

Rice
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World

Annual Report of the Director General, 2006-07

IRRI



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IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE
www.irri.org

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, Rockefeller Foundation, Food and Agriculture Organization of the United Nations, and agencies of the following countries: Australia, Brazil, Canada, Denmark, France, Germany, India, Iran, Japan, Malaysia, Norway, People's Republic of China, Republic of Korea, Republic of the Philippines, Sweden, Switzerland, Thailand, United Kingdom, United States, and Vietnam.

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Cover photo (by Gene Hettel): In the small village of Tatrav, a few kilometers northeast of Angkor Wat in Cambodia, Ms. Pao Ly, protector of some of the previous season's rice crop, prepares to distribute some of the precious grain to her neighbors. Tatrav is one of six target villages in this impoverished region of Siem Reap Province where a new project called PROVIDE (Poverty Reduction Options Validated in Drought Environments) is getting under way. This collaborative initiative of the Cambodian Agricultural Research and Development Institute (CARDI), the NGO Plan International, and IRRI aims to improve the livelihoods of Cambodian farmers through the application of drought management technologies.

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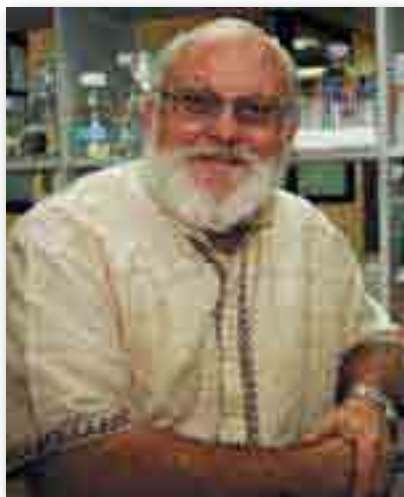
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An update from Robert Zeigler

DIRECTOR GENERAL



On 9 October 2006, I publicly unveiled IIRI's new Strategic Plan (2007-2015), *Bringing Hope, Improving Lives*, during the opening day of the International Rice Congress (IRC) in New Delhi. It was the culmination of a process that began 16 months earlier on 31 May 2005. I am pleased how this course of action has played out with the positive reactions to our Plan from the CGIAR Science Council in mid-2006 and its subsequent implementation on 1 January 2007.

The world has changed enormously since IIRI developed its last strategic plan a decade ago. Recent scientific discoveries—particularly in genetics and genomics—now open up new opportunities to achieve impact that would have been difficult if not impossible as recently as the turn of the century. A reduction in poverty and

sustainability of the rice production environment, through the use of modern technology and the latest communication tools, are at the heart of IIRI's exciting and innovative Plan.

Our new Plan maintains the Institute's traditional emphasis on food security—a vital strategy to be sure—but has for the first time put as its first goal reducing poverty among rice farmers and consumers. As I told the IRC gathering, "If the world is serious about achieving the first and most important of the UN's Millennium Development Goals (MDGs) on poverty, then we must focus on the livelihoods of poor rice farmers and consumers because together they make up almost half the world's population."

Our four other goals focus on environmental sustainability, health and nutrition, access to information and knowledge, and laying the foundation for the next generation to develop new and improved rice varieties. All of these are contributing both directly and indirectly to achieving the MDGs (see figure opposite page), not to mention having a close connection to the CGIAR system priority areas for research.

We have set these five new strategic goals by imagining a perfect world. We do not realistically believe that IIRI by itself can, for example, eliminate poverty and protect the environment. But, unless these are explicitly articulated as "goals," it is unlikely that our

efforts will make a meaningful impact on poverty and the environment.

As we tackle poverty issues as spelled out in our first goal, the equation must change to placing a new, major effort on improving farmers' income in unfavorable rainfed areas. Yields are very low in the extremely large rice-producing areas of South Asia and also the Greater Mekong Subregion (GMS) where rice is grown under rainfed conditions. This is precisely why IRRI has opened a GMS regional office based in Vientiane, Lao PDR, which I inaugurated on 12 January 2007. It will be a hub for coordinating research in Cambodia, Myanmar, Laos, Thailand, Vietnam, and two southern provinces of China. This is where many poor Asians live.

By focusing on poverty, we must invest relatively more resources and

establish a greater presence in these rainfed areas. And, if we look at the challenges, such as flooding and drought, that face farmers who grow rice in rainfed areas, they are very different from the challenges that face farmers who grow rice in intensive production systems. We should also keep in mind that rainfed rice accounts for 50% of the rice-growing area. So, by improving productivity in these locations, not only do we improve people's lives, we also contribute to food security.

In addition to our goals, IRRI has begun several ground-breaking scientific frontier projects that include efforts to develop rice varieties that would help poor farmers cope better with climate change and drought and to completely reconfigure what's known as

the engine of rice production, the plant's photosynthetic system. We are determined to continue to push the frontiers of plant science in an effort to improve the lives of poor rice farmers and consumers. And we invite all our partners around the world to join with us in achieving these vitally important goals. By doing so, we are confident we will ensure a brighter future for rice farmers and consumers everywhere.

As you can see in the balance of my update below, it's been a busy year of achievement and progress as we completed the research agenda of our past medium-term plan and set the mechanisms in place to begin our first medium-term plan of our exciting new agenda. The details of our Strategic Plan (2007-2015), *Bringing Hope, Improving Lives*, can be accessed online at www.irri.org/bringinghope/improvinglives.pdf and the targets of its first Medium-Term Plan (2007-09) can be found at www.irri.org/science/mtp/pdfs/MTP2007-09.pdf.

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

IRRI strategic goal	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

RESEARCH PROGRESS IN 2006

In 2006, IRRI completed work on 11 projects under four programs of the previous strategic plan—*Genetic resources conservation, evaluation, and gene discovery; Enhancing productivity and sustainability of favorable environments; Improving productivity and livelihood for fragile environments; and Strengthening linkages between research and development*. Much of the work continued to be guided by and implemented through two research consortia—the Irrigated Rice Research Consortium (IRRC) and the Consor-

tium for Unfavorable Rice Environments (CURE)—that bring together IRRI scientists and their colleagues from the national agricultural research and extension systems (NARES) of the Institute's partner countries.

Both the IRRC and CURE have important roles in our new strategic plan. This fact and the research progress and achievements in 2006 confirm the reality that our new strategic plan has truly been built on the strengths of the recent past. A summary of highlights begins on page 15 and the details begin on page 18.

FUNDING

On the financial front, I believe that IRRI's situation is balanced in a very tough environment. On the upside is the USAID decision not to cut its support to IRRI and funding increases from the UK's Department for International Development (DFID) and Germany. On the downside are the already announced cuts from Japan and the Netherlands. Of course, the inability of the World Bank and the European Commission to reach agreement on how funds should be handled has had serious negative impact on all CGIAR centers. I would like to emphasize that the Institute is no longer looking at only traditional donors. We are taking specific steps to interest new potential donors and we are looking at innovative ways to tap into the new spirit of philanthropy emerging in Asia.

A summary of financial support begins on page 61. Appendix 3, beginning on page 170, contains the audited financial statements for 2006.

BOT MEMBERSHIP CHANGES

IRRI welcomed three new members of the Board of Trustees for 2007-09. They are **Jillian Lenné**



(United Kingdom), **M. Syeduzzaman** (Bangladesh), and **Usha Barwale Zehr** (India). Dr.

Lenné is currently a consultant in agricultural research for development and visiting professor in agro-biodiversity, University of Greenwich, UK. Mr. Syeduzzaman is



currently chairman of several companies and institutions in Bangladesh. Dr. Zehr is the joint director of research at the Maharashtra



Hybrid Seeds Company Limited, India. We bade farewell to **Fazle Hasan Abed** of Bangladesh, who served on the BOT for two terms during 2001-06.



NEW FLOOD-TOLERANT RICE OFFERS RELIEF FOR WORLD'S POOREST FARMERS

A gene that enables rice to survive complete submergence has been identified by a team of researchers at IRRI led by PBGB head **David Mackill** (pictured at top right) and at the University of California's Davis and Riverside campuses. The discovery allows for the development of new rice varieties that can withstand flooding, thus overcoming one of agriculture's oldest challenges and offering relief to millions of poor rice farmers around the world.

Although rice thrives in standing water, like all crops it will die if completely submerged for more than a few days. The development and cultivation of the new varieties are expected to increase food security for 70 million of the world's poorest people, and may reduce yield losses from weeds



in countries such as the United States, where rice is seeded in flooded fields. Results of this study appear in a letter published in the 10 August issue of the prestigious journal *Nature*. I am pleased to say that this significant achievement, in addition to being published in *Nature*, was picked up heavily in the popular media, including *BBC*, *Bloomberg*, *Bangkok Post*, *Life Style Extra*, *SciDevNet*, *Voice of America*, *Sacramento Bee*, *Christian Science Monitor*, *FoodNavigator.Com*, *Truth About Trade and Technology*, *Toronto Star*, *Earthtimes*, U.S. Department of State, and *Yahoo News*.

MOU SIGNED FOR ESTABLISHING GMS OFFICE IN VIENTIANE

On 12 January 2007, the Lao Minister for Agriculture and Forestry **Sitaheng Rasphone** and I signed a memorandum of understanding for the establishment of





IRRI's office for the Greater Mekong Subregion (GMS) in Vientiane. The IRRI GMS office is being headed by **Gary Jahn**, IRRI's representative and coordinator for the GMS. This MOU gives full cognizance to the existing commitment of IRRI to rice research in the GMS. To this end, IRRI and the NARES of the six GMS nations (Cambodia, China, Lao PDR, Myanmar, Thailand, and Vietnam) will formulate an agreed strategy for rice research collaboration and technology transfer to improve food security, reduce poverty, improve livelihoods, and protect the environment of the GMS. Coordinating our research efforts in these six nations will increase the pace and quality of development as opportunities for synergy and mutual gain emerge.

ASEAN ENDORSES IMPORTANT RICE ACTIVITIES FOR SOUTHEAST ASIA

Rice production in Southeast Asia, arguably the region's most important industry, received a major boost with the endorsement of three new strategies by the agricultural ministers of the 10-nation Association of Southeast Asian Nations (ASEAN),

who met in Singapore on 16 November 2006. Implemented and coordinated by IRRI, the new measures are



aimed at three major challenges facing rice production in the ASEAN:

- *The environment.* ASEAN has endorsed the development of a series of environmental indicators for rice production in the region focused on production, biodiversity, pollution, land degradation, and water.
- *Getting the latest knowledge and information to rice farmers.* ASEAN has endorsed the further development of IRRI's Rice Knowledge Bank for rice farmers, Asia's first digital extension service in agriculture.
- *Developing the next generation of rice farmers and scientists.* Few young people in Asia today are interested in rice production, despite its obvious importance to the region, so ASEAN has endorsed the development of rice camps for young Asians to encourage them to consider a career in rice.

CLIMATE CHANGE AND RICE PLANNING WORKSHOP

On 20-24 March 2006, we conducted a Climate Change and Rice Planning Workshop to describe succinctly how climate affects rice. Coordinated by CESD senior scientist **John Sheehy**, the workshop, which included technical sessions, field visits (photo at top right), group discussions, and group presentations and syntheses, also summarized the contribution of rice to climate change and the current understanding of climate change research, with particular emphasis on crops. The end result of this landmark gathering of experts was the development, a couple of months later, of IRRI's Concept for Managing Rice and Rice Systems in a Changing Climate—the Rice Climate Change Consortium



(RCCC), which I have since been promoting to prospective donors. The findings of our RCCC meeting were documented in the highly influential *Stern Review on the Economics of Climate Change* (www.hm-treasury.gov.uk). In July, I had the opportunity to meet with **Sir Nicholas Stern** in the UK.

