRI in past decades have made critical contributions to the success of the first Green Revolution and to achieving rice self-sufficiency in their countries. However, in some countries, NARES are now facing a "generation gap," especially of senior rice scientists who have retired or are near retirement age and are not being replaced. In sub-Saharan Africa, it is not unusual to find one or two rice specialists struggling to serve millions of farmers. The shortage of scientists is compounded by the "technology divide," in which many scientists are not benefiting from rapidly evolving modern science and technologies.

Agriculture and agricultural research must be attractive opportunities for today's youth.

But, seizing the opportunities offered by the Information Age will bring practical knowledge to anyone with access to the Internet. Access to knowledge will invigorate the heart of national rice science communities. It will also capture young minds to launch a career in rice research.

Objectives

4.1 Provide optimum stewardship of, and access to, data, information, and knowledge about rice to help improve the lives of poor rice producers and consumers

2015 Targets

- Develop and implement appropriate systems for monitoring and optimizing the dissemination, use, and impact of IRRI's knowledge products.
- Develop standards, infrastructure, and partnerships to allow global sharing and community curation of scientific data, information, and knowledge.
- Develop and maintain a process for annotation and conservation of high-quality rice databases as global public goods.
- Catalyze the development of a globally accessible network of integrated information resources pertinent to the rice community.

4.2 Serve as the convener of dialogues about rice science and development through a global hub for rice information

2015 Targets

- Catalyze the formation of communities and stimulate dialogue among these individuals and groups by promoting objective discussion of research and development issues related to rice.
- Implement effective communication activities that allow scientists, extension workers, rice consumers, and policymakers to make informed decisions on the use, extension, and adoption of appropriate and effective technologies.

Source: Philippine Rice Research Institute (PhilRice).

4.3 Build the next generation of rice scientists able to access and use appropriate information and technologies

2015 Targets

- Double the number of scientists in NARES and advanced research institutes who collaborate with IRRI in rice research and development problems.
- Achieve demonstrable formation of a new cadre of rice scientists for the main rice-producing developing countries of Asia and East and southern Africa by doubling the number who participate with IRRI scientists in advanced degree programs and in targeted training courses.
- Integrate the new cadre of rice scientists and scientists from advanced institutes into an effective research community, solving practical problems in rice science and development and contributing to global knowledge about rice.
- Substantially close the "communication gap" by applying new technology to ensure that rice-related knowledge reaches farmers.
- Increase the percentage of women in IRRI's degree and postdoctoral programs to 35.

GOAL 5 Provide rice scientists and producers with the genetic information and material they need to develop improved technologies and enhance rice production

Rationale

IRRI has assembled and now maintains the world's most complete and diverse collection of rice germplasm to provide current and future generations with the germplasm most appropriate for their requirements. However, there are significant gaps in IRRI's germplasm collection and, despite the advanced state of knowledge of the rice genome, information is scant on what diversity of genes exists within the rice gene pool, what these genes do, and how they may help meet the needs of rice producers and users. Meanwhile, *in situ* genetic erosion continues.

Further, the rice genetic resource needs of future users cannot be anticipated. In a future with different pests, diseases, climates, technological capacities, economies, and policy objectives, current elite varieties may have little value, and sustained agricultural development may rely on genetic resources that have no known current value. Thus, the value of a variety or set of traits for meeting current development goals is not a reliable indicator of its value to accomplish future goals in future conditions.

Collection and characterization of representative samples of the entire world's rice germplasm and an effective delivery system would, to the extent possible, assure meeting future rice genetic resource needs. However, various policy, scientific, and economic issues present constraints to achieving this. At the policy level, there is ongoing intergovernmental debate and increasingly tight national and international regulation on the exchange and use of genetic resources. At the scientific level, despite rapid recent advances in bioinformatics and biotechnology, seeking to understand the rice genome still presents major difficulties. At the economic level, although it has been established that economic benefits arising from the free exchange of germplasm exceed the cost of its conservation, there is a need to optimize the targeting of limited financial resources toward more efficient conservation and use.

Clearly, no one organization can overcome all the constraints to achieving this goal. Through its T.T. Chang Genetic Resources Center and its participation in the Global Crop Diversity Trust, IRRI is in a unique position to develop and lead a global consortium on rice diversity that could address many of these constraints, and thus facilitate the sustainable development of rice-based systems.

To achieve this goal, it is essential to understand functional diversity in the rice gene pool, conserve rice genetic resources, and deliver the right germplasm to each user.

FRONTIER PROJECT

A much more productive and efficient rice plant

Plants such as maize and sorghum have a more efficient photosynthetic mechanism (called C_4) for converting energy to biomass than rice (a C_3 plant). Such plants are also more efficient in nitrogen and water use, and are generally more tolerant of high temperatures. Genomic sciences and comparative biology may yield new insights to break the yield ceiling of rice and enhance its water- and nitrogen-use efficiency by changing the photosynthetic mechanism in rice to that of the more efficient plants. IRRI will form a C_4 rice consortium of senior scientists from both advanced research institutes and developing countries to chart and conduct research to invent a C_4 rice plant.

Objectives

5.1 Increase knowledge of the value and diversity of rice genetic resources through improved understanding of the rice plant at the gene and molecular level

2015 Targets

- Identify the basic functions of all rice genes and quantify the genetic diversity of rice through a worldwide consortium of public- and private-sector organizations.
- Complete the revision of the taxonomy of *Oryza* based on improved understanding of genetic diversity and phylogeny.

5.2 Conserve and augment rice diversity in *ex situ* germplasm collections, and improve the efficiency of conservation

2015 Targets

- Develop and implement a rationalized system for the conservation of rice genetic resources in collections worldwide through a global network in partnership with the Global Crop Diversity Trust.
- Develop and implement new international genebank standards to improve the economic efficiency and genetic effectiveness of genebanks.
- Increase the diversity of genetic resources conserved in IRRI's genebank by targeted acquisition of 10 percent additional novel accessions.

5.3 Ensure and facilitate access to rice germplasm and associated knowledge compliant with national and international legislation

2015 Targets

- Implement an online system for the selection of germplasm most likely to meet specific user needs through seamless integrated access to genetic, phenotypic, and ecogeographic information in genebanks worldwide.
- Improve capacity for improved phytosanitary procedures for rice germplasm exchange in at least 20 countries.
- Increase germplasm exchange by 20 percent through reconciliation of global developments in intellectual property concepts.

5.4 Assemble the knowledge and genetic, physiological, and morphological components needed to construct a C_4 rice plant (Frontier Project)

2015 Targets

- Determine to what extent wild rice has evolved C_4-like photosynthesis, including C_3-C_4 intermediate characteristics.
- Identify the genotypes in wild rice species containing the most C_4-like anatomical and biochemical characteristics and identify genes responsible for Kranz anatomy.
- Identify the rice genotype with the lowest rate of photorespiration and investigate variation in CO_2 loss through respiration in rice, and quantify the contribution to yield, water-use efficiency, and nitrogen-use efficiency resulting from eliminating photorespiration in rice.
- Evaluate the "C_4-ness" of photosynthesis in rice panicles and investigate the "C_4-ness" of photosynthesis in rice stems.
- Construct and evaluate transgenic rice plants containing C_4 maize genes.

Table 3.1. The relationship between IRRI's strategic goals and the Millennium Development Goals.

IRRI strategic goals	Millennium Development Goals							
	1	2	3	4	5	6	7	8
	Poverty & hunger	Primary education	Gender equality	Child mortality	Maternal health	Diseases	Environment	Partnerships
Goal 1: Reduce poverty through improved and diversified rice-based systems	■	■	□	□	□	□	□	□
Goal 2: Ensure that rice production is sustainable and stable, has minimal negative environmental impact, and can cope with climate change	□	□	□				■	□
Goal 3: Improve the nutrition and health of poor rice consumers and rice farmers	□		□	■	■	■		□
Goal 4: Provide equitable access to information and knowledge on rice and help develop the next generation of rice scientists	□	□	■	□	□	□	□	■
Goal 5: Provide rice scientists and producers with the genetic information and material they need to develop improved technologies and enhance rice production	■			□	□		■	□

■ A direct contribution toward achieving the MDGs
□ An indirect contribution toward achieving the MDGs

Table 3.2. Relationship between IRRI's strategic goals and the CGIAR system priority areas for research.