IRRI AND CIP ESTABLISH THE FIRST CGIAR ACCESS GRID LINK

On 7 April 2006, after successful previous testing, IRRI and CIP made some CGIAR history by becoming the first two CG centers to have a video conference using the Access Grid (AG). They were joined in the conference by the Advanced Science and Technology Institute (ASTI) at U.P. Diliman, Quezon City, IRRI's partner in using Access Grid technology (ASTI and IRRI are the only Access Grid nodes in the Philippines). The Access Grid is a technology for enabling multiple locations, even dozens, to participate simultaneously in a video conference. Thanks to perseverance, **Rolando Navarro** of CIP and **Lino Suarez** of IRRI's IT Services finally succeeded in establishing a working connection and the CGIAR entered a new era. **Paul O'Nolan** and other ITS staff were joined by **Graham McLaren** and **Thomas Metz** from the IRRI-CIMMYT Crop Research Informatics Laboratory (CRIL), who had been keenly awaiting this moment as the



technology will facilitate improved communication between IRRI and CIMMYT on a regular basis, a vital link for our Alliance. By December, such video conferences had indeed become commonplace as shown in the photo above, which depicts a trans-Pacific discussion between IRRI and CIMMYT staff during a workshop on *Assessing the potential of rice-maize systems in Asia*.

RDA SHIPS 25 TONS OF HIGH-QUALITY RICE SEED MULTIPLIED AT IRRI

As part of the “New Rice Revolution” campaign of the Rural Development Administration (RDA) in the Republic of Korea, 25 tons of high-quality rice seed were harvested at IRRI headquarters and then transported in a fleet of trucks to the Manila airport on 31 March 2006 (photo right). The precious cargo made its way to the National Institute of Crop Science (NICS), RDA in Korea, via an Asiana Aircargo flight on 2 April. Korea’s achievement in rice self-sufficiency through the Green Revolution of the 1970s was made possible through similar past memoranda of agreement between IRRI and RDA.

CSWS BECOMES CESD

It was a momentous occasion for Crop, Soil, and Water Sciences (CSWS) and entomology staff members on 5 June

as they celebrated their integration into the new Crop and Environmental Sciences Division (CESD). This was part of an OU repositioning tied to implementation of the strategic plan. This new division epitomizes the new strategic direction of IRRI—an integration of disciplines at a systems level with a strong focus on the

environment. I was very pleased to see the positive attitude of the staff in this merger, which will provide added strength to the growth of IRRI. CESD is composed of 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.

C₄ RICE WORKSHOP HELD IN JULY AT IRRI

Feeding Asia in the 21st century and preserving natural environments requires a second “Green Revolution.” This also requires increasing the efficiency of photosynthesis in crops such as rice (C₃ photosynthesis) to resemble that of more efficient crops such as maize (C₄ photosynthesis).

Boosting the photosynthetic efficiency of rice by changing it from C₃ to C₄ photosynthesis will be like adding a supercharger to a car’s engine. According to **John Sheehy**, organizer of a July workshop on *Supercharging the Rice Engine*, C₄ rice could be achieved



by exploiting the genetic resources of wild rice types as well as those of C₄ plants such as maize and employing genetic engineering. Until the advent of genetic engineering, the idea of boosting photosynthesis seemed to be an intractable problem. Now, I believe there are many reasons for being optimistic about finding a solution. This imaginative approach was featured in an article in the 9 December issue of *The Economist*.

TYPHOON MILENYO RAISES HAVOC AT IRRI AND IN SURROUNDING COMMUNITIES

Powerful and rain-laden Typhoon Milenyo (international name: Xangsane) made a direct hit on IRRI on 28 September 2006, with the eye passing over in the late morning.



While this storm did not pack the winds of Super Typhoon Rosing on 3 November 1995 (which many use as a benchmark of recent times), it carried much more rainfall,



which made it particularly destructive. Widespread flooding and many landslides occurred in and around IRRI in Laguna Province. Areas in Los Baños that had never experienced flooding in recent memory were inundated. Sadly, the flooding and landslides resulted in at least 20 deaths, many people injured, and more than 3,000 homes either partially or totally destroyed. In the neighboring town of Bay, 3 people were killed and 20 injured, with more than 16,000 homes affected. Fortunately, no one in the IRRI community was killed or seriously injured. However, many staff members in the local community had their homes badly damaged. At the height of the storm, IRRI's Emergency Brigade led a dramatic rescue of neighbors on the brink of drowning.

In the wake of the storm, IRRI extended the facilities of the International Rice Genebank to the National Plant Genetic Resources Laboratory (NPGRL) at the Institute of Plant Breeding, University of the Philippines Los Baños (IPB-UPLB), to temporarily store its medium-term germplasm collections of major Philippine agricultural crops after the typhoon damaged its genebank facilities. We are committed to doing

everything we can to help our local colleagues get through this difficult period. Genebanks are fundamental to a country's ability to feed itself and maintain its agricultural productivity.

With climate change certain to cause an increase in extreme weather events like typhoons, more than 20 of which swept across rice-producing Asia in 2006, IRRI, in a report sent to the Ministry of Foreign Affairs of Japan (MOFA), has urged that action is

needed now to protect the international rice industry.

2nd INTERNATIONAL RICE CONGRESS (IRC) IN NEW DELHI

As I have already mentioned, I used the occasion of the 2nd IRC to publicly unveil IRRI's new strategic plan. I congratulate the Indian Ministry of Agriculture and Indian Council for Agricultural Research (ICAR) for hosting and organizing this important event, which attracted nearly 1,400 rice researchers, traders, rice millers, farmers, and agriculture ministers (photo below right), including 400 delegates from 45 countries other than India. The Congress came at a crucial time for the international rice industry. In addition to major international debates on genetically modified rice and the future price of rice, the industry faces several common challenges—all of which we discussed during the IRC. I saluted Indian **Prime Minister**



Man Mohan Singh for his recent call for India to redouble its investments in scientific research and challenged the other great nations of Asia to step forward and commit to supporting rice research to meet the world's needs, much as Western nations did decades ago.

During the Congress, nine agriculture ministers representing China, Indonesia, Laos, Nepal, Pakistan, the Philippines, Sri Lanka, Vietnam, and India made a historic Delhi Declaration in which they stressed the fostering of cooperation among Asian countries to safeguard the environment and food and nutritional security. They agreed to "establish a comprehensive partnership through strengthened dialogue on a regular basis for strengthening rice research and development efforts laying greater emphasis on the social, cultural, and human dimensions, and that IRRI would host a task force comprising experts from all the countries and centers of excellence in the region to prepare a road map for that purpose."



FORMER STAFF MEMBERS PASS AWAY

Several past IRRI staff members, who had made a significant impact in their respective professions, have sadly passed away since my last update.

Te-Tzu (T.T.) Chang, 79, died of a heart attack in Taiwan on 24 March 2006. He was IRRI's principal geneticist for more than 30 years and head of



the International Rice Germplasm Center when he retired in 1991. He was considered a world authority on rice genetics and conservation. On 12-13 March 2007, IRRI held a 2-day symposium *The Application of Genetic Resources in Crop Improvement*, in Dr. Chang's memory attended by colleagues, family, and friends to coincide with the dedication of the Genetic Resources Center in his name.

A plaque now mounted at the entrance reads, in part: "Dedicated with respect and affection, to a true giant in the field of rice genetics and conservation. His research on the evolution and variation of rice led to major advances in plant breeding, productivity, and disease resistance, with a profound impact on agricultural productivity throughout much of Asia, Africa, and South America. His mobilization of international and multiagency resources in Asian and African nations resulted in enormous field collections of nearly 40,000 specimens, many on the verge

of extinction. This effort made IRRI's rice genebank holdings the largest collection in the world for a single crop plant. Desirable genes from this invaluable resource continue today to sustain advances in global rice production."

Henry "Hank" Beachell (photo right), a rice breeding pioneer, passed away at his home in Texas on 13 December 2006. Along with **T.T. Chang** and **Peter Jennings**, he was part of the research team behind the "miracle rice" IR8, which launched the Asian Green Revolution 40 years ago. Less than 3 months previously, Dr. Beachell had celebrated his 100th birthday on 21 September. After 32 years at the USDA, Dr. Beachell came to IRRI, where he joined the research team. In 1996, he and former IRRI principal plant breeder **Gurdev Khush** received the World Food Prize, known informally as the "Nobel Prize for Food and Agriculture." Hank's passing was a great loss not just for the world of rice research, but also for his many friends and colleagues all over the world, and especially in Asia. Giving us strength, however, is the wonderful legacy that he left behind.

Jerry Pat Crill, a former IRRI plant pathologist (1978-81), passed away on 17 January 2007 at his home on the Little Manatee River in Florida. Dr. Crill joined IRRI's plant pathology program, replacing **S.H. Ou**, in 1978, and headed the program for four years.



UPDATE ON IRRI STAFFING

In early January 2007, as the Institute began implementing the new MTP 2007-09, I announced appointments within the research management matrix. The seven research program



leaders are **David Mackill** for Program 1, *Raising productivity in rainfed environments: attacking the roots of poverty* (Dr. Mackill has stepped down as the PBGB division head); **Achim Dobermann** for Program 2, *Sustaining productivity in intensive rice-based systems: rice and the environment*, effective 1 September 2007 (**David Johnson** continues to serve as the interim program leader with full responsibility for the implementation of the program until the arrival of Dr. Dobermann); **Joseph Rickman** for Program 3, *East and southern Africa: rice for rural incomes and an affordable urban staple*; **Gerard Barry** for Program 4, *Rice and human health: overcoming the consequences of poverty*; **Hei Leung** for Program 5, *Rice genetic diversity and discovery: meeting the needs of future generations for rice genetic resources*; **Graham McLaren** for Program 6, *Information and communication: convening a global rice research community*; and **Sushil Pandey** for Program 7, *Rice policy support and impact assessment for rice research*.

Heads of the six research OUs are **Darshan Brar** for Plant Breeding, Genetics, and Biotechnology (PBGB); **To Phuc Tuong** for the Crop and Environmental Sciences Division (CESD); **Mahabub Hossain** for the Social Sciences Division; **Ruaraidh Sackville Hamilton** for the T.T. Chang Genetic Resources Center (GRC);

Melissa Fitzgerald for the Grain Quality, Nutrition, and Postharvest Center (GQNPC); **Graham McLaren** for the IRRI-CIMMYT Crop Research Informatics Laboratory (CRIL); and **Noel Magor** for the Training Center (TC). **Julian Lapitan** is the acting head of the International Programs Management Office (IPMO).

Achim Dobermann is also the project leader for the IRRI-CIMMYT Alliance Project on Intensive Production Systems in Asia (IPSA), effective 1 September 2007. Dr. Dobermann is serving as a consultant from 1 January to 31 to August 2007 to provide assistance and advice to the interim project leader, **Roland Buresh**.

The program leaders are responsible for the development and delivery of the research outputs to achieve the goals of our strategic plan and are appointed for a renewable 5-year term. The division and center (organizational unit) heads are responsible for providing research infrastructure and a home base for the scientists contributing to the programs and the quality of research. The division heads are appointed to a 3-year term and can be renewed. Upon completion of this appointment, they can be assigned to be full-time scientists or to other responsibilities at IRRI.

In February 2007, **Xiaochun Lu**, postdoctoral fellow in CESD, was transferred to PBGB.

Departures and arrivals since the last DG report. Attorney **Walfrido E. Gloria** (photo) retired on



8 February 2007 after faithfully serving the Institute for 23 years. He was head, Human Resources Development (1984-91); secretary, Board of Trustees (in a concurrent capacity, 1996-2000); and senior legal counsel, Legal Services (1992-2007). Just before his departure, I recognized him for his wise and timely counsel, advice, and guidance, not only on what was legal but, more importantly, on what was right.

Also departing were **Gary Atlin**, senior scientist, plant breeding (2000-06); **Vethaiya Balasubramanian**, soil scientist and team leader, Madagascar Project (1991-94); agronomist and coordinator, Crop and Resource Management Network (1994-2000); agronomist, Training and Technology Delivery and Impact (2000-05); and IRRI coordinator for Africa (2005-06); **Jingsheng Zheng**, postdoctoral fellow (2004-06); **Paul O’Nolan**, ITS head (1999-2006); and **Monina Escalada**, international research fellow—communications specialist, IPMO (2002-06).

Arrivals in 2006-07 were SSD international research fellow **Zahirul Islam**; SSD agricultural economist **Kei Kajisa**; CESD international research fellow **Jill Cairns**; head of Operations

Management **Terry Jacobsen**; Training Center head **Noel Magor**; FoSHol project team leader and IRRI representative in Bangladesh **M. Zainul Abedin**; PBGB postdoctoral fellow **Hao Chen**; PBGB project scientist **Daisuke Fujita**; PBGB postdoctoral fellow **Minu Joseph**; PBGB postdoctoral fellow **Susanna Polleti**; PBGB senior scientist and INGER coordinator **Edilberto Redoña**; CESD coordinator of the Rice and Climate Change Consortium

Reiner Wassmann; CESD international research fellow **Elizabeth Humphreys**; PBGB postdoctoral fellow **Dule Zhao**; CESD postdoctoral fellow **Bhagirath Singh Chauhan**; PBGB postdoctoral fellow **Joong-Hyuon Chin**; HRS head **Hector Hernandez**; PBGB scientist **Arvind Kumar**; CRIL postdoctoral fellow **Ramil Mauleon**; ITS head **Marco van den Berg**; and part-time IRRI liaison scientist for China **Zhao Ming**.

AWARDS AND HONORS

On 9 October 2006, the plenary session of the 2nd International Rice Congress featured the presentation of the **M.S. Swaminathan Award for Leadership in Agriculture** to former IRRI principal plant breeder **Gurdev Khush**. Sponsored by the Trust for Advancement of Agricultural Sciences, the award cited Dr. Khush for his excellent leadership for global rice improvement that has benefited millions of resource-poor rice growers around the world. In the photo, **Prime Minister Man Mohan Singh** presents the award to Dr. Khush, with Dr. Swaminathan and me looking on.



CIO Asia, the magazine for information executives, officially recognized IRRI as one of Asia’s top strategic users of IT. For having achieved excellence in strategic IT

deployment, IRRI was named a CIO 100 Honoree for 2006 and was placed on *CIO Asia's* annual index of Asia's top-performing enterprise users of IT. A certificate signifying this was presented to **Paul O'Nolan**, ITS head. In a letter to Mr. O'Nolan, **Gerald Wee**, executive editor of *CIO Asia*, stated, "The CIO 100 are the crème de la crème of organizations across the region that have used IT strategically to deliver innovations, strategic value, and high dollar returns to their businesses, industries, sectors, and societies. They are exemplars of IT deployment excellence, and role models for their counterparts and competitors in the region."

On 8 April 2006, during an NRS awards ceremony at the conclusion of the BOT meeting, I presented **Floren-cia "Flor" Palis**, postdoctoral fellow in EPPD, and the **IRRI Emergency Brigade** with, respectively, the Director General's Award for Outstanding Scientific Achievement and the IRRI Award for Outstanding Support of IRRI's Mission. Dr. Palis, an anthropologist and a widely published author of research publications, was chosen for her independent ethnographic research that encompassed many community settings and IRRI projects, including her research for the advancement of knowledge. The IRRI Emergency Brigade, a group of 63 volunteer firefighters from various organizational units, was chosen for unselfish devotion of their personal time to protecting the interests and property of the Institute.

In May, **David Mackill**, head of PBGB, was named 2006 Honorary Fellow of the Crop Science Society of the Philippines for his contributions to the rice varietal improvement programs in the Philippines and other rice-growing countries.

Adam Barclay, international research fellow in CPS and *Rice Today* managing editor, won a Gold Award (1st

place) in the Writing for Magazines Category for the article *Dreams beyond drought*, which appeared in the September 2005 issue of *Rice Today*, from the Association for Communication Excellence in June. Later, in December, the CGIAR Secretariat announced that Mr. Barclay had been awarded 1st Prize in the 2006 CGIAR Photo Competition for his image *Direct success*, at below right.

National Scientist, eminent sociologist, and IRRI consultant **Gelia T. Castillo** was conferred with a Doctor of Science (Rural Sociology), honoris causa, by the De La Salle University (DLSU) in Manila on 17 June. DLSU recognized Dr. Castillo's "outstanding contributions as a rural sociologist, and her being the first social scientist to raise the level of research as a tool for development studies."

On 23 August, **Roland Buresh**, senior scientist, soil science, CESD, was presented with a merit medal by the Ministry of Agriculture and Rural Development (MARD) in a ceremony in Hanoi. He was recognized for his long-term efforts in the support of Vietnamese agriculture and rural development.

In recognition of their contributions to the revival of rice research and development in the country, Prime Minister Hun Sen presented the Royal Government of Cambodia's Sahametrei

Medal (below) to 11 individuals, including former IRRI directors general



M.S. Swaminathan and **Ronald Cantrell**. Dr.

Swaminathan was one of the driving forces in the inception of the Cambodian Agricultural Research and Development Institute (CARDI) when, back in 1987, he proposed establishing the project design team to prepare a plan to set up CARDI. Dr. Cantrell, who was IRRI DG in 2000 when CARDI officially opened, was instrumental in strengthening IRRI's partnership with the fledgling institution.

IRRI BOT member **Ronald L. Phillips** of the University of Minnesota shared the 2006-07 Wolf Prize for Agriculture for his "groundbreaking discoveries in genetics and genomics, laying the foundations for improvements in crop and livestock breeding, and sparking important advances in plant and animal sciences."

During the CGIAR-AGM in Washington, D.C., in December, the CGIAR genebank community received the CG's Science Award for Outstanding Partnership. The Genebank community, which includes **IRRI's T.T. Chang Genetic Resources Center (GRC)** led by **Ruaraidh Sackville Hamil-**



ton, involves 11 CGIAR centers that collectively hold the world's largest collection of agrobiodiversity. The CGIAR genebanks hold plant genetic resources in trust for the world community. The genebanks, which safeguard 600,000 accessions of crop, forest, and agroforestry species—the majority of which are stored as seeds—provide an insurance policy of sorts, underwriting food security and preserving genetic diversity well into the future. IRRI's GRC currently holds nearly 110,000 rice accessions.

As in every year, numerous IRS and NRS received various awards and honors. See the complete listing beginning on page 76.

OTHER NOTABLE ACTIVITIES AND EVENTS SINCE MY LAST UPDATE (MARCH 2006)

IRRN celebrates 30th anniversary. Originally named the *International Rice Research Newsletter (IRRN)*, the first issue in October 1976 men-

tioned the need for a mechanism that would facilitate communication among scientists working on rice. Three decades later, that important role remains, as the *International*

Rice Research Notes continues to fill a special niche in rice science publishing. The 30th anniversary observation included an *IRRN* Best Article competition in which manuscripts submitted were evaluated according to a set of criteria (scientific content, originality, relevance, and organization). I presented individual winners (one winner from each of the six discipline sections of *IRRN*) with a plaque and a \$500 cash prize during the 26th International Rice Research Conference, 9-13 October in New Delhi, India.

Chinese minister of agriculture visits IRRI. The minister of agriculture from the People's Republic of China, Hon. **Qinglin Du**, made an official visit to IRRI on 26 March 2006. It was the first-ever visit to IRRI by China's minister of agriculture. During his stay, DDG-R **Ren Wang** gave Minister Du an overview of IRRI's research agenda.

Seasonal flu vaccination administered to IRRI staff. During the week of 17-21 April 2006, almost 2,000 staff and dependents received the seasonal flu vaccination (photo above right) as part of the Institute's program to be prepared for pandemic flu, which still poses a threat worldwide.

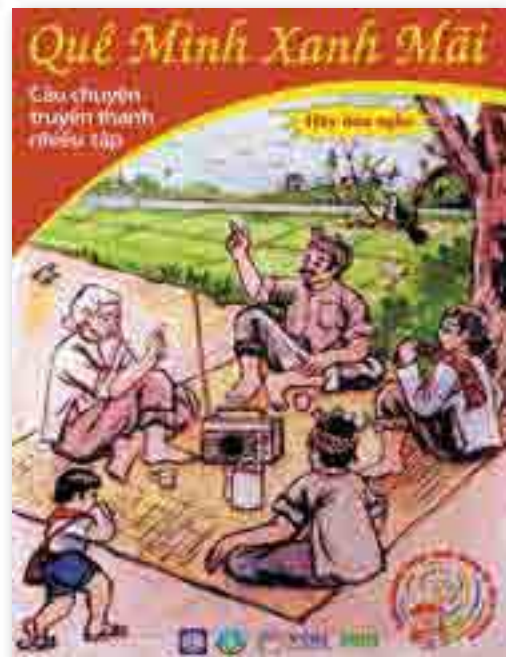
CPWF Project 7 (DPPC 2003-21) holds annual review and planning meeting. During the 2nd Annual Review and Planning Meeting of the project "Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong, and Nile river basins," funded by the Challenge Program on Water and Food (CPWF), 25-27 April in Karnal, India, international scientists discussed ongoing research efforts and future plans to assist farming communities near the Indo-Gangetic, Mekong, and Nile river basins. IRRI and its partners from Bangladesh, India, Vietnam, and Iran jointly tackled problems faced by thousands of farmers in areas that have high salt content resulting in low land and water productivity and predominance of poverty.

Rice campers graduate with better appreciation for rice. After working hard in the rice fields, listening to various lectures, and participating in fun-filled learning activities, 19 students from Thailand and the Philippines graduated from the rice camp hosted by IRRI, 24-28 April. Among the many high points during a very successful



week were TV reports on the rice camp produced by Reuters Television, which were sent all over Asia and especially to Thailand, and by the BBC, which broadcast a 3-minute feature worldwide. But perhaps the most remarkable outcome was that immediately upon their return to Thailand, the Thai students walked straight into a press conference at Bangkok International Airport that included several Thai TV stations wanting to report on their IRRI adventure.

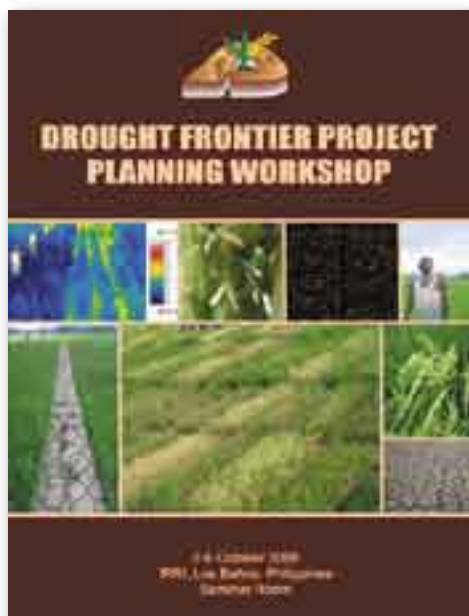
Launch of radio soap opera. IRRI, in collaboration with the Ministry of Agriculture and Rural Development (MARD) of Vietnam and the World Bank, formally launched the Environmental Radio Soap Opera for Rural Vietnam (promotional poster below)



and announced an environmental initiative in conjunction with ASEAN. I announced both of these projects on 2 June, which was World Environment Day, at MARD's headquarters in Hanoi.

Vietnam adopts "Three Reductions, Three Gains" as national policy. Also in June, the Vietnamese government endorsed "Three Reductions, Three Gains" (locally called "Ba Giam, Ba Tang"), initiated as an IRRI project in 2002, as a national agricultural policy. This was communicated in a letter from the minister of agriculture and rural development, **Dr. Cao Duc Phat**, who instructed the agricultural sector to disseminate the system of technology and knowledge throughout the country. With government endorsement and financial support, "Three Reductions" practices now have the potential of reaching all rice farmers in Vietnam. I believe this project represents a clear example of how research is directly linked to policy adoption and the importance of understanding farmer decisions and using a multistakeholder process in building quality partnerships.

Drought Frontier Project Planning Workshop. A planning workshop on the Drought Frontier Project was held at IRRI on 2-4 October to assess the current status and future challenges facing rice cultivation in drought-prone environments; review the recent progress, breakthroughs, and potential impact of drought research in rice and other tropical crops; identify priority research areas and state-of-the-art methodologies and approaches to address drought challenges; and establish a research consortium and an integrated research strategy on drought resistance in rice. Drought is the major constraint to rice production in rainfed areas across Asia and sub-Saharan



Africa, with at least 23 million ha (20% of rice area) potentially affected in Asia alone. Frequent droughts result in enormous economic losses and have long-term destabilizing socioeconomic effects on resource-poor farmers and communities.