IRRI strategic goals	CGIAR system priority areas for research																			
	Sustaining biodiversity for current and future generations				Producing more and better food at lower cost through genetic improvements				Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products				Poverty alleviation and sustainable management of water, land, and forest resources				Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger			
	1A	1B	1C	1D	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C	4D	5A	5B	5C	5D
Goal 1: Reduce poverty through improved and diversified rice-based systems		Partner			Lead	Lead	Lead		Partner	Partner	Partner		Partner/Lead		Lead	Lead	Partner	Partner/Lead		Partner/Lead
Goal 2: Ensure that rice production is sustainable and stable, has minimal negative environmental impact, and can cope with climate change	Lead	Lead							Partner		Partner	Partner	Lead	Partner	Lead	Lead	Lead			
Goal 3: Improve the nutrition and health of poor rice consumers and rice farmers							Lead	Lead									Lead	Partner		Lead
Goal 4: Provide equitable access to information and knowledge on rice and help develop the next generation of rice scientists	Lead	Lead			Lead	Lead	Lead	Lead	Partner	Partner	Partner	Partner	Lead	Partner	Lead	Lead	Lead	Partner		Lead
Goal 5: Provide rice scientists and producers with the genetic information and material they need to develop improved technologies and enhance rice production	Lead	Lead			Lead	Lead	Lead	Partner/Lead							Lead					

IRRI lead role
IRRI partner role

Chapter 4

ACHIEVING THE GOALS

A programmatic approach that integrates across disciplines is key to solving complex problems

New program structure and mechanisms for research and delivery

IRRI will implement its strategic plan through seven programs (Box 4.1) that will take effect in the first phase, the Medium-Term Plan 2007-2009, with each program constituting an "MTP project." These programs are product and impact oriented with clearly defined activity domains and time-bound targets and outputs. Each program may have a number of working teams to achieve one or a set of outputs. Program leaders will be accountable for achieving the outputs and delivering products. They will be responsible for research planning, budgeting, resource mobilization, and project monitoring and evaluation, as well as team building and staff evaluation and motivation. The program leaders will also be expected to undertake their own research work as well as play key roles in fund raising. The programs will draw expertise and supporting staff from IRRI's discipline-based research divisions and/or centers (Box 4.2), and will ensure collaboration with advanced research institutes (ARIs) and national agricultural research and extension systems (NARES). The mechanisms for delivery and impact (the consortia and networks) are managed within the programs.

The objectives and outputs of the programs are based on the goals described in Chapter 3, and a program may contribute to one or a number of goals. Also, at least 80 percent of the program activities fall under the Consultative Group on International Agricultural Research (CGIAR) system priorities (as shown in Chapter 3). These programs align very closely with the recommendations of the favorable Sixth External Program and Management Review of IRRI in 2004. Research on social sciences, genetic resources, rainfed systems, and intensive systems has been highlighted.

Box 4.1: IRRI programs.

1. Raising productivity in rainfed environments: attacking the roots of poverty
2. Sustaining productivity in intensive rice-based systems: rice and the environment
3. East and southern Africa: rice for rural incomes and an affordable urban staple
4. Rice and human health: overcoming the consequences of poverty
5. Rice genetic diversity and discovery: meeting the needs of future generations for rice genetic resources
6. Information and communication: convening a global rice research community
7. Rice policy support and impact assessment for rice research

The Frontier Projects introduced in Chapter 2 and described in Chapter 3 are intended to accentuate the Institute's commitment to achieving the goals. They will constitute novel and focused research on problems of strategic importance to future rice production and the environment. These projects will be undertaken by multi-institutional, international research teams. A significant part of the agenda is expected to be conducted at collaborating institutions in both developed and developing countries. IRRI will make a significant contribution from its unrestricted net assets (reserves) to support the startup of the Frontier Projects (see Chapter 5), and their continuity is expected to be provided by a diverse grants portfolio. These projects will be housed in the programs to strengthen their scientific power and partnership.

Research divisions and centers for scientific excellence

One of IRRI's challenges in managing the multidimensional complexities of mission-oriented research for international public goods is to maintain a scientifically rigorous "research for development" agenda. IRRI must avoid two opposing temptations to execute development projects that, while generating funds for the Institute, do not generate public goods; and to embark on purely academic discovery science. Most strategic research activities require long-term investments in specialized skills, involving a critical mass of scientific expertise and supporting infrastructure. These investments may even fall at the edge of a strict definition of "research for development." Striking a balance between discovery science and research for development was the underlying justification for the two-dimensional research management matrix that has supported IRRI's achievements for more than a decade. Since the early 1990s, IRRI has learned a great deal about managing this complexity. Today, IRRI conceptualizes its activities being conducted in programs with clear delivery mechanisms built upon a firm foundation of governance, management, support services, and scientific disciplines. This integration of support

IRRI's well-maintained and modern field, laboratory, and greenhouse infrastructure forms the fundamental platform for executing this plan.

Box 4.2: Research divisions/centers and their expertise.

Plant Breeding, Genetics, and Biotechnology Division (PBGB): rice genetics and plant breeding, hybrid rice, molecular biology, proteomics, rice genomics, wide hybridization, development and use of molecular markers, rice transformation and genetic engineering, plant pathology, and host-plant disease resistance.

Crop and Environmental Sciences Division (CES): agronomy, crop ecology and modeling, soil science, water science and engineering, plant/crop physiology, weed science, insect and plant ecology, nematology, rodent research, and ecological pest management.

Social Sciences Division (SSD): agricultural economics, economics, policy analysis, sociology, gender analysis, impact assessment, and geographic information systems.

T.T. Chang Genetic Resources Center (GRC): plant genetics and molecular genetics, *ex situ* conservation of plant genetic resources, evolution ecology, rice taxonomy, international policy and legislation on genetic resources, and information and database management.

IRRI-CIMMYT Crop Research Informatics Laboratory (CRIL): biometrics, bioinformatics, experimental design and data analysis, methodology development for statistical analysis and data management, molecular research data annotation, germplasm data curation, and database development.

Grain Quality, Nutrition, and Postharvest Center (GQNPC): cereal chemistry, analysis of physical quality of grain, grain sensory chemistry, micronutrient analysis, postharvest handling and processing, and rice grain value addition for enhanced marketing.

services, research programs, and delivery mechanisms is graphically illustrated in the conceptual framework shown in Figure 4.1.

Under the research management matrix per se, research outputs are achieved through implementation of the programs, while the discipline-based research divisions and centers provide the technical infrastructure, administrative support, and coordination for professional growth and evaluation of the scientists. Scientists are housed in a division or center, and their time is allocated among different working teams according to the needs of the programs. Each scientist will participate in up to two programs. The divisions and centers also serve as a longer-term platform for knowledge management, curation, and sharing, a focal point to establish and maintain links with other research institutions—particularly those conducting basic research—and a mechanism to facilitate efficient use and management of supporting staff with similar skills.

Capacity building

IRRI's mandate includes strengthening the research capacity of the NARES. In this strategic plan, IRRI will promote and contribute to national and international efforts to develop the next generation of rice scientists and will endeavor to increase its capacity-building activities for the NARES. In addition to the conventional degree programs and training courses, initiatives and tools will be developed and used, including

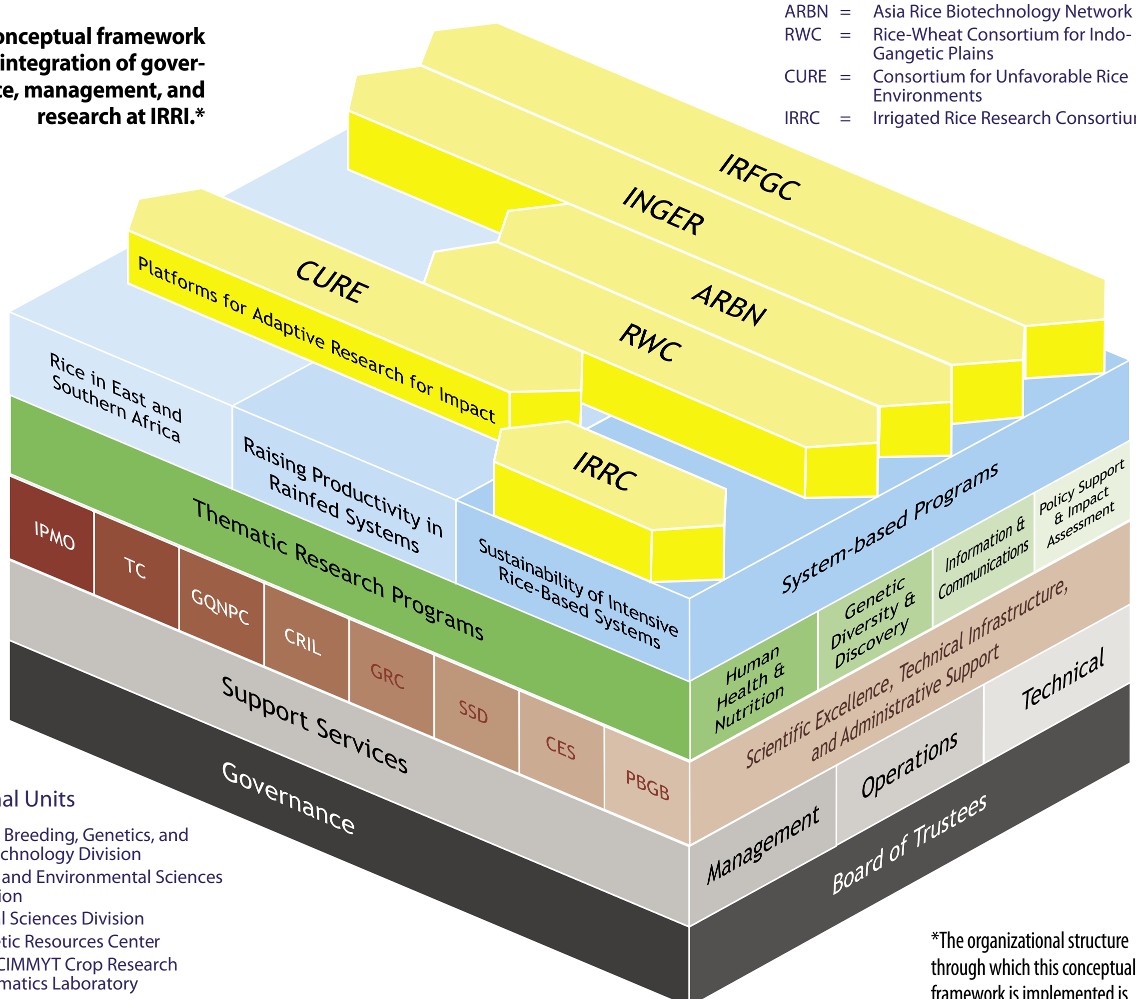
- the Rice Knowledge Bank with country sites in local languages, and Web-based self-learning, housed in Program 6;
- a "shuttle scientist" program to enable mid-career scientists to work with leading scientists during a critical period of their careers; and
- focused hands-on training for entry-level students, particularly in the areas of rice genomics, molecular marker technologies, bioinformatics, plant physiology, modeling, and climate change.

All future training activities at IRRI will be embedded in the programs and supported by the Training Center.

Partnerships

Throughout the years, IRRI has developed close and strong partnerships with ARIs and Asian NARES. Collaboration and networks with the NARES in sub-Saharan Africa will be revived through regional/subregional networks as well as the Future Harvest Alliance. Also, IRRI is developing increasingly sophisticated relationships with the private sector. Such partnerships, as pointed out in Chapter 2, are essential to achieving IRRI's impact. Recognizing the continuing evolution of NARES and the variation in their research

Fig. 4.1. Conceptual framework for the integration of governance, management, and research at IRRI.*



Delivery mechanisms

IRFGC = International Rice Functional Genomics Consortium
INGER = International Network for Genetic Evaluation of Rice
ARBN = Asia Rice Biotechnology Network
RWC = Rice-Wheat Consortium for Indo-Gangetic Plains
CURE = Consortium for Unfavorable Rice Environments
IRRC = Irrigated Rice Research Consortium

Organizational Units

PBGB = Plant Breeding, Genetics, and Biotechnology Division
CES = Crop and Environmental Sciences Division
SSD = Social Sciences Division
GRC = Genetic Resources Center
CRIL = IRRI-CIMMYT Crop Research Informatics Laboratory
GQNPC = Grain Quality, Nutrition, and Postharvest Center
TC = Training Center
IPMO = International Programs Management Office

*The organizational structure through which this conceptual framework is implemented is shown in Figure 6.1 on page 55.

The Rice Knowledge Bank (www.knowledgebank.irri.org) is a one-stop resource for practical rice information, often in local languages. It is now evolving into a "Cereal Knowledge Bank" under the IRRI-CIMMYT Alliance.

capacities and needs, IRRI will endeavor to develop and adapt modes of collaboration with these partners, for example, by

- focusing on the mandate of developing international public goods to support the NARES to develop locally adapted technologies and solutions;
- engaging in more equal-role research projects with NARES;
- fostering participation in IRRI programs by scientists from ARIs through staff secondment, scientific sabbaticals, a "shuttle scientist" program, and graduate student internships;
- engaging farmers in germplasm improvement, crop and natural resource management, and gender research, particularly in rainfed environments; and
- building global or regional platforms to increase information exchange and dialogue among NARES, ARIs, and the private sector, with an emphasis on enhancing NARES' access to modern technologies.

IRRI has been providing technical or institutional support and coordination to global or regional networks and consortia as platforms for information exchange, dialogue, and collaboration. These networks and consortia will continue to be the main mechanisms for technology and knowledge delivery for impact, as well as interactive channels for learning about new trends and emerging issues in the target countries to ensure the relevance of IRRI's research. IRRI coordinates with the International Center for Tropical Agriculture

(CIAT) in Colombia for germplasm exchange with Latin America and the Caribbean and actively participates in the East and Central Africa Rice Research Network (ECARRN) coordinated by the Africa Rice Center (WARDA). IRRI and WARDA have formally agreed to initiate and manage joint activities in sub-Saharan Africa.

The three IRRI-CIMMYT Alliance Programs represent a new approach for the CGIAR in managing intercenter collaboration and research agendas, including jointly appointed scientists, common budgets, and shared Board of Trustees members. IRRI also has a scientist located with WARDA in West Africa.

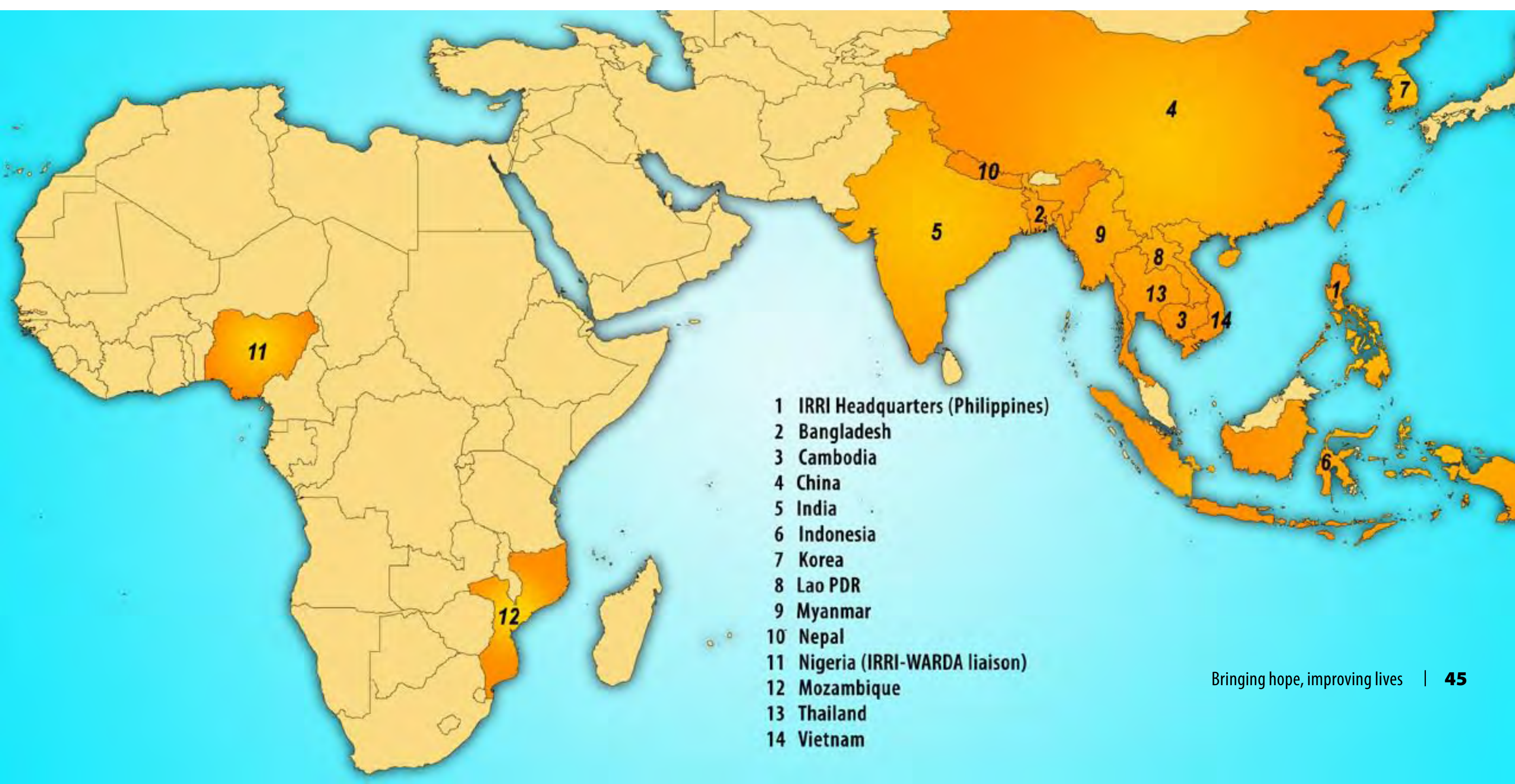
Communication

Communication of IRRI's mission, goals, core values, ideas, and achievements to stakeholders is a vital part of this strategic plan. The communication activities of the motivated and dynamic specialists and support teams in IRRI's regional and country offices, Training Center, Visitors and Information Services, Library and Documentation Services, Communication and Publications Services, and Information Technology Services will be coordinated toward achieving Goal 4 of providing equitable access to information and knowledge on rice and helping to develop the next generation of rice scientists.