CPWF Project 11 (DPCC 2003-23) organizes training workshop. As part of the CPWF project "Rice landscape management in upper catchments," Chiang Mai University, the World Agro-Forestry Center, and IRRI's Social Sciences Division organized a training workshop on "Upland-lowland interactions and approaches to participatory land-use mapping" in Chiang Mai, 23-25 January 2007. The workshop helped develop analytical capacity of the project members from Laos and Vietnam to apply various tools to study land-use changes at the landscape level.

Events, Visitors, and Information Services. One of the Institute's

most important nonresearch activities is organizing and holding events such as seminars, workshops, symposia, and conferences. For several years, the conveners of these events at IRRI have largely worked alone with their own small organizational teams. After careful consideration and considerable discussion, management decided to centralize the coordination and overall organization and management of these events at IRRI in Visitors and Information Services (VIS) starting 24 January 2007, when VIS was renamed Events, Visitors, and Information Services (EVIS).

Ambassadors visit IRRI. Eight ambassadors to the Philippines visited IRRI since my last update. IRRI staff and I enjoyed giving them all an overview of IRRI's work and we were impressed with their keen interest in rice. They were **Muhammad Naeem Khan**, Islamic Republic of Pakistan (9 May 2006); **W.M. Senevirathna**, Democratic Socialist Republic of Sri Lanka (6 June 2006); **Peter Beckingham**, United Kingdom of Great Britain and Northern Ireland (26 September 2006); **Manuel Perez Iturbe** (in photo below with DDG-OSS **William Padolina**), charge d'affaires, Bolivar-





ian Republic of Venezuela (2 February 2007); **Gérard Chesnel**, Republic of France (19 February 2007); **Annika Markovic**, Sweden (21 February 2007); **George Rey Jimenez**, Republic of Cuba (5 March 2007); and **Stale Torstein Risa**, Norway (20 March 2007).

IRRI Books for Africa and Asia. With the imminent closing down of the CPS book storage facility in Chandler Hall, about 38,450 IRRI books (with a retail value of more than US\$384,000) were shipped via sea freight in February and March 2007. Soon, these books will be arriving at IRRI's East and Southern Africa Region office in Mozambique, WARDA's office in Nigeria (where IRRI rice breeder Glenn Gregorio [shown making book selections in photo above] is currently based), and IRRI's 11 country offices in Asia. They will be redistributed to needy NARES libraries across these regions. New IRRI policies on publication press runs and printing on demand negate the future need for a book storage warehouse.

A KEYNOTE ON CLIMATE CHANGE

closed out 2006 with a keynote speech on climate change during the Annual General Meeting of the CGIAR in Washington, D.C.

We here at IRRI had been thinking about how to tackle this urgent challenge throughout the year as shown by our Climate Change and Rice Planning Workshop in March and our subsequent creation of the Rice Climate Change Consortium (RCCC) with the hiring of **Reiner Wassmann** to coordinate it. In my presentation on *Climate change and agriculture in the tropics and subtropics: preparing for the worst with a winning approach*, I pointed out that poor countries are overwhelmingly dependent on natural resources, and, given their limited financial or institutional ability to adapt to profound



change, they are severely at risk. Helping poor farmers adapt to climate change will require a concerted international effort to improve crops, techniques of cultivation, and soil and water management. I think I struck the right chord with the CGIAR audience and I am confident the CG centers will work together in a collaborative spirit to come up with solutions to meet this threat, whether agriculture starts feeling the heat next year or a decade from now.

BREAKING BREAD WITH STAFF

In December 2005, I initiated what became a monthly practice (or as near to this that my schedule would permit) of having an early-morning breakfast with a cross section of nationally recruited staff (NRS). I believe that it is very important for me, as director general, to get to know the staff, find out about their work, and talk with them about their jobs, IRRI, and special concerns.

Since my last report, I have had eight more of these breakfasts with 179 NRS in total. I have come to look forward to these informal bread-breaking sessions in this relaxed and cordial atmosphere. I have found interacting directly with the staff from the many different sectors of the Institute to be enjoyable, interesting, and instructive. These breakfasts have reinforced one more thing that I already knew, that IRRI staff members are truly interested in the Institute community and genuinely want to make it a better place for themselves and colleagues.

During the last quarter of 2006, I was very proud of the response of the IRRI community to pitch in and try to help as best it could those who were hit with some terrible losses due to several typhoons that ravaged the region. This generosity from people who suffered even more is something that I carry within me as I contemplate what it means to be a member of this exceptional community. It truly hit home as Crissan, my daughters, and I posed with more than 700 of the staff in a giant



family portrait taken during the Institute's Christmas party on 15 December 2006.

With such an involved, industrious, and conscientious staff, I am confident that we can do pretty much what we set our minds to—including meeting the challenges that we have set for ourselves in our strategic plan. It is without a doubt, in my mind, that we will achieve

our goal of “bringing hope and improving lives” throughout the world.

Robert S. Zeigler
Robert S. Zeigler
Director General





Program highlights 2006

Using contents of the genetic vault

At the end of 2006, the International Rice Genebank (IRG) held 108,955 accessions, and total distribution of germplasm reached a record high of nearly 95,000 seed packets for the year.

A historic agreement, signed on 16 October 2006 between IRRI and the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture, required IRRI to change its procedures for germplasm exchange by 14 January 2007, in particular to conform to the requirements of a new Standard Material Transfer Agreement. IRRI was the only international agricultural research

center able to immediately comply with the Treaty by the deadline and therefore to continue germplasm exchange without interruption. IRRI's system has been demonstrated at international meetings as a model for others to follow.

Two key outputs supported the genetic resource systems of IRRI's national partners. First, the establishment in 2006 (to be completed in 2007) of a rice biodiversity network provides a mechanism for global rationalization of efforts to conserve rice genetic resources and will enhance germplasm conservation and use around the world. Second, the improvement of the Lao PDR rice genebank will improve conservation and use of Lao germplasm. Samples of all remaining

Lao accessions conserved in IRRI were restored to the Lao genebank for duplicate conservation there.

In 2006, IRRI developed and verified a novel high-throughput technique for genetic fingerprinting, which will allow tens of thousands of IRG samples to be characterized. This knowledge will facilitate the identification of important genes and allow better use of conserved germplasm samples for breeding and research.

TILLING (Targeting Induced Local Lesions IN Genomes) is now an established part of the research tool kit for finding variation in potential drought-tolerance genes in the IRG. Researchers have characterized 10 candidate genes for drought tolerance in 1,536 accessions of cultivated rice (*Oryza sativa*), five candidate genes in 190 accessions of African species *O. glaberrima*, and five candidate genes in 152 accessions of wild rice species.

Recessive mutations for resistance to rice tungro disease and the rice pest brown planthopper (BPH) were mapped to regions on rice chromosomes 4 and 6, respectively. Several candidate genes for each were identified. These results boost researchers' chances of successful marker-assisted selection when breeding for resistance to both tungro and BPH. Genetically tagged germplasm for resistance to tungro, which can devastate crops, is rare and badly needed for controlling the disease.

Improving rice production

In 2006, we developed 10 promising lines with a 15–20% yield advantage over check varieties and that possess improved grain quality and multiple resistance to diseases and insects. Two IRRI-bred superior rice lines were recommended for release in the Philippines as national rice varieties for commercial cultivation by rice farmers. These varieties out-yielded the most popular check varieties by an average of 7.4% and 14.2%. Four hybrid rice varieties were identified with yield (more than 8.3 tons per hectare in the dry-season trial) higher than that of popular commercial hybrid Mestizo 3, and a yield advantage of more than 15% over the inbred check.

Using wide crosses (crossing modern rice varieties with their wild relatives), IRRI researchers developed elite breeding lines resistant to BPH, bacterial blight, blast, and tungro. We developed five breeding lines possessing the BPH resistance gene *Bph18* in the genetic background of two high-yielding BPH-susceptible japonica cultivars, Jinbubyeo and Junambyeo. These lines conferred strong resistance to BPH biotypes of Korea and China. We also developed transgenic lines resistant to stem borer and bacterial blight.

National agricultural research and extension system (NARES) breeders from 20 countries used breeding lines from International Network for the Genetic Evaluation of Rice nurseries (758 breeding lines used as parents in hybridization, 879 used in further yield evaluation, 242 screened for resistance to insect pests and diseases and evaluated for salinity and cold tolerance, and 600 conserved in genebanks).

In Uttar Pradesh, India, a study of the rice-wheat cropping system has shown that, using a no-till system for both crops, water use can be cut by 35–40% while maintaining productivity similar to that of the more commonly used transplanting of rice followed by dry-tilled direct-sown wheat.

We determined shifts in weed species resulting from the change from transplanting to direct seeding in India and Bangladesh. This information is helping to define management strategies to respond to undesirable shifts in weed populations. Weed management options for direct-seeded rice have been tested in farmers' fields in the Indo-Gangetic Plains in more than 100 farmer field trials over a total of 975 hectares. Direct-seeding options gave yields similar to those of transplanting.

In Indonesia, Cambodia, Lao PDR, Vietnam, and Myanmar, postharvest management practices, improved storage technologies, market information, and quality-enhancing production technologies for reduced losses and improved quality were made available for wide-scale delivery.

New tools were developed and implemented in rice quality evaluation. Protocols for chalkiness—a major problem in the grain quality of hybrid rice—continue to be refined. Such improved methodology for assessing grain quality will boost efforts to improve hybrid grain quality.

Easing scourges of flooding and drought

One major IRRI success in 2006 was the transfer of submergence tolerance to three major rice varieties. Using marker-assisted selection, the *Sub1* gene was bred into popular varieties Swarna, Samba Mahsuri, and IR64. When these varieties possess *Sub1*, they yield up to three times more than they do without *Sub1* after 10–14 days of submergence. Seed was sent to NARES in Bangladesh, India, Indonesia, Lao PDR, and Myanmar, and promises greater productivity and more secure livelihoods in areas subject to flash flooding.

With six NARES partners, IRRI tested elite salt-tolerant lines at nine locations in Bangladesh, Egypt, India, Iran, and Vietnam, allowing the identification of better adapted and stable salt-tolerant lines for coastal and inland salinity. Researchers developed and validated genetic markers associated with the *Saltol* gene, which confers salt tolerance to rice. The

gene was fine-mapped and about 30 gene-specific markers were identified in the *Saltol* region.

IRRI researchers identified drought sensitivity at flowering in 10 major Asian varieties. This offers improved efficiency in breeding for enhanced drought tolerance at flowering in popular varieties. Short-duration lines and hybrids were identified with yield at least 50% higher than that of popular high-yielding variety IR64 under severe reproductive-stage drought stress. These were distributed for adaptive testing and use as parents by NARES breeders in drought-prone areas.

A research monograph was compiled to improve understanding of drought-coping mechanisms of rice farmers. Published by IRRI in early 2007, the monograph shows the increased relevance of technology and policy for drought mitigation. The incidence and severity of poverty increase during drought years as people “fall back” into poverty and those who are already below the poverty line fall deeper into poverty.

We developed new approaches for site-specific crop and natural resource management for rice-based drought-prone rainfed lowlands. One significant achievement was the basic outline of a novel framework for nutrient management in this environment, which promotes flexible site- and system-specific options over uniform recommendations.

Participatory varietal selection enabled farmers to evaluate promising lines tolerant of drought, submergence, sodicity, and salinity, and resistant to blast in target rainfed environments. We conducted 200 farmer participatory trials in the rice-wheat system of the Indo-Gangetic Plains of Nepal and eastern India and evaluated integrated crop and resource management practices—such as land leveling, tillage and crop establishment, nutrient management, and pest management—that enhance crop performance, resource-use efficiency, and farmers’ income. The trials showed that the management strategies increased both yield and farmers’ benefit-cost ratio.

Reducing pesticide use and stabilizing soil quality

The major recommendation from the Livelihood Improvement Through Ecology project in Bangladesh was that insecticides (as currently used by farmers) should not be applied, regardless of the type of crop in the neighboring field. Farmers spending the highest amounts on insecticides were not gaining any benefit and therefore had reduced profits.