International programs and regional/country offices

IRRI currently has offices in 14 countries managed by the International Programs Management Office (IPMO; Fig. 4.2). Country offices and outposted staff play an indispensable role in representing IRRI's interests by facilitating IRRI activities in the country, providing support to IRRI-coordinated networks and consortia, communicating and

Fig. 4.2. IRRI has staff based in 14 countries.



Annual meeting of the Consortium for Unfavorable Rice Environments (CURE) in Dhaka, Bangladesh, 8-9 March 2006.

promoting rice research and IRRI's mission, identifying emerging issues and opportunities as well as NARES' needs for training and information, and contributing directly to the research planning and initiatives of NARES.

In 2004, IRRI commissioned an external expert panel to review the Institute's models of staff placement for optimum impact. The review panel recommended that IRRI expand its outreach activities and strengthen support to and coordination of its in-country activities in response to the increasing complexity of problems on the ground and the dynamics of partnerships. The expert panel highlighted the role of the IRRI country offices and the suggested "regional hubs" to promote closer interactions of IRRI scientists with NARES partners, especially those participating in CURE and work in the rainfed environments.

To support the implementation of this strategic plan, IRRI will restructure its outreach offices in response to the external review recommendations and especially to the emerging needs of IRRI's activities in East and southern Africa. There will be three regional offices:

- Greater Mekong Regional Office (GMRO) based in Vientiane, Lao PDR, supported by country offices in Vietnam, Thailand, Myanmar, and Cambodia;
- South Asia Regional Office to be based in Delhi, India, supported by country offices in Bangladesh and Nepal, and to provide support to Pakistan, Sri Lanka, and Bhutan (the exact timing of establishing this regional office will be subject to consultations with the host country and the experiences and lessons learned from the GMRO);
- East and southern Africa Regional Office to be based in Dar es Salaam, Tanzania, in conjunction with the East and Central Africa Rice Research Network coordinated by the Africa Rice Center (WARDA).

In addition, the IRRI country offices in China (based at the Chinese Academy of Agricultural Sciences in Beijing), Republic of Korea (based at the Rural Development Administration in Suwon), and Indonesia (based at the Indonesia Agency for Agricultural Research and Development in Bogor) will continue to function and report directly to the deputy director general for research.

Chapter 5

RESOURCE MOBILIZATION

IRRI's strong financial management leaves it well positioned to launch this plan

This plan is aligned with the Millennium Development Goals (MDGs) and the priorities of the CGIAR as developed by the Science Council, its objectives are attainable, and the research activities are the results of extensive external and internal consultation. Thus, IRRI believes that the needs of the poor and the environmental requirements for the rice-growing and -consuming world—essentially the entire world—are best served by the forward-looking research program laid out herein. IRRI is therefore among the best investment instruments for helping the poor and hungry. To fund the dynamic research agenda put forth in its new strategic plan, IRRI will need at least $40 million per year during 2007-15.

The summary below shows IRRI's current and prospective sources of support and indicates how they may develop.

Unrestricted and attributed funding

Current investors

To a significant degree, IRRI's current investors (mainly CGIAR members) have kept their commitment to maintain levels of unrestricted funding to the Institute. In return, IRRI has a responsibility to maintain a rigorous, exciting, relevant, highly visible, highly productive, and impact-oriented research for development agenda. This means actively contributing to global efforts to achieve the MDGs while aligning IRRI's program with the CGIAR priorities. At the same time, the Institute must use the most creative and advanced scientific approaches, through novel and strong partnerships. Considering the constraints

H.E. Dr. A.P.J. Abdul Kalam, President of the Republic of India, visited IRRI in February 2006.

many CGIAR members face, IRRI expects to maintain unrestricted and attributed funding at 2005 levels, at a minimum.

To protect these substantial investments by CGIAR members, IRRI has in place comprehensive risk assessment and management procedures to ensure the integrity of its infrastructure and operations. IRRI has implemented an ongoing process of analyzing and improving the efficiency of its operations and support services. Rigorous internal and external audits assure the overall integrity of the Institute's governance and management. These measures will guarantee optimal use of resources and promote donor confidence.

New investors

As the economies of China, India, Republic of Korea, and other countries in Asia continue to grow, IRRI will make every effort to secure increased unrestricted and attributed financing from them because they have benefited significantly from IRRI's work over the past 45 years. By 2010, the target will be a total of $5 million per year additional unrestricted or attributed funds from these countries.

Restricted funding

It is certain that many investors will provide significant levels of support through restricted grants. IRRI will develop project proposals first and foremost to cover the activities that are spelled out in the strategic and annual rolling medium-term plans. The business plan will describe a portfolio of restricted grant needs toward 2015 to implement the research agenda. While IRRI cannot dictate which projects will be supported, it will work with potential investors to assure that the highest priority research is funded before that of lesser priority.

Support for development activities

A very few selected projects may fall outside the explicit strategic agenda. The rice research sectors of Myanmar and the Democratic People's Republic of Korea are in desperate need of rebuilding. IRRI will likely be called upon to assist these programs. IRRI will do so with the understanding that relationships are being built that will evolve into scientific partnerships over the years. This approach has been successful in the past. Indeed, many of IRRI's most important partnerships today developed under that model. Nonetheless, these projects will be designed to fully cover IRRI's costs, including backstopping at headquarters and in third countries. IRRI could absorb up to $3–5 million per year in such activities.

East and southern Africa

IRRI's exciting prospects for increasing rice farm productivity in sub-Saharan Africa over the coming decade reflect an entirely new dimension in IRRI's activities. After an initial start-up investment from unrestricted net assets, IRRI will seek specific contributions—either restricted or attributed—to support these activities. IRRI will target raising at least $3–5 million per year to support its work in Africa over the next decade.

Cost recovery

IRRI will continue its efforts to recover as many direct costs as practically feasible. Increasingly, IRRI will recover staff salaries through restricted grant budgets to the extent that staff contribute to these projects. IRRI aims to bring into line its overall staff salary recovery from restricted grants to the same level as the proportion of restricted funding for the Institute as a whole. While maximizing direct costing, IRRI will also strive to recover all indirect costs.

Challenge Programs

IRRI is very active in three Challenge Programs, and will continue to contribute significantly to their development and success. The Challenge Programs are now a significant component of the Institute's income from restricted grants.

Partnership funding

IRRI's partnerships are driven by the research agenda, not by revenue considerations. In some cases, little revenue is involved. Examples of this kind of partnership are

- Seconded or "shuttle scientists" from advanced research institutes to work at IRRI, whose salaries are paid by their home institutes while IRRI provides research support and shares the costs of their social benefits;
- "Sandwich" programs in which students conduct thesis research at IRRI on issues of strategic importance but are funded by their home institution;
- IRRI as a partner in highly relevant projects yet can expect to receive only limited funding (e.g., components of Frontier Projects that are conducted by ARIs); and
- IRRI is a designated preferred recipient of research results that otherwise would be unavailable.

IRRI welcomes all forms of partnerships that are mutually beneficial and help the Institute to attain its goals.

Private sector

Where IRRI derives income from nontraditional sources, care will be taken to be sure its mission is never compromised.

The private sector is unlikely to make direct cash contributions to IRRI, although there are already private-sector contributions to and involvement with some elements of IRRI's current research.

Some companies have developed technologies or knowledge that could be of direct relevance to IRRI and that would cost the Institute millions of dollars and many years to develop independently. IRRI will work with these companies to develop mechanisms for them to transfer such technologies for the benefit of impoverished rice farmers and consumers. Although these contributions will not visibly affect IRRI's finances, they will enable the Institute to advance its agenda much more quickly and at a much lower cost.

Also, some IRRI technologies, such as some hybrid rice technologies or software that may be taken up by the private sector, could generate income. In any venture that generates income for IRRI, care will be taken to make sure that IRRI's mission to end poverty and hunger is not compromised.

Exploring philanthropy in Asia

Many Asian entrepreneurs and philanthropists now wish to "give back" to societies that have treated them so well.[1] Some are particularly sensitive to the importance of rice in the overall Asian culture and landscape. IRRI will seek ways for these people to support IRRI as a contribution to Asian values. Some areas that may be attractive to philanthropists are enhancing the Rice World Museum and endowments for new facilities and staff at the Institute.

Earned income

Interest income

IRRI's Board of Trustees has instructed management to maintain approximately $22 million in reserves to cover potential staff separation liabilities, catastrophic losses, capital refurbishment, and unanticipated and precipitous drops in funding. Approximately three-quarters of this can be kept in medium- to long-term deposits. IRRI expects $1.1 million in interest income annually.

Commercial sponsorship

IRRI is and will continue to be a nonprofit organization dedicated to generating international public goods. But some important IRRI activities, such as the publication of the *Rice Today* magazine and the maintenance of the Rice Knowledge Bank, are increasingly difficult to sustain from existing income. IRRI will pursue innovative ways for commercial sponsorship of these activities that will eventually cover a major portion of their costs. The Institute will also explore how commercial sponsorship could contribute to the upkeep of its infrastructure. IRRI will be vigilant in assuring that there is no conflict of interest between commercial interests and the Institute's mission.

Unrestricted net assets

IRRI is perhaps unique within the CGIAR in that it is able to launch such an ambitious strategic plan at this time. It can do so only because of the many years of sound financial management that have resulted in high-quality facilities and a significant accumulation of unrestricted net assets. Since its founding in 1960, IRRI has carefully managed and developed these assets with two goals in mind:

(i) to support the Institute's own strategic research initiatives and
(ii) to insulate it against any unexpected downturns in donor funding and any other potential adverse financial shocks.

Two guiding principles have been the major planks of IRRI's financial management. First, on an annual basis, the Institute plans for balanced budgets. Second, cash resources over and above immediate needs are prudently invested to generate earned income, which goes to increase IRRI's revenue. Other income has been generated as fees for services.

[1] Asia Pacific Philanthropy Consortium. 2005. Philanthropic Leadership & Development: Perspectives from Six Asian Countries. Monograph, APPC, Ateneo de Manila University, Quezon City, Philippines.

Over the life of the Institute, as shown in its audited financial statements, IRRI generated earned income totalling US$48,940,000. IRRI used this earned income to fund a cumulative shortfall of $24,943,000 of expenses versus grant income and retained the remainder as unrestricted net assets or reserves. The value of IRRI's expenditure has slightly exceeded grants received, that is, every dollar of donor grant funds has been spent, and then some.

Earned income is the main source of IRRI's current level of unrestricted net assets. The other source was the accumulation for the Institute's capital replacement and acquisition needs through the annual depreciation charge, as mandated by CGIAR accounting practice.

The level of IRRI's net assets (excluding investments in fixed assets of $8,524,000) as of 31 December 2005 was $36,815,000, and included over $4,223,000 in unrealized foreign exchange gains.

Designation of IRRI's reserves

In order to better manage these assets and in pursuance of its responsibility to ensure the financial stability and viability of the Institute, the IRRI Board has designated unrestricted net assets for various purposes. IRRI management and its Board of Trustees believe that to be financially sound, and, depending on the size of its budget, IRRI requires $20–25 million in operational reserves.

IRRI designates its reserves as Operational Reserves, Unrealized Foreign Exchange Gains, and Research Innovation Fund.

Operational Reserves (total of $20,130,000). The components are Capital Acquisition and Replacement Reserves, Staff Separation Reserve, and Risk Management Reserve.

- Capital Acquisition and Replacement Reserves are to be used to replace, refurbish, or upgrade IRRI's capital assets, and are currently set at $9,557,000. This is set at about $1,000,000 above the current net book value of IRRI's fixed assets.
- Staff Separation Reserve is to cover major or complete staff retrenchments in the case of a severe downsizing or closure of the Institute. This value of $6,632,000 is based on estimates of the cost of meeting all obligations to international and national staff.
- Risk Management Reserve of $3,941,000 is to allow the Institute to adjust in an orderly manner to a donor default, serious realignment of donor priorities away from IRRI, or exchange rate fluctuations. This value is set to allow adjustment over a three-year period to a hypothetical worst-case realignment of IRRI's two largest donors suddenly reducing their contributions by 50 percent. IRRI would fully cover the shortfall over the first year, approximately 50 percent the second year, and 25 percent the third year.

Unrealized Foreign Exchange Gains. IRRI has substantial investments in non-US$ holdings. Over the last 3 years, about $4,223,000 in unrealized foreign exchange gains have accrued to IRRI as a result of translating (i.e., booking) these non-US$ currencies into US$ (the reporting currency) at the end of the financial year. These funds are not available until the currency is actually exchanged into US$, and can fluctuate widely until that time.

Research Innovation Fund ($12,462,000)**.** The Institute believes that enormous challenges and opportunities face humankind and that some of these can be addressed through high-risk and potentially high-payoff rice research. In addition to assuring long-term financial stability, the purpose of accumulating net assets was to allow the Institute to embark upon such ventures and to be in a position to rally the global scientific and development communities to join with it.


Frontier Projects will benefit the children of these children.

This fund consists of three subfunds whose relative values can shift:

- The Strategic Research Initiatives Fund. This fund provides seed money for innovative projects and opportunities that arise and may be outside the MTP.
- The Africa and Needy Countries Fund. This fund is to allow IRRI the flexibility to launch programs and proof-of-concept activities in areas the Institute believes to be important, but for which it has not yet received donor support. Resources from the other funds may also be invested in activities of direct relevance to Africa and/or used in activities undertaken in Africa.
- The Frontier Projects Fund. IRRI will develop two to three major new scientific ideas into projects with the potential to revolutionize rice production and have a major impact on IRRI's main goals of food security and poverty alleviation. Considering the frontier nature of such projects, IRRI's traditional donors would unlikely be willing to fully support such pioneering research on their own.

IRRI's Board of Trustees and management believe that the Institute's net assets provide the security and flexibility that are essential to the success of any major international organization, especially one supported—as IRRI is—by unpredictable and uncertain donor funding coming from many different sources, largely on an annual basis. The current level and designation of reserves positions IRRI to move aggressively into new areas of research for development while maintaining a secure financial base.

Chapter 6

GOVERNANCE AND MANAGEMENT

An effective research for development program depends upon sound governance and management

The International Rice Research Institute operates exclusively for scientific and educational purposes as a nonprofit, autonomous international organization. It is registered as a 501 (c) (3) charitable organization in the United States. As such, IRRI is nonpolitical in management, staffing, and operations. IRRI maintains and operates an international rice research facility in accordance with its Charter, which was affirmed by an international agreement signed in Manila on 19 May 1995 by 19 countries and entered into force when five signatories, including the Philippines, ratified the agreement.

The Board of Trustees

As provided for in the Charter, IRRI is governed by a Board of Trustees composed of 15 members: 12 are members-at-large and three are ex officio members. Three of the 12 members-at-large are designated by the Consultative Group on International Agricultural Research following the prescribed procedure. The three ex officio members are the secretary (minister) of agriculture of the Republic of the Philippines, the president of the University of the Philippines, and the director general of the Institute.

All members-at-large are qualified reputable individuals drawn from the international community, primarily from rice-producing countries and donor entities. Regard is paid especially to the proposed members' relevant expertise, experience, influence, and knowledge that can be placed at the disposal of the Institute. The composition of the Board will

IRRI Board of Trustees, 6 April 2006.

Left to right: Steve Linscombe (Scientific Liaison Officer of USAID to the Board), Domingo F. Panganiban (Department of Agriculture Secretary, Philippines), Mangala Rai (India), Achmad Fagi (Indonesia), Ruth Oniang'o (Kenya), Keijiro Otsuka (BOT chair, Japan), Robert Zeigler (IRRI DG), Fazle Hasan Abed (Bangladesh), Ronald L. Phillips (United States), Ralph Anthony Fischer (Australia), Elizabeth J. Woods (Australia), Emerlinda R. Roman (UP president, Philippines), and Eun-Jong Lee (Korea). Not present: Baowen Zhang (China).

continue to reflect the need to both represent the countries that IRRI serves and meet changing requirements for enhanced governance of the Institute's program and assets. The Board will respond to recommendations of reviews that are commissioned by the Board itself or externally, such as the Stripe Review of Corporate Governance of CGIAR Centers completed in 2006. An example of the dynamism of IRRI's Board is to appoint common board members with CIMMYT to provide oversight to the IRRI-CIMMYT Alliance.

The Board is responsible for the selection of the officers of the Institute. It stimulates, approves, reviews, evaluates, and revises all research and training programs and other activities of the Institute. The Board also reviews and audits the accounts and financial condition, as well as the management and operating systems and procedures of the Institute, including guidelines and procedures pertaining to human resources development, finance and budget, and other administrative matters. As provided in the Charter, the officers of the Institute are the chair of the Board, the vice-chair of the Board, the director general, the treasurer of the Board, the secretary of the Board, and such other officers that the Board may see fit to designate.