In Vietnam, 135 episodes of the “IPM soap opera”—with storylines designed to educate farmers on the best integrated pest management (IPM) practices for reducing pesticides—were developed and broadcast over three radio stations. In

Vinh Long, the series contributed toward a 30% reduction in insecticide sprays. In Lao PDR, 104 episodes were developed and broadcast over National Lao Radio.

New approaches to stabilize soil quality and increase the productivity of rice-based uplands were developed. We investigated the use of biochar—incompletely burned organic matter such as charcoal, which is incorporated into soils—from rice residues for soil improvement in rice-based systems. Biochar is easily produced from rice residues and improves crop productivity on poor soils.

Spreading the knowledge

Research on gender roles showed that persisting indifference to rural women’s contribution to agriculture (especially to rice production) and the constraints to women’s access to productive resources are impeding the achievement of food security goals. The knowledge gained from these studies facilitates the development of policies and research strategies that provide men and women with equal access to technical knowledge, skills, and opportunities to enable their families to improve income and reduce drudgery for female rice farmers.

Leaf color chart (LCC) use to manage nitrogen fertilizer applications in Nadia District of the Indian state of West Bengal has led to an average savings of 900 rupees (US\$20) per hectare (11.2% of the average profit) and the environmental benefit from reduced nitrogen and insecticide use has been considerable. LCC adopters reduced nitrogen application by about 19% (25 kg per hectare) and insecticide sprays by 50% without affecting yields.

Hands-on postharvest management and grain quality training was conducted in Indonesia, Lao PDR, Myanmar, Vietnam, and Cambodia. Laser-leveling training was conducted in Myanmar and private-sector contractors were taught how to provide laser-leveling services to farmers.

Over 100 researchers and extension agents from Cambodia, China, Laos, Myanmar, and Vietnam were trained on the use of IRRI’s Rice Knowledge Bank (www.knowledgebank.irri.org). Around 40 researchers from Bangladesh, Burundi, Indonesia, Iran, Japan, Myanmar, Nepal, the Philippines, Sri Lanka, and Vietnam received training on statistics and experimental design at IRRI headquarters. Around 100 researchers and extension workers received training on site-specific nutrient management. Twenty-seven researchers and extension agents from Bangladesh, Cambodia, India, Indonesia, Lao PDR, Nepal, the Philippines, Thailand, and Vietnam were trained on participatory approaches to research and extension, also at IRRI headquarters.

Read about IRRI’s 2006 research achievements in more detail in the next section, pages 18-60.



Program 1

Genetic resources conservation, evaluation, and gene discovery

IRRI's work to collect, conserve, document, and exchange germplasm (plant seeds and tissues) is covered by Program 1. This work encompasses the crucial tasks of conserving and sustaining biodiversity. Further, through this program, IRRI aims to make public and freely available the knowledge

generated from these genetic resources, which includes an understanding of the biological functions encoded in the rice genes. Beneficiaries of this information are the international research community, national research and extension agencies, and any other interested party whose goal is improving rice

productivity and production, and reducing poverty for poor rice producers and consumers.

As well as possessing an excellent capacity to produce genetic resources, IRRI is a leader in the identification of important rice traits. This expertise is combined with an extensive collaborative research network that evaluates the behavior of newly found traits in diverse environments and under a range of biotic stresses (such as pests and diseases) and abiotic stresses (such as drought and problem soils). IRRI occupies a key position as a center for

collaboration among and between both developed and developing countries. As such, the Institute is in a unique position to undertake this program's important information generation and dissemination tasks on behalf of publicly funded rice researchers and the poor rice farmers and consumers they serve.

Program 1 comprises two projects. One deals with all aspects of maintaining the germplasm and the other seeks to understand the functioning of the rice genome.



PROJECT 1

Germplasm conservation, characterization, documentation, and exchange

Since its foundation almost 50 years ago, IRRI has led international efforts to collect and conserve the genetic resources of rice. The world's largest rice germplasm collection is held in trust in the International Rice Genebank at IRRI (along with a collection of biofertilizer germplasm, including Azolla, blue-green algae, and nitrogen-fixing bacteria). Plant breeders and researchers worldwide use these genetic resources to develop new rice varieties, which are also freely available to any interested party—including farmers. The germplasm held in the genebank has also allowed the re-establishment of traditional rice varieties thought lost and even the restoration of an entire rice industry—such as in the case of Cambodia, where agriculture was devastated after years of warfare and civil strife. Effective use of germplasm requires characterization (Output 1),



evaluation (Output 2), and access to information (Output 3).

Output 1: Rice and biofertilizer genetic resources conserved and characterized

In 2006, IRRI developed and verified a novel high-throughput technique for genetic fingerprinting, which will ultimately allow tens of thousands of accessions to be characterized. The molecular characterization of the International Rice Genebank (IRG) mini-core collection of 1,536 accessions was partly completed, and will continue in 2007. The Generation Challenge Program (GCP) composite rice collection of 2,757 lines was also genotyped and the population structure determined. This knowledge will facilitate the identification of important genes by the application of association genetics, and hence will allow better use of conserved germplasm accessions for breeding and research.

The Institute's Grain Quality, Nutrition, and Postharvest Center characterized rice cooking quality in the mini-core collection (comprising cultivated and traditional varieties, and wild rice species) referred to above, which included representatives of each germplasm class of rice. We also characterized grain quality in 50 varieties of black rice. Specifically, the 1,536 mini-core accessions were characterized for amylose content, gelatinization temperature, a simple sequence repeat (SSR) marker located on an amylose gene, and a single nucleotide polymorphism on the *starch synthase IIa* gene (which contributes to gelatinization temperature). The black rice varieties were tested for all possible traits of physical, chemical, and nutritional quality, and for trait-specific and other SSR loci. We found that the mini-core samples were not diverse geographically or in terms of cooking quality. They were heavily skewed toward high amylose and high gelatinization temperature. We found evidence for an

additional gelatinization-temperature haplotype, but more research is needed to confirm this. If there is another, this means that there are now five known haplotypes—linked genetic loci—that define gelatinization temperature. We also found two polymorphisms in the amylose gene and rare combinations of genes not found in domesticated rice that confer broader-than-usual quality traits (the range of gelatinization temperatures, for example, was 51–85 degrees Celsius versus the usual 60–75 degrees Celsius seen in most domesticated rice varieties). Starch structure in some accessions indicates the starch was synthesized by a combination of genes not usually found. This work offers a better understanding and better documentation of characteristics of the rice held in the genebank. It also gives breeders insight into quality traits for breeding and will help them add new traits to domesticated rice.

To better use and conserve wild relatives, we authenticated the taxonomic identification of 50% of the accessions of wild *Oryza* species held in the IRG. The newly obtained molecular, morphological, chromosomal, and biosystematic data have significantly improved the overall classification of wild rice.

General IRG maintenance continued, with all incoming samples processed, subsamples of all accessions placed in long-term storage and in safety backup, and viability tests on 12,000 samples, and multiplication of 5,000 accessions done.

Two key outputs in 2006 supported the genetic resource systems of IRRI's national partners. First, the establishment in 2006 (to be completed in 2007) of a rice biodiversity network provides a mechanism for global rationalization of efforts to conserve rice genetic resources and will enhance germplasm conservation and use around the

world. Second, the improvement of the Lao PDR rice genebank will improve conservation and use of Lao germplasm as well as lower the cost and boost the efficiency of the national rice genetic resource system in Lao PDR. Samples of all remaining Lao accessions conserved in IRRI were restored to the Lao genebank for duplicate conservation there.

The total number of accessions at the end of 2006 was 108,955, of which the core collection, a subset of samples representing the range of rice varieties and ecosystems, was about 10%. Rejuvenation, characterization, and viability monitoring continue as core activities.

Output 2: Rice germplasm exchanged and evaluated internationally

In 2006, 18 new nurseries—14 ecosystem-based and four stress-oriented—were assembled for the International Network for the Genetic Evaluation of Rice (INGER). These were distributed to 30 countries. Outstanding materials from these nurseries were identified, used in national breeding and testing programs, and subsequently either released as varieties or used to develop new varieties with better characteristics for farmers' use. Twelve regular nurseries and four special nursery sets were also composed and dispatched to 38 countries. The IRG sent a record high of nearly 50,000 seed packets in response to 225 requests from 32 countries. Combined with nearly 45,000 seed packets distributed by INGER and other IRRI organizational units (12,000 packets sent by INGER in response to 164 seed requests from 38 countries; 33,000 packets sent by both INGER and other IRRI organizational units to INGER partners and other breeding collaborators), total distribution of germplasm reached a record high of nearly 95,000 seed packets in 2006.



The 2006 users of the breeding lines from 2003-05 INGER nurseries are NARES breeders in Bangladesh, China, DPR Korea, Egypt, India, Iran, Italy, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Sudan, Surinam, Thailand, Turkey, and Vietnam, with 758 breeding lines used as parents in hybridization; 879 breeding lines used in further yield evaluation; 242 breeding lines from 2003-05 INGER nurseries screened for resistance to insect pests and diseases and evaluated for salinity and cold tolerance; and 600 breeding lines from 2003-05 INGER nurseries conserved in gene banks. NARES breeders in the countries listed above are using the germplasm developed in 2003-05 in characterization and evaluation research in the search for new traits or adaptation, and in local breeding programs to increase the diversity of local gene pools for subsequent testing by the national testing authorities and ultimate release to, and use by, farmers.

The Genetic Resources Center, Crop Research Informatics Laboratory, Seed Health Unit, and Plant Breeding, Genetics, and Biotechnology Division worked together assiduously to prepare IRRI for implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture. A historic

agreement, signed between IRRI and the Governing Body of the Treaty on 16 October 2006, required IRRI to change its procedures for germplasm exchange by 14 January 2007, in particular to conform to the requirements of a new Standard Material Transfer Agreement (SMTA). This involved an extensive exercise to classify the status of all IRRI's germplasm under the Treaty, record this information in the International Rice Information System (IRIS), develop new software in IRIS to process seed requests, create an SMTA for each seed request, and create a new Web site to publish data associated with each SMTA. IRRI was the only international agricultural research center able to immediately comply with the Treaty by the 14 January 2007 deadline and therefore to continue germplasm exchange without interruption, and IRRI's system has been demonstrated at international meetings as a model for others to follow.

The role of intellectual property rights (IPR) in international agricultural research—in germplasm exchange, for example—is growing rapidly, and it is vital that NARES breeders and germplasm specialists increase their awareness in this area. In 2006, IRRI provided two half-day training courses (one at IRRI headquarters, one in India) and one 5-day training course (in

Myanmar) in IPR issues associated with genetic resources.

Output 3: International Rice Information System (IRIS) developed and used by rice breeders and researchers

To improve management of information in the IRG, a genetic resource information management module for the International Crop Information System (ICIS) was completed and deployed as part of IRIS. The resultant integration and joint publication of genetic resource and crop improvement information will benefit genetic resource specialists and plant breeders working with rice and other crops, ultimately allowing accelerated development of new, improved varieties that exploit novel alleles from genetic resource collections.

The development of an ICIS module for molecular characterization of germplasm will benefit biologists and genetic resource specialists working on biodiversity analysis, functional genomics, and allele mining. The module integrates molecular characterization from different projects with phenotypic evaluation of germplasm used to identify novel alleles from rice accessions. This information resource will allow the development of improved rice cultivars with enhanced traits conferring resistance or adaptation to intractable environments. In 2006, the core data model and database were completed. Software development and data encoding are continuing within the context of the GCP and within various other collaborative projects.

Project leader

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Functional genomics

Genomics, the science of deciphering DNA sequence structure, variation, and function, is now considered a key discipline in the discovery of plant traits that can improve crop production. As such, it is a crucial tool in the campaign to improve the livelihoods of millions of resource-poor rice farmers. Ultimately, genomics will allow researchers to discover every rice gene, the functional diversity of the various versions of these genes among the myriad rice species and varieties, and the relationship between a rice variety's DNA sequence and its phenotype—the actual form the plant takes in the field. This body of knowledge is growing exponentially and is already leading to new strategies for genetic improvement that are helping farmers grow rice more efficiently and profitably.

Through the efforts of the International Rice Genome Sequencing Project and private-sector contributions, the finalized sequence of the rice genome was published in August 2005. Scientists are using this information to delve further and further into the rice plant's genetic secrets. Structural genomics—determining the sequence of the DNA and mapping the location of genes or relatively small regions of the genome that influence phenotypic traits—is catalyzing great advances in functional genomics—the discovery of which biological functions belong to specific DNA sequences (such as genes) and how these work together to produce and influence traits.



To discover which parts of the genome are responsible for traits of interest, scientists create novel genetic resources such as mutants in which certain genes are disabled or activated. Combining this with the genomic information present within the rice germplasm and the plants' behavior under different conditions allows researchers to link genotype and phenotype. Genomic databases and resources are rapidly growing in size, number, and quality. IRRI continues to play a key role as a creator, compiler, and disseminator of genomics tools and information, and as a promoter of public access to these invaluable resources.

Output 1: Forward genetics to identify novel genetic variation using specialized genetic stocks for intensive phenotypic screening and characterization

Near-isogenic lines (NILs) and mutant analysis enhanced our understanding of tungro resistance in 2006. NILs are almost genetically identical to each other but one line possesses a small genetic component from a donor line, representing a special genetic resource for assigning function to chromosomal regions. A recessive mutation for tungro resistance was mapped to a region on rice chromosome 4 and several candidate genes were identified. The



candidate genes are being examined for association with different phenotypes. We also identified candidate genes for tungro resistance on chromosome 7 of Utri Merah, a traditional Indonesian variety. Screening for tungro resistance is notoriously difficult because of the need for rearing a virus-bearing insect vector. Genetically tagged germplasm for resistance to tungro, which can devastate crops, is rare to come by and badly needed for controlling the disease. These results boost researchers' chances of successful marker-assisted selection (MAS). A marker is a segment of DNA linked to an allele (a version of a gene) that controls an important trait and can easily be detected in the lab; MAS involves linking a desired gene with a marker so that it can easily be bred into a rice variety. Developing markers close to the tungro resistance gene will give breeders greater confidence when screening for resistance.

To combat insect problems, IRRI scientists, collaborating with Korea's Rural Development Administration

(RDA), have successfully transferred rice brown planthopper (BPH) resistance from an Australian wild rice species (*Oryza australiensis*) to cultivated rice. Many wild species are known to be insect-resistant and are therefore a valuable reservoir of desirable traits for modern varieties. The location of a gene for BPH has also been localized to a region on rice chromosome 6. As in the tagging of tungro resistance, tightly linked markers for BPH resistance have been developed to help the selection in breeding.

Similarly, work is continuing on mapping tolerance for flooding during germination. Genetic stocks (recombinant inbred lines) have been created for this purpose, and will allow the development of efficient markers for MAS and gene discovery.

Output 2: Reverse genetics to identify allelic series in candidate genes for stress tolerance, and nutritional and grain quality

TILLING (Targeting Induced Local

Lesions IN Genomes) is a technique designed to detect small variations (such as single-base mutations) in gene sequences in natural germplasm or mutant populations. These variations are known as single nucleotide polymorphisms (SNPs). In 2005, IRRI scientists converted the EcoTILLING technique (a version of TILLING) to an agarose-based approach, which made it much easier and cheaper to perform (recently published in *Molecular Breeding*). TILLING is now well established at IRRI, where researchers use the approach to screen genes of interest in the rice germplasm pool and in mutants. IRRI's simplified TILLING method has allowed the Institute to expand its collaboration with other organizations. With France's Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), IRRI is using TILLING to look for virus resistance genes important for Africa. TILLING is now an established part of the research tool kit for finding variation in potential drought tolerance genes in the germplasm bank. Researchers have characterized 10 candidate genes for drought tolerance in 1,536 accessions of *O. sativa*, five candidate genes in 190 accessions of African species *O. glaberrima*, and five candidate genes in 152 wild accessions.

Output 3: Genomewide expression analysis to determine causal relationships between genes and phenotypes

In collaboration with the RDA and Japan's National Institute for Agro-biological Sciences (NIAS), IRRI continued to develop whole-genome methodologies for identifying and locating genes of interest. We have developed a general method to align gene expression patterns with introgression segments in NILs. Whole-genome tools—such as gene chips (small slides on which

samples of DNA of thousands of genes, from across the whole genome, are arranged in a grid—can be used to see where the NILs show different patterns of expression. This allows the introgressed segments to be localized. Comparing the phenotypes of the plants when grown under certain conditions (e.g., disease or drought stress) then allows researchers to locate genes in the genome responsible for certain traits. Because advanced backcross lines and NILs are common genetic materials used in breeding programs, we expect that the new method will help researchers to efficiently identify a short list of genes responsible for desirable traits such as resistance to pests and diseases, and tolerance for abiotic stresses.

Output 4: Candidate gene identification and functional verification for stress tolerance and nutritional quality

Progress was made toward developing apomictic hybrid rice. Apomixis is a

trait that allows seed formation without fertilization. Achieving apomixis in hybrids would allow farmers to reuse hybrid seed rather than purchase new seed each season. Hybrid rice has higher yields than the best inbred varieties but is often too expensive for poor farmers. IRRI aims to make the production of hybrid rice cheaper and more flexible through the development of a synthetic form of apomixis that prevents loss of hybrid vigor.

Although unknown in rice, apomixis is common in grasses, especially in the form known as apospory. Aposporous initials are ovule cells that avoid meiosis (cell division that scrambles the chromosomes) but in other respects resemble so-called megaspore mother cells (MeMCs; cells that undergo meiosis). We hypothesized that apospory may involve mutations affecting the formation of MeMCs. Indeed, rice mutants that switch off a gene called *multiple sporocytes (MSP1)* produce multiple MeMCs in the ovule but are



male-sterile. Since male sterility would be an impediment to achieving our goal, we have sought to disrupt the function of MSP1 in the ovule alone, by using a technique known as RNA interference (RNAi) to silence a gene that encodes *OstDL1A*, a protein that binds to MSP1. We have demonstrated that RNAi silencing of the *OstDL1A* gene produces multiple MeMCs in the ovule without affecting the anther or causing male sterility. Our data suggest that targeted disruption of this particular process in sexual reproduction may be a starting point for developing synthetic apospory. Our next task is to bypass meiosis in the additional MeMCs.

Work is continuing on the validation of candidate genes for salinity tolerance (the *Saltol* gene). This will allow researchers to develop more efficient gene-specific markers for breeding and better understand the molecular and physiological pathways involved in salt tolerance. In 2006, fine-mapping of the region of the rice genome containing the *Saltol* gene was almost completed, and genes in the region are being annotated and studied. A short list of candidate genes will be available in 2007.



Output 5: Bioinformatics research and integration of convergent data for the identification and validation of target candidate genes and pathways

Work continued on the production of the next-generation International Rice Information System (IRIS) for local and Web-based access to functional genomics data integrated with crop germplasm data and crop modeling. This activity has been merged with the Generation Challenge Program (GCP) crop information platform development effort. As part of the GCP-funded data analysis and comparative stress-gene catalog projects, tool kits have been developed to enable integration of results from multiple experiments and short-listing of target genes for allele mining (finding the unknown valuable alleles in a germplasm collection).

Output 6: International Rice Functional Genomics Consortium: public research platform to leverage national and international collaboration

The International Rice Functional Genomics Consortium, coordinated by IRRI, has led an effort to undertake genome-wide SNP discovery by re-sequencing diverse rice varieties. Preliminary results from a unique



region from chromosome 3 revealed a total of more than 2,000 SNPs (one SNP per 200 DNA base pairs on average) among 20 varieties, providing a glimpse of the variation in the rice germplasm. In this collection of genotypes, we have traditional and modern varieties that are known to exhibit tolerance for a suite of stresses that adversely affect rice productivity across many production environments. These lines include valuable traits such as tolerance for heat, submergence, drought, problem soils, and diseases. Also included were varieties with high yield potential and other attributes that are favored by farmers in a wide range of locations. Genome-wide genetic variation data from the 20 diverse varieties are scheduled to be available in early 2007. This project enables IRRI to mobilize the research community to participate in phenotyping of the diverse collection of varieties, thus establishing a foundation for unlocking the genetic variation of key rice germplasm.

Output 7: Asian Rice Biotechnology Network: dissemination of tools and training

Elite lines for breeding submergence-tolerant varieties were produced using MAS and made available to NARES breeders. Specifically, we developed and distributed lines in three genetic backgrounds containing the *Sub1* gene, which allows survival of 10–14 days' submergence with minimal yield loss. *Sub1* lines with three additional backgrounds were scheduled for distribution in early 2007.

IRRI's Gene Array and Molecular Marker Application (GAMMA) Laboratory and the Asian Rice Biotechnology Network Shuttle Research Laboratory continued to host researchers from the NARES to conduct research and obtain training on specific skills. In 2006, 40 visiting researchers worked in the facility. Key achievements included training on new chip-based genotyping techniques and contributions to the development of low-cost markers.

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Program 2

Enhancing productivity and sustainability of favorable environments

The adoption of improved rice varieties and production technologies in the favorable irrigated environment is a major factor in poverty alleviation across Asia. The resultant increased production in this ecosystem—which accounts for 55% of rice harvested area and contributes to about 75% of total rice production—has led to a reduced unit cost of production and

lower food prices. Low food prices benefit the urban laboring class as well as the rural landless and marginal farmers who are net buyers of food and who often spend one-third or more of their income on rice alone. Consequently, a declining rice price is effectively a rise in income and, as such, improves the food security of the poor.

The favorable irrigated environment will remain the major source of rice supply to the rural landless and an expanding urban population. As populations increase and demand grows, we need to sustain the high yields already achieved in this ecosystem. Further, we need to harness high-quality advanced science to explore further increases in yield potential.

In feeding more people, however, we need to ensure the health of the environment. As populations grow, the irrigated rice production system intensifies, placing increasing pressure on limited natural resources—many of which are already overexploited. Take

the example of water: increased competition from the domestic and industrial sectors and the constant scourge of drought are threatening a water crisis. In many countries, therefore, we will not have the option to increase the area under high-yielding modern rice varieties by further developing irrigation infrastructure. Farmers will need to grow more rice with less water and learn how to operate irrigation systems more efficiently. We also need to continue our development of technologies that help maintain soil fertility and manage pests.

On top of all this, rising living standards in most of Asia are ac-

celerating demand for high-quality rice. We need varieties with higher yield potential, multiple resistance to diseases and insects, and tolerance for problem soils, and we need rice with superior grain quality and higher micronutrient content. In the past few years, IRRI has expanded its activities in the area of rice quality and nutrition. The Institute has a strong and growing capacity to develop rice germplasm and management strategies that can ultimately help eliminate micronutrient deficiencies—especially of iron, zinc, and vitamin A—for many of the millions of poor Asians who receive most of their nutrition from rice.

PROJECT 3

Genetic enhancement for yield, grain quality, and stress resistance

As population growth continues to boost demand for rice, production growth in the irrigated ecosystem is approaching a plateau. In this favorable ecosystem, which produces 75% of the world's rice, IRRI is continuing its effort to increase and sustain rice productivity. Meanwhile, the irrigated rice area is shrinking, irrigation water is being diverted for other uses, agricultural labor is moving to industry, and concern is rising about the misuse of pesticides and inefficient use of fertilizers. Farmers across the rice-producing world need to produce more rice using less land, water, labor, and chemical support. There is also a growing need to improve grain quality and nutrition and so alleviate the “hidden hunger” of micronutrient deficiency that afflicts



millions of poor people across different ecosystems.

IRRI researchers use both conventional breeding and biotechnological approaches to develop new improved cultivars and rice hybrids with 15–20% higher yield than existing high-yielding varieties. The development of even higher yielding rice cultivars and hybrids is also a key aim. We also develop suitable agronomic management practices for new plant types and hybrids to optimize their performance in farmers' fields.

Conventional breeding, marker-assisted selection, and genetic engineering are all employed to improve rice varieties' pest and disease resistance as well as to enhance the palatability and nutrition of rice varieties, including higher content of micronutrients such as iron, zinc, and provitamin A.

Output 1: Germplasm possessing high yield, multiple resistance, and superior grain quality developed

In 2006, we developed 10 promising lines with a 15–20% yield advantage over check varieties, and that possess multiple resistance to diseases and insects and improved grain quality.