The Board also assists in raising funds for the Institute.

A Headquarters Agreement with the Philippine government defines the conduct of affairs of IRRI as an international organization within the host country, with all the rights, immunities, and privileges that this entails.

Management

IRRI's financial and program management are characterized by rigorous internal controls and are geared toward efficient and effective use of resources. These are supported by transparent and responsive planning, budgeting, and reporting systems. The Institute has also implemented a comprehensive risk assessment and management system covering all aspects of the Institute's administration and research. The system also ensures that appropriate controls are in place to mitigate the risks identified.

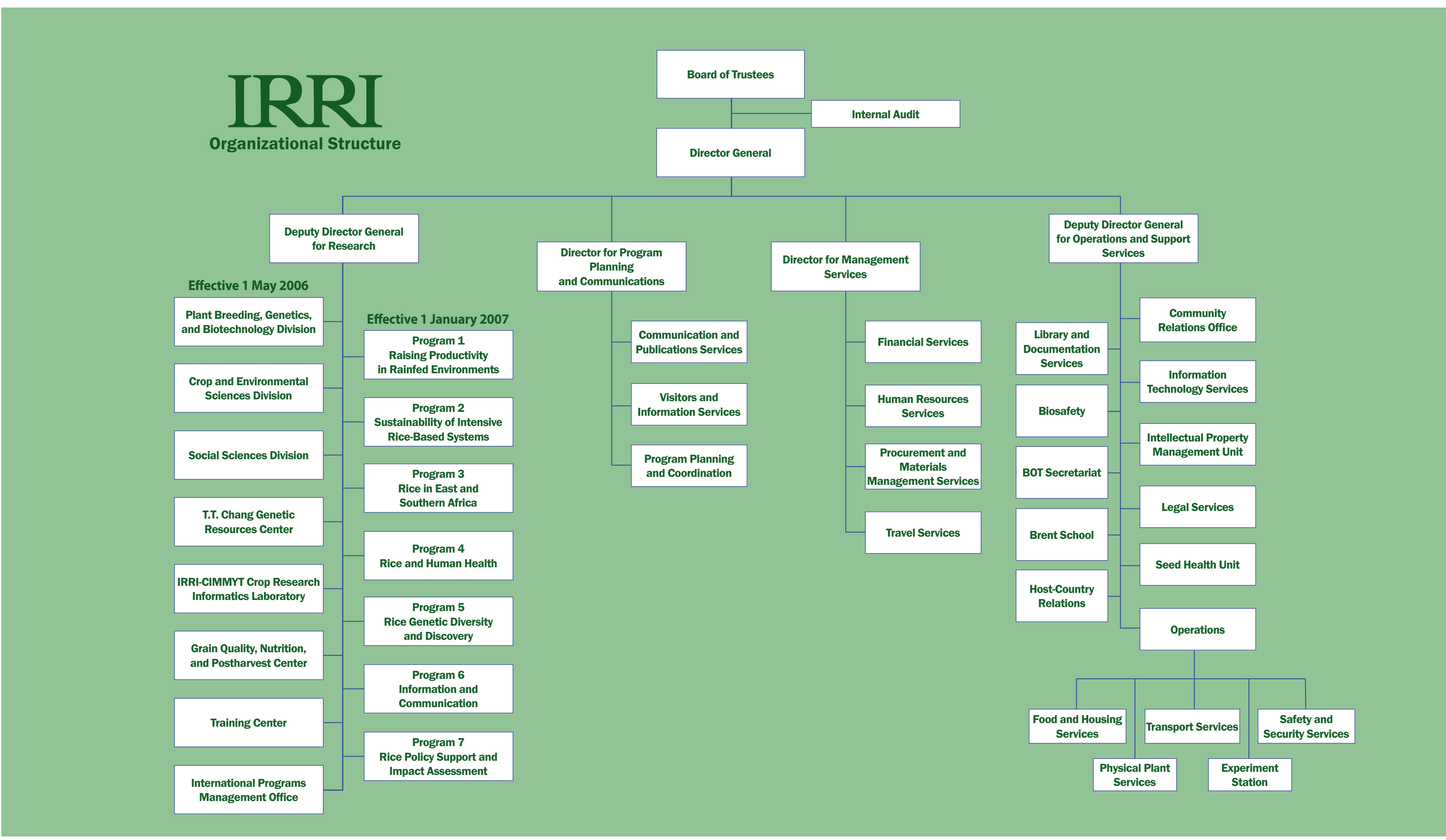
The director general is the chief executive officer of IRRI and directly manages and administers the Institute, in accordance with the policies and decisions of the Board. The director general is an ex officio member of the Board, without voting rights, and of all standing committees of the Board, except the Audit Committee.

The director general is assisted by a senior management team, which he appoints following the procedures set by the Board. The members of this team manage the various research, support, operations, communication, financial, and human resources functions of the Institute, as shown in Figure 6.1.

Research activities of IRRI are implemented through a program-based management system. The management team ensures that research and training activities focus on IRRI's strategic goals and objectives and that work plans are developed in collaboration with partners in the national agricultural research and extension systems, advanced research institutes, and other institutions in both the public and private sector. Interdisciplinary work is the cornerstone of the research activities. Furthermore, the design of the research agenda is explicitly done to align with the CGIAR priorities.

Detailed implementation plans are outlined in IRRI's Medium-Term Plan, which is updated and submitted annually to the Science Council.

Fig. 6.1. IRRI's organizational structure.



Research activities are organized using a two-dimensional matrix to manage the multidimensional complexities of mission-oriented research. One dimension of the matrix comprises the research programs; the other is the scientific disciplines in appropriate organizational units. The lines of authority and division of labor between the projects and the disciplines are clearly defined in order to foster accountability and effective implementation of research activities.

IRRI makes every effort to provide adequate human, physical, and financial resources to support the implementation of its strategy. Furthermore, operations and management services strive to provide the environment for efficient and effective use of IRRI's scarce resources. Some services, expertise, and facilities at IRRI are centralized and made available to support the implementation of the Institute's activities. Management facilitates the sharing of resources.

The Institute will continue to exert all efforts to recruit, retain, and train high-quality international and national staff. It will strive to remain a lean institution and provide a working environment conducive to professional growth at all levels. Furthermore, the Institute will strive to ensure that its physical facilities continue to provide cost-effective and state-of-the-art support to all its activities.

Annex 1. Key information on rice situation, poverty, health, and malnutrition.