Two IRRI-bred superior rice lines were recommended by the Philippine National Rice Technical Working Group to the National Seed Industry Council for release as national rice varieties for commercial cultivation by rice farmers. IR77186—the first new-plant-type indica line—was released as NSIC Rc158 (Tubigan 12). IR71137—the first high-yielding semidwarf aromatic line—was released as NSIC Rc144 (Mabango 2). Multilocational adaptive trials across the Philippines showed that these varieties outyielded the most popular check varieties by an average of 7.4% (IR77186) and 14.2% (IR71137). Another semidwarf aromatic line (IR67406),



which has grains similar to those of basmati rice, was reported to yield more than 4 tons per hectare in Brunei, where popular varieties commonly yield 1.5–2.5 tons per hectare.

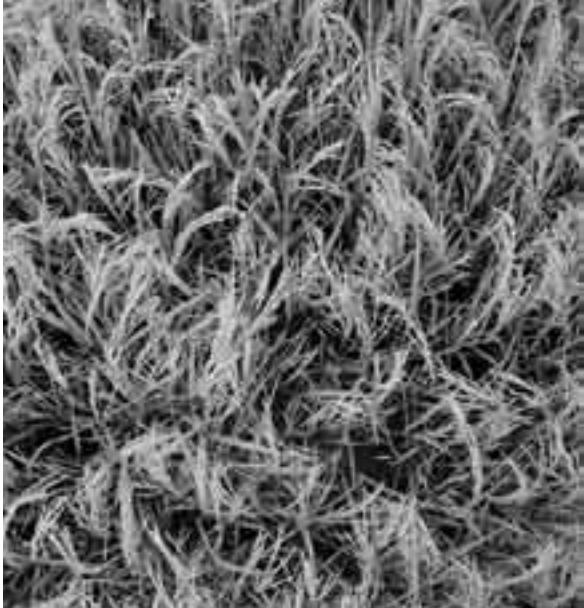
Thirty-one monogenic lines (lines that are genetically identical, except for one segment of the genome), representing 24 different blast resistance genes, have been developed and shared with partners in NARES for enhancing resistance to blast disease through methods such as gene pyramiding (meaning several genes for blast resistance are combined to confer a broader spectrum of resistance). Near-isogenic lines (NILs) for yield-related traits in the background of IR64 (that is, lines that are identical to IR64 apart from a small section of the genome that confers a particular trait) have been developed and characterized using molecular markers. These lines offer new opportunities to dissect and combine yield components for enhancing the yield potential of rice cultivars.

Transgenic lines resistant to stem borer and bacterial blight (BB) have been developed. Resistance to stem borer is conferred by a gene known as *Bt*; BB resistance is conferred by a gene known as *Xa21*. Three BB-resistant transgenic lines of high-yielding variety

IR72 (one from IRRI, two from the Philippine Rice Research Institute) have been field-tested at IRRI. These showed increased resistance to BB compared with untransformed IR72. When available to farmers, varieties like these will lead to reduced use of chemicals and yield sustainability.

Using wide crosses (crossing modern rice varieties with their wild relatives), our researchers developed elite breeding lines resistant to brown planthopper (BPH), BB, blast, and tungro. Specifically, there are seven lines for BPH resistance (derived using two wild species, *Oryza minuta* and *O. australiensis*, and *O. glaberrima*), two blast-resistant lines (*O. minuta* and *O. australiensis*), seven BB-resistant lines (*O. longistaminata*, *O. minuta*, and *O. brachyantha*), and three lines for tungro resistance (*O. rufipogon*). These have been shared with NARES breeders. Broadening the rice gene pool in this way offers new sources of pest resistance and new cultivars derived from these lines will lead to reduced use of chemicals, environmental protection, and yield sustainability.

In 2006, we developed five advanced backcross progenies possessing the resistance gene *Bph18* in the genetic background of two high-yielding BPH-



susceptible japonica cultivars, Jinbubyeo and Junambyeo. These breeding lines conferred strong resistance to BPH biotypes of Korea and China. The breeding lines also possess desirable agronomic traits and grain characteristics of temperate japonica cultivars. Three BB resistance genes, *Xa4*, *xa5*, and *Xa21*, have been bred into the genetic background of an elite japonica cultivar, Mangeumbyeo, using molecular breeding approaches. Five advanced breeding lines possessing *Xa4+xa5+Xa21* genes have broad-spectrum resistance to four races (K1, K2, K3, and K3a) of BB in Korea. K3a is a new race that is currently the most virulent in Korea. These breeding lines have been shared with NARES in Korea, Japan, and China where temperate japonica rice is widely cultivated.

In our work with elite japonica breeding lines that are adapted to the tropics, we conducted yield trials and blast- and cold-screening nurseries in temperate regions (high latitude) and tropical regions (high altitude) to select lines that have broad-spectrum adaptability. We identified several highly adaptable lines with considerable resistance to blast and tolerance for cold in either tropical or temperate regions. These lines, as well as additional elite lines, will be continuously evaluated in 2007 to further widen the genetic pool

of materials. We also set up several japonica demonstration fields in Bohol, Philippines, using variety IRR1 142 (registered as MS11 by the Philippine Seed Board), which showed good performance and higher yield capacity than local varieties. Notably, milled IRR1 142 grains were comparable with those of popular varieties of japonica rice. There are therefore good prospects for IRR1 142 to enter the premium rice market. IRR1 142 cultivation is potentially another way of increasing the average income of rice farmers in Bohol as well as tropics-based rice farmers in general.

High-throughput techniques for determining amylose content were established by developing calibrations using artificial neural network technology. The proportion of amylose (a linear starch) in the rice endosperm contributes to all traits of cooking and sensory quality. The calibrations, which have been developed for small samples of polished and unpolished rice, enable amylose to be measured 16 times faster than previously. Being able to use unpolished rice further speeds the process by removing the bottleneck that polishing introduces. Researchers also employed marker-assisted selection for amylose and fragrance, allowing more efficient screening of high-quality grain with desirable cooking and eating traits. Markers for gelatinization temperature are being developed.

Output 2: Rice hybrids possessing stronger heterosis, improved grain quality, and multiple resistance to diseases and insects developed

Four hybrids were identified with yield higher than commercial hybrid Mestizo 3, and a yield advantage of more than 15% over PSB Rc82 (the inbred check). All of these hybrids yielded more than 8.3 tons per hectare in the dry-season yield trial. Specifically, IR82386H produced 8.9 tons per hectare of grain,

with a yield advantage of 6.7% over Mestizo 3 and 23.2% over PSB Rc82. These hybrids (and their parents), along with protocols for higher hybrid seed yield and improved grain quality, were shared with NARES. The efficiency of nitrogen use of the hybrids was higher than that of the inbreds. The hybrids also had a higher harvest index (the ratio of grain yield to aboveground total dry matter) than the inbreds. We determined agronomic management practices and physiological attributes for the new lines that allow their potential to be achieved. These lines are now being used by breeders to develop new cultivars that will increase productivity for farmers.

New tools were developed and implemented in the quality evaluation of both hybrids and inbreds. Protocols for chalkiness—a major problem in the grain quality of hybrid rice—continue to be refined. Such improved methodology for assessing grain quality of hybrids will increase the efficiency with which we can improve hybrid grain quality.

Hybrid vigor at an early stage, commonly reported as contributing to the higher performance of hybrid rice, was not observed in the wet season for hybrid rice and elite lines with the same crop duration and crop management. The higher grain yield observed in hybrid rice was instead due to greater dry matter accumulation during grain filling and higher harvest index, with regard to genotypes. Higher harvest index was commonly observed for the Mestizo hybrid compared with variety IR72 in both the wet and dry seasons, and was correlated with higher stem elongation rate.

Project leader

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PROJECT 4

Managing resources under intensive rice-based systems

The highly productive favorable irrigated environment produces nearly three-quarters of the world's rice. Increased production due to improved rice varieties, expanded irrigation, improved management, reduced losses due to pests, and higher rates of fertilizer use in the two major intensive rice production systems—double cropping of rice and the rice-wheat rotation—have resulted in Asia's rice production doubling over the past three decades.

Yield growth in recent years, however, has stagnated. If this stagnation continues, producing enough rice to satisfy a growing population of urban poor and rural landless will become increasingly difficult, especially when com-

bined with postharvest losses. Further, as laborers continue to move away from farms to find jobs in the cities, farmers will face worsening labor shortages and a consequent increase in labor costs. At the same time, shortages of irrigation water and misuse of agrochemicals are causing environmental concern.

Current irrigated rice yields in rice-rice and rice-wheat systems average 5 tons per hectare. This is well below the estimated potential yield of 8 tons per hectare of popular rice varieties. Without new knowledge, techniques, and practices, it will be difficult for farmers to bridge this gap and achieve both increased profitability and minimal environmental impact.

Environmentally sound, socially appropriate technologies and machinery can help increase farmers' income and livelihood as well as enhance or sustain the productivity of favorable environments. In addition to integrating management of soil, water, weeds, pests, and diseases, such technologies must also conserve biodiversity and environmental health. Fully developing these technologies requires research on crop physiology, nutrient cycling, pest ecology, the rice crop in its environs, and mechanization systems—all within the context of farmers' management approaches and limitations.



Output 1: Crop and soil management practices and strategies developed and deployed for sustaining productivity, enhancing profitability, and minimizing environmental impact in intensive systems

In 2006, we established principles and approaches for site-specific nutrient management (SSNM) that are now being used for locally adapted nutrient management recommendations and practices in seven countries: Bangladesh, China, India, Indonesia, Myanmar, the Philippines, and Vietnam. This included the revision of fertilizer recommendations of NARES, nongovernment organizations, and the private sector. This process has also enhanced

partnerships between NARES and the private sector. Environmental benefits are being seen through the production of more rice per unit of nitrogen lost (as a greenhouse gas or nutrient) from rice fields. Farm-level productivity and profitability of rice production have increased in several major rice-growing areas of Asia. In addition, we developed an SSNM Web site that contains locally adapted recommendations for the same seven countries, including multiple areas for some countries.

Principles and practices were developed for integrated management of crop residues with nutrients, water, and tillage for optimal nutrient supply and input-use efficiency, and minimal greenhouse gas emissions. This included new recommendations for nitrogen management with straw incorporation and new recommendations for minimizing greenhouse gas emissions.

Output 2: Improved pest management practices developed and deployed to increase productivity and conserve and enhance the environment

IRRI researchers measured stem borer abundance under different field conditions and identified germplasm with variation in resistance to this pest during the booting phase, when damage leads to the greatest yield loss. A farmer participatory study in the Philippines was begun to determine the environmental and management factors associated with stem borer damage. Evaluations of varietal mixtures and interplanting for tungro and blast control were completed and made available to NARES and advanced research institute scientists. A management strategy for tungro was developed and presented to a farmers' discussion forum and is now being evaluated on-farm. Variety mixtures were evaluated for suppression of tungro in fields and the greenhouse. The seed mixture of varieties

Matatag 9 and IR64 at a ratio of 3:1 can be recommended in tungro-endemic areas to achieve yields in conditions of high disease pressure that are similar to those of IR64 grown under low or no tungro pressure. Interplanting one row of high-quality glutinous rice in every four to six rows of high-yielding hybrid rice continues to be adopted in Yunnan Province and has expanded to Sichuan and other provinces in China. Interplanting for rice blast control has extended to a total area of 1.6 million hectares in Yunnan, Sichuan, and other provinces since 2000. Based on survey results from 202 counties, efficiency of blast control has reached 70% and fungicide application has been reduced by almost 60%, resulting in improved farmers' income through increased yield and reduced costs. In Yunnan, the diversification concept has been extended to control diseases and insect pests of other major crops, such as wheat, barley, and broad bean. In a span of 4 years, the area grown with such crop mixtures in Yunnan has reached more than 470,000 hectares.