Region/country	Rice situation						Projected population[e] (million)		Rice consumption per capita[h] (kg/person/yr)		Projected consumption, paddy[h,d] (000 Mt)		Increase in consumption of paddy (000 Mt) 2005-15	Indicators of poverty, health, and malnutrition			
	Area[a] (000 ha) 2003-05	Rain-fed area[b] (%)	Yield[a] of paddy (t/ha) 2003-05	Production[a] of paddy (000 Mt) 2003-05	Import,[c,d] paddy (000 t) 2004	Export,[c,d] paddy (000 t) 2004	2005	2015	2005	2015	2005	2015		Poverty ratio[f] (%)	Calorie intake[a] (Kcal/person/day) 2002	Under-nourished population[g] (% of total) 2000	Underweight children under age 5[g] (%) 2000
East Asia	**31499**	**7**	**6.19**	**195071**	**3752**	**1410**	**1514.2**	**1593.4**	**79**	**73**	**179712**	**174568**	**-5144**	**9.48**			
China	28232	7	6.22	175694	1392	1337	1315.8	1393.0	82	75	161110	157588	-3522	10.00	2,951	11	10
Japan	1682	0	6.27	10547	993	73	128.1	128.0	56	49	10755	9400	-1355	0.00	2,761	...[j]	4
Korea, DPR	586	33	4.05	2371	1053	0	22.5	23.3	62	79	2103	2768	665	45.00	2,142	36	28
Korea, Rep	999	0	6.47	6459	314	0	47.8	49.1	80	65	5744	4812	-931	4.00	3,058	...	...
Southeast Asia	**42886**	**58**	**3.75**	**160689**	**3465**	**21361**	**557.0**	**625.1**	**144**	**142**	**119933**	**133292**	**13359**	**25.63**			
Cambodia	2167	92	2.01	4360	113	8	14.1	17.1	152	178	3210	4553	1342	34.00	2,046	33	45
Indonesia	11734	46	4.55	53404	586	1	222.8	246.8	150	145	50156	53682	3526	27.00	2,904	6	25
Laos	756	86	3.20	2418	49	0	5.9	7.3	171	171	1522	1877	355	40.00	2,312	22	40
Malaysia	675	35	3.30	2229	785	12	25.3	29.6	81	86	3088	3828	740	8.00	2,881	0	20
Myanmar	6176	70	3.62	22382	27	225	50.5	55.0	206	206	15630	16961	1331	25.00	2,937	6	35
Papua New Guinea	0	0	0.00	0	321	0	5.9	7.0	36	40	321	421	100	37.00	...	...	...
Philippines	4083	33	3.49	14266	1574	0	83.1	96.8	108	123	13486	17914	4428	34.00	2,379	22	32
Thailand	9864	77	2.63	25966	2	14985	64.2	69.1	104	95	10061	9842	-219	10.00	2,467	20	18
Timor-Leste	20	100	3.27	65	7	0	0.9	1.5	71	63	101	140	39	42.00	2,806	...	43
Viet Nam	7412	45	4.80	35599	0	6130	84.2	95.0	177	169	22358	24076	1717	28.00	2,566	19	34
South Asia	**58382**	**48**	**3.14**	**183409**	**1882**	**9939**	**1451.0**	**1677.0**	**79**	**77**	**171223**	**193496**	**22273**	**33.88**			
Bangladesh	10941	45	3.62	39633	1488	1	141.8	168.2	160	163	33971	41218	7247	36.00	2,205	30	48
India	42570	46	3.03	129167	0	7192	1103.4	1260.4	76	73	126049	138058	12009	34.00	2,459	21	47
Nepal	1537	51	2.79	4282	32	9	27.1	32.7	104	112	4248	5478	1230	38.00	2,453	17	48
Pakistan	2494	0	2.96	7387	1	2734	157.9	193.4	17	20	4080	5708	1628	32.00	2,419	20	38
Sri Lanka	840	25	3.50	2942	361	4	20.7	22.3	92	91	2875	3034	159	22.00	2,385	22	33
CWANA	**1253**	**0**	**7.60**	**9520**	**6123**	**1544**	**223.2**	**268.2**	**35**	**39**	**11639**	**15826**	**4187**	**11.87**			
Egypt	643	0	9.71	6243	4	1255	74.0	88.2	41	48	4525	6327	1802	16.00	3,338	3	11
Iran	610	0	5.37	3277	1479	0	69.5	79.9	30	29	3155	3481	326	2.00	3,085	4	11
Iraq	0	0	0.00	0	1172	38	28.8	36.5	35	35	1512	1915	402	...	...	...	16
Kuwait	0	0	0.00	0	226	0	2.7	3.4	51	62	206	316	110	0.00	3,010	5	2
Saudi Arabia	0	0	0.00	0	1811	4	24.6	30.8	41	52	1497	2415	918	0.00	2,845	3	...
Syria	0	0	0.00	0	355	0	19.0	23.8	11	12	308	430	122	20.00	3,808	4	7
UAE	0	0	0.00	0	1077	247	4.5	5.6	65	112	436	942	506	0.00	3,225	...	14
Yemen	0	0	0.00	0	483	0	21.0	28.5	12	12	388	517	129	45.00	2,038	36	46
SSA	**7991**	**84**	**1.46**	**11649**	**9228**	**153**	**475.6**	**583.4**	**27**	**33**	**19261**	**28764**	**9503**	**45.14**			
Angola	11	100	1.42	15	401	0	15.9	20.9	1	10	28	317	289	70.00	2,083	40	31
Benin	24	100	2.52	61	715	0	8.4	11.2	7	19	85	324	239	33.00	2,548	15	23
Burkina Faso	49	100	1.67	81	273	0	13.2	17.7	14	16	282	421	138	45.00	2,462	19	34
Cameroon	20	100	3.10	62	452	0	16.3	19.0	19	27	454	765	311	48.00	2,273	25	23
Congo, Dem Rep	417	100	0.76	315	30	0	57.5	78.0	4	8	339	956	617	68.00	1,599	71	31
Côte d'Ivoire	471	94	2.30	1083	1302	1	18.2	21.6	71	88	1937	2846	909	40.00	2,631	14	21
Gabon	1	100	2.00	1	67	1	1.4	1.6	27	30	56	72	16	24.00	2,637	6	12
Gambia	14	100	1.54	22	44	0	1.5	1.9	43	52	97	149	51	40.00	2,273	27	17
Ghana	119	100	2.03	241	673	2	22.1	26.6	24	32	808	1284	476	39.00	2,667	13	25
Guinea	525	95	1.71	900	147	0	9.4	11.9	82	95	1155	1687	532	40.00	2,409	26	23
Guinea-Bissau	62	100	1.32	82	59	0	1.6	2.1	73	88	173	280	107	50.00	2,024	...	25
Kenya	12	100	3.78	47	335	0	34.3	44.2	7	11	349	736	387	35.00	2,090	33	21

...continued on next page

(continued)

Annex 1. Key information on rice situation, poverty, health, and malnutrition.

Region/country	Rice situation						Projected population[e] (million)		Rice consumption per capita[h] (kg/person/yr)		Projected consumption, paddy[h,d] (000 Mt)		Increase in consumption of paddy (000 Mt) 2005-15	Indicators of poverty, health, and malnutrition			
	Area[a] (000 ha) 2003-05	Rain-fed area[b] (%)	Yield[a] of paddy (t/ha) 2003-05	Production[a] of paddy (000 Mt) 2003-05	Import,[c,d] paddy (000 t) 2004	Export,[c,d] paddy (000 t) 2004	2005	2015	2005	2015	2005	2015		Poverty ratio[f] (%)	Calorie intake[a] (Kcal/person/day) 2002	Under-nourished population[g] (% of total) 2000	Underweight children under age 5[g] (%) 2000
Liberia	120	100	0.89	107	162	3	3.3	4.4	42	74	209	486	277	31.00	1,900	46	27
Madagascar	1222	60	2.42	2953	227	1	18.6	23.8	92	92	2572	3292	720	50.00	2,005	37	40
Mali	436	79	1.81	789	63	0	13.5	18.1	50	68	1012	1848	835	64.00	2,174	29	33
Mauritania	15	0	4.55	70	54	0	3.1	4.0	31	46	144	277	133	40.00	2,772	10	32
Mauritius	0	0	0.00	0	108	1	1.2	1.3	60	56	113	113	0	10.00	2,955	6	15
Mozambique	179	100	1.08	193	394	0	19.8	23.5	9	12	281	423	143	70.00	2,079	47	26
Nigeria	3646	85	0.96	3486	2097	0	131.5	160.9	26	30	5053	7242	2189	34.00	2,726	9	31
Senegal	84	55	2.53	212	1234	119	11.7	14.5	81	91	1424	1984	560	54.00	2,280	24	23
Sierra Leone	210	72	1.26	265	28	0	5.5	6.9	76	97	629	1005	376	68.00	1,936	50	27
South Africa	1	100	2.29	3	1117	20	47.4	47.9	14	18	1004	1312	308	50.00	2,956	...	12
Tanzania	353	95	1.90	670	273	4	38.3	45.6	17	18	953	1206	252	36.00	1,975	44	29
Togo	35	100	1.95	68	88	1	6.1	7.8	23	32	215	380	165	32.00	2,345	26	25
Uganda	90	100	1.44	130	91	11	28.8	41.9	5	8	228	488	260	35.00	2,410	19	23
Latin America	**5954**	**56**	**3.84**	**22894**	**3276**	**1414**	**435.8**	**490.4**	**31**	**32**	**20008**	**23360**	**3352**	**11.59**			
Bolivia	141	100	2.44	345	4	8	9.2	10.9	20	20	275	323	49	14.00	2,235	21	8
Brazil	3617	66	3.39	12251	1278	55	186.4	209.4	35	32	9917	10161	244	8.00	3,050	9	6
Colombia	501	30	5.23	2622	145	1	45.6	52.1	31	33	2114	2602	488	8.00	2,585	13	7
Costa Rica	51	0	4.35	220	162	7	4.3	5.0	63	80	411	595	183	18.00	2,876	4	...
Cuba	183	0	3.38	618	287	0	11.3	11.4	72	95	1209	1622	413	20.00	3,152	11	4
Dominican Republic	120	0	4.88	584	117	1	8.9	10.1	43	43	573	649	76	25.00	2,347	25	5
Ecuador	333	62	3.99	1328	1	3	13.2	15.1	51	56	1012	1280	268	18.00	2,754	4	14
Guyana	130	95	3.86	502	1	384	0.8	0.7	104	89	117	99	-18	35.00	2,692	9	14
Haiti	53	100	1.95	103	448	0	8.5	9.8	48	55	608	804	196	40.00	2,086	47	17
Mexico	46	0	4.19	192	689	3	107.0	119.1	6	8	980	1406	426	10.00	3,145	5	8
Nicaragua	84	100	3.06	256	8	2	5.5	6.6	36	36	297	359	62	45.00	2,298	27	10
Panama	136	100	2.36	321	16	0	3.2	3.8	34	26	163	147	-16	7.00	2,272	26	8
Peru	321	5	6.54	2101	121	0	28.0	32.2	53	65	2218	3144	926	18.00	2,571	13	7
Suriname	52	100	3.76	195	0	37	0.4	0.5	46	62	31	44	13	40.00	2,652	11	13
Uruguay	188	0	6.71	1258	0	914	3.5	3.7	16	22	83	124	41	21.00	2,828	4	...
Europe	**613**	**0**	**5.94**	**3638**	**3115**	**1991**	**587.2**	**546.3**	**5**	**7**	**4743**	**6010**	**1267**	**8.40**			
Armenia	0	0	0.00	0	20	0	3.0	3.0	2	10	8	45	37	50.00	2,268	34	3
France	19	0	5.68	108	711	175	60.5	62.3	5	6	473	603	130	6.00	3,654	...	...
Germany	0	0	0.00	0	446	89	82.7	82.5	5	7	597	837	240	0.00	3,496	...	...
Greece	24	0	7.11	168	27	58	58.1	11.2	9	11	142	192	50	0.00	3,721	...	...
Italy	223	0	6.37	1423	212	1003	58.1	57.8	6	7	516	575	59	0.00	3,671	...	...
Netherlands	0	0	0.00	0	313	106	16.3	16.8	6	6	141	143	2	0.00	3,362	...	...
Poland	0	0	0.00	0	151	5	38.5	38.1	2	3	132	187	55	18.00	3,375	...	...
Portugal	25	0	5.47	139	138	31	10.5	10.8	19	22	298	354	56	0.00	3,741	...	...
Russian Federation	131	0	3.59	471	682	5	143.2	136.7	5	6	988	1181	193	25.00	3,072	4	3
Spain	119	0	7.31	867	183	519	43.1	44.4	8	9	526	615	89	0.00	3,371	...	...
Turkey	72	0	6.45	462	230	1	73.2	82.6	8	10	922	1278	356	2.00	3,357	3	8
Ukraine	21	0	3.95	85	153	0	46.5	41.8	3	4	197	246	49	2.00	3,054	3	3
United Kingdom	0	0	0.00	0	854	90	59.7	61.4	3	5	279	443	164	17.00	3,412	...	2
Oth. dev. countries	**1358**	**0**	**7.59**	**10312**	**1356**	**4690**	**350.6**	**383.0**	**9**	**11**	**5026**	**6313**	**1287**	**0.00**			
Australia	54	0	8.77	474	134	87	20.2	22.3	12	17	349	576	227	0.00	3,054	...	...
Canada	0	0	0.00	0	501	3	32.3	35.1	12	10	371	505	134	0.00	3,589	...	2
USA	1304	0	7.55	9839	721	4600	298.2	325.7	10	11	4306	5232	926	0.00	3,744	...	1
World[k]	**151249**	**43**	**3.98**	**601440**	**32199**	**42501**	**5594.7**	**6166.8**	**63**	**63**	**531545**	**581629**	**50085**				

[a]FAOSTAT, FAO, 2006 (accessed 30 Jan 2006). [b]Estimated using data from World Rice Statistics and CORIFA of FAO. [c]Estimated by subtracting import data from export data using FAOSTAT data accessed 30 Jan 2006 and data from The Rice Report. [d]Used a conversion ratio of 1:1.5 to convert milled rice to paddy. [e]Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision, http://esa.un.org/unpp, 21 March 2005; 9:14:34 PM. [f]World Development Indicators 2004. [g]FAO, 2004. The State of Food Insecurity in the World. Rome:FAO. [h]Estimated by analyzing the trend from time series data for 1990-2002. [i].... Insignificant or data not available. [k]Figures for population and estimates of rice consumption are for countries listed.

Annex 2. Developing the strategic plan

In developing this strategic plan, IRRI took the opportunity to consult widely among its partners and stakeholders, and to seek expert guidance throughout. A staff task force was established to coordinate, facilitate, and implement the planning process.

There were six main activities:

1. A stakeholder survey conducted through the Internet and by email
2. An expert consultation
3. Staff workshops
4. Consultation with national agricultural research and extension system (NARES) leaders through the Council for Partnerships on Rice Research in Asia (CORRA) and consortium workshops
5. Farmer focus-group discussions in several countries
6. Input from the IRRI Board of Trustees

1. Stakeholder survey

In May 2005, IRRI launched an electronic survey targeting more than 1,500 scientists and administrators around the world, seeking their feedback on a wide range of issues concerning IRRI's current agenda, what should be carried forward, and what could be de-emphasized or even dropped. Guidance was also sought in terms of developing a stronger relationship with the private sector and the Institute's perspectives on moving back into Africa. In a special section of the survey, scientists and research leaders from IRRI's NARES partners were asked to comment on specific components of a rice research agenda, its importance for the national agenda, and how research should be carried forward—jointly, or with an IRRI lead or a NARES lead. There were over 230 responses and the findings of the survey were used in the next important planning element, the external expert consultation. A full report of the stakeholder survey is available at www.irri.org/stakeholder.

2. Expert consultation

An external panel of 25 experts in various fields from all over the world met at IRRI during 8-12 August 2005. The panel members spent their first two days developing their input for the planning process and then presented their thoughts to IRRI staff (including international and national senior staff) during a special session on the third day.

The panel provided authoritative advice and ideas and focused on four major areas in identifying new trends: science and technology, economic and political, environmental and ecological, and institutional. The panel members also stressed the need for IRRI to become more impact-focused, and to align a future research program with achieving the UN Millennium Development Goals. These topics were then the subject of round-table discussions facilitated by members of the panel and participated in by a cross section of the IRRI staff. After these discussions, IRRI staff further refined the ideas and trends to identify strategic areas to guide the Institute's agenda for the next 10–15 years. The panel members also provided incisive personal opinions and observations.

3. Staff workshops

Following the expert consultation, a group of 90 IRRI staff (international and senior national staff) held a 2-day workshop to assess the implications of the trends outlined by the external panel. Staff working groups also discussed the impact of IRRI's efforts in the past and tried to identify reasons why some projects achieved more than others. They also looked at IRRI's research in comparison with that of advanced research institutes and NARES and the implications of this research for the future. The output from these discussions was distilled, synthesized, and further refined. From this analysis, a number of potential strategic goals were formulated focusing on poverty in rainfed systems, environmental issues in intensive systems, and health and nutrition. It was clear that IRRI's future program must also become goal or target focused. Furthermore, it was clear from the comments of the external panel that a greater commitment to rice in Africa should feature in IRRI's future program.

The results of the expert consultation and staff workshop were studied and further considered during a special management retreat on 15-17 August 2005. During this time, some preliminary work was also done on the development of a business plan for implementing the strategic plan.

4. Consultation with NARES leaders through CORRA and consortium workshops

The membership of CORRA was consulted in a two-day meeting in September 2005. The following countries were represented at the meeting: Bangladesh, Cambodia, China, India, Indonesia, Japan, Korea, Laos, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam. Working groups reviewed the draft strategic goals and provided feedback. One important aspect was that, although understanding the need for IRRI to expand its program in Africa, CORRA members urged IRRI not to undertake any new activities there at the expense of its focus on and investment in rice research in Asia.

A later draft of the strategic plan was shared with participants at the Steering Committee meeting of the Consortium for Unfavorable Rice Environments (CURE) held in Bangladesh in March 2006. The focus of the draft was broadly endorsed by the CURE Steering Committee, which is made up of senior NARES personnel from the participating countries.

5. Farmer focus-group discussions

Given the time and financial limitations, it was not possible to interview thousands of farmers in Asia or bring a selected few farmers to IRRI. Thus, the focus-group discussion (FGD) format was used to solicit farmers' opinions of IRRI's new strategic plan and to reflect voices from the field. IRRI scientists conducted the FGDs in Bangladesh, India, Philippines, Thailand, and Vietnam with the help of NARES partners. FGDs were conducted in villages representing irrigated and rainfed growing provinces from December 2005 to February 2006. A more detailed report is available at www.irri.org/stakeholder.

6. The IRRI Board of Trustees

IRRI's Board of Trustees was involved at all stages of the development of the strategic plan. The Board approved the overall planning process at its April 2005 meeting. Two members participated in the external consultation in August 2005. Drafts of the plan were shared periodically with the whole Board, and a progress report was given to the Board at its meeting held in Bali, Indonesia, in September 2005. A Board subcommittee evaluated and approved in November 2005 the goals as formulated herein. Near-complete drafts were sent to the Board for their inputs in March 2006 prior to the Board's annual meeting in early April 2006. During that meeting, there was in-depth review and feedback on the draft and approval given for the draft strategic plan and outline of the business plan. The Board of Trustees Executive Committee made a final reading and gave enthusiastic approval of the strategic plan.

Rice Science for a Better World