We determined shifts in weed species resulting from the change from transplanting to direct seeding in two

countries (India and Bangladesh). Over four cropping cycles of direct seeding, there were increases in the annual grasses *Ischaemum rugosum* and *Lepidochloa chinensis* and the annual sedge *Fimbristylis miliacea* with wet seeding while the perennial sedge *Cyperus rotundus* increased in dry-seeded rice. The establishment method for wheat, grown in rotation with rice, also had an effect on the weeds in rice. Zero-tillage for wheat encouraged *C. rotundus* while the annual grass *Echinochloa colona* declined. Equivalent studies began in Indonesia and the Philippines. This information is helping to define management strategies to respond to undesirable shifts in weed populations, and assist with the development of integrated measures.

In Vietnam, 135 episodes of the "IPM soap opera"—with storylines designed to educate farmers on the best integrated pest management (IPM) practices for reducing pesticides—were developed and broadcast over radio stations Voice of Ho Chi Minh City, Voice of Vinh Long, and Voice of Cantho. In Vinh Long, the series contributed toward a 30% reduction in insecticide sprays. In Lao PDR, 104 episodes were



developed and broadcast over National Lao Radio. Overall, improved disease management due to mixed planting, refined focus for the development of weed management, and host-plant resistance to stem borers advanced knowledge that is leading to improved management options. Through the use of mass media, IPM information became more widely available to farmers.

Output 3: Mechanization systems that improve the efficiency and sustainability of rice production developed

Postharvest management practices, improved storage technologies, market information, and quality-enhancing production technologies for reduced losses and improved quality were made available for wide-scale delivery in Indonesia, Cambodia, Lao PDR, Vietnam, and Myanmar. Specifically, market information was posted on village price boards in four villages in Vietnam and eight villages in Cambodia on a monthly basis; farmer field trials were conducted on a hermetic storage bag—known widely as the “superbag,” and which allows cereal grains to be safely stored for extended periods—in Indonesia, Vietnam, Lao PDR, and Cambodia; superbag production was established in Indonesia and planning for production began in Vietnam; manufacture of the cheaply produced IRRI moisture meter was established in the Philippines and Vietnam; and promotion of laser leveling continued in Vietnam and Myanmar.

The transfer of appropriate drying systems from Vietnam to neighboring countries with similar climatic conditions continued and manufacturers in Lao PDR, Myanmar, and Cambodia started producing flat-bed dryers with a 4-ton daily capacity for the commercial sector and farmers’ group usage. In Lao PDR, a manufacturer made 30 units of a

low-cost farm-level dryer. Commercial prototypes of a labor-saving rice hull furnace for use with the flat-bed dryer were installed in Vietnam at farmers’ cooperatives for long-term evaluation. Laser-assisted land leveling, a technology for more accurate leveling of rice fields for water savings and more even maturing of the crop, was introduced to Myanmar through operator training and field demonstrations. Together, these advances offer options for resource-saving plant establishment and informed decisionmaking for reduced postharvest losses, improved rice quality, and increased profitability.

Output 4: Resource-use efficiency in rice-wheat systems increased

In 2006, we designed integrated crop and weed management options—particularly for minimum-till and direct-seeded systems—that are efficient in labor, water, energy, and agrochemical use. These were evaluated with farmers in four areas in Bangladesh, India, Nepal, and Pakistan. Significant



progress was made in perfecting the double-zero-till system (drill-seeded rice and after zero-tillage wheat) and its benefits in terms of yield, income, and water savings were quantified. A study at Modipuram in the Indian state of Uttar Pradesh has shown that it is possible to cut water use by 35–40% with a double-no-till system while maintaining productivity similar to that of the more commonly used transplanting of rice followed by dry-tilled direct-sown wheat. More than 1,000 on-farm trials and technology demonstrations were conducted in Bangladesh, India, Nepal, and Pakistan for refining resource-conserving technologies’ potential to improve productivity, increase income, and minimize adverse environmental impact. The enhanced technologies include zero-till drills, double-disc drills, and rotary-disc drills. These have been modified for multicrop seeding and simultaneous seed and fertilizer application with residue mulch.

Finally, weed management options for direct-seeded rice have been tested in farmers’ fields in the Indo-Gangetic

Plains (in the Indian states of Uttaranchal, Uttar Pradesh, and Bihar) in more than 100 farmer field trials over a total of 975 hectares. Direct-seeding options gave yields similar to those of transplanting but achieving good crop establishment and effective weed management requires that farmers acquire new knowledge. Increased efforts will be made to make more information available to farmers.

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5 PROJECT 5

Enhancing water productivity in rice-based production systems



In many rice-growing regions, supplies of irrigation water are declining. Not only are water quality and availability decreasing, but farmers are also facing increasingly fierce competition from growing industrial, urban, and domestic sectors. Making better, more efficient use of water in irrigated rice production systems is now a crucial issue. Frequent and widespread drought compounds the problem. Further, as supplies diminish, the price of water is rising, either via direct costs or through the power outlay for pumping groundwater.

Asia is highly dependent on irrigated rice for food security. Irrigated agriculture in Asia uses 90% of total diverted fresh water, and about half of that is used for rice. Irrigated rice

varieties, grown in continuously flooded paddies, require substantially more water to produce a given amount of food than does any other major crop.

If we are to avoid a widespread water crisis, we must offer a range of new crop management strategies, such as alternate wetting and drying, and we need to continue to develop aerobic rice, which produces good yields in soils far too dry for conventional modern rice varieties.

As we strive to develop socially acceptable and economically viable irrigated rice-based systems that save water, we also need to look beyond the individual field level at system- or basin-wide scales. Knowledge of the behavior of water within whole irrigation systems will help us to optimize water use across entire farming regions.

Output 1: Strategies for enhancing water productivity at the farm level developed

In 2006, we completed a review—*Rice: feeding the billions*—that was published as a synthesis chapter in the *Comprehensive Assessment of Water Management in Agriculture (CA)*. The CA is aimed at policymakers at various levels along with organizations such as the Food and Agriculture Organization of the United Nations, the Ramsar Convention on Wetlands, other Consultative Group on International Agricultural Research centers, NARES, and advanced research institutes. The publication ensures that researchers and policymakers are aware of the complex issues of water use in rice production, and have an idea of potential response options. This knowledge promotes improved and better informed policies and decisions on investments in agricultural water management and research in rice-based cropping systems. A four-page policy brief was also produced, and

a more detailed and scientific version of the chapters was published in *Advances in Agronomy*.

Key CA findings were that

- Keeping rice prices low, while reducing production costs, is crucial for poverty reduction in rice-growing and -consuming areas.
- Rice systems provide not only food but also ecosystem services—such as flood mitigation, ground-water recharge, erosion control, and habitats for birds, fish, and other animals—which need to be recognized and protected.

income, and food security of poor rice growers—both men and women.

- Because of the hydrological connectedness of rice fields and because of the unique role rice cultivation plays in many cultures, solutions need to be developed with communities.

Advances in the development of water-saving irrigation technologies were synthesized, enabling researchers to better prioritize follow-up research. This information also ensures more efficient use of research resources and improved targeting of best-bet options.



- To keep up with the food needs of the world's increasing population, rice cultivation will have to adapt to water scarcity, drought, flooding, salinity, and climate change. Greater investment in research and extension is needed to meet these challenges.
- Solutions need to be tailored to the specific physical and socio-economic context and evaluated in terms of impacts on the environment and on the health,

The synthesis was partly included in the CA chapter and in 15 published papers on technologies such as aerobic rice, alternate wetting and drying, raised seedbeds, direct seeding, rainfed rice versus supplementary irrigation, and using crop modeling to support experimental data analysis.

Output 2: Interactions among the hierarchical scales of irrigation systems investigated and strategies for translating water savings

at the farm scale into savings at the scale of irrigation systems identified

Irrigated rice receives at the field level two to three times more water than other cereals and is a major target for the development of water-saving irrigation technologies. Between 25% and 85% of all water inputs to rice fields leave the field as percolation. Though percolation flows are losses at the field level, they can be captured and reused downstream and do not necessarily lead to true water depletion at the irrigation system level. It has been argued that the efficiency of water use and the water productivity of rice increase with spatial scale. To test this hypothesis, a multiscale water balance and water accounting study was undertaken in the rice-based Upper Pampanga River Integrated Irrigation System (UPRIIS) in Central Luzon, Philippines.

The amount of net surface water input (rainfall plus irrigation) decreased and the water productivity and amounts of water reuse increased with increasing spatial scale. About 57% of all available surface water was reused by internal check dams and 17% through pumping by farmers. The efficiency of water use in the area can be increased by reducing any “uncommitted outflow” (flow that is not committed for other users downstream of UPRIIS), by further increasing the internal reuse of drainage and percolation water (more check dams, more pumping), or by adopting water-saving technologies such as alternate wetting and drying (that keep more surface water in the system).



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PROJECT 6

Irrigated Rice Research Consortium

More than 2 billion Asian rice farmers and consumers depend on the productivity of irrigated rice systems for their livelihoods and/or food security. Three-quarters of all rice is produced with irrigation, making the irrigated rice agricultural ecosystem—which produces the most food to feed the most people—the most important in Asia. Despite rice’s enormous importance, however, many rice farmers remain poor.

The Irrigated Rice Research Consortium (IRRC) provides a framework for partnership that combines IRRI and national agricultural research and extension systems (NARES). The Consortium, which is active in nine Asian countries that grow irrigated rice, facili-

tates and strengthens NARES research and technology delivery and includes on its steering committee policymakers, senior scientists, and communication specialists from Bangladesh, China, India, Indonesia, Myanmar, the Philippines, and Vietnam. The IRRC also seeks partnerships with nongovernment organizations and the private sector to identify and help solve farmers’ problems.

Phase III of the IRRC, which began in 2005, will continue until 2008. The Consortium comprises four work groups composed of interdisciplinary teams of research and extension workers within each of the sites at which the Consortium operates. The work groups,

based on national research priorities, facilitate activities designed to solve farmers’ production problems in the irrigated and favorable rainfed rice ecosystem. Each activity is designed to have high impact for the collaborating site at which it is undertaken and, most importantly, for the region. The work groups—Productivity and Sustainability, Water Saving, Postproduction (Postharvest), and Labor Productivity—are linked to an overarching Coordination Unit, which provides farmer participatory appraisals, facilitates outreach programs, and monitors and evaluates the adoption and impact of improved technologies.

Output: Regional and NARES-driven multidisciplinary research and extension partnerships strengthened and new technologies for irrigated rice adopted

In 2006, the IRRC set up mechanisms and processes in 11 countries (Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Sri Lanka, and Vietnam) for large-scale dissemination and uptake of relevant rice technologies through partnerships at national or provincial levels. These achievements promote enhanced integration of NARES and IRRI research, and enhanced relevance and efficiency in the dissemination of rice technologies and methodologies by NARES. Apart from NARES scientists, beneficiaries of these

operations include extension agencies, postproduction-sector users, private-sector users, nongovernment organizations, policymakers, contract service providers, farmers, and processors.

National meetings were held with scientists, extension staff, and policy advisers on key IRRC technologies in Vietnam, Indonesia, the Philippines, and Myanmar. These technologies included water conservation, site-specific nutrient management (SSNM), crop establishment, postharvest processing, and ecologically based pest management (weeds and rodents). In China, meetings were held on SSNM only. At the meetings in Indonesia, Myanmar, the Philippines, and Vietnam, policy advisers and key politicians were made aware of IRRC outreach activities. The



meetings in Indonesia and China also provided policy recommendations for the respective ministers of agriculture. In Indonesia, this advice provided the

platform for a national policy on fertilizer management in favorable lowland rice crops that was rolled out in April 2006.

The strength of the science was underlined by the publication of 15 peer-reviewed papers, two peer-reviewed book chapters, and 15 proceedings of conferences. A majority were co-authored with NARES partners.

Capacity building, communication activities, and strengthening of interactions among consortia countries remained strong in 2006. The IRRC conducted 15 training workshops (four at a national level and covering all work groups). These were conducted in Myanmar and the Philippines on each of the key technologies listed above; in Vietnam on postproduction, water saving, and nutrient management technologies; and in Indonesia on SSNM and postproduction. One highlight was the development of the Postharvest e-learning training course (the development of which was funded by the Asian Development Bank, with verification and optimization funded by IRRC and the Swiss Agency for Development and Cooperation), which is now available on the Rice Knowledge Bank. In addition, 19 NARES partners were sponsored by IRRC to attend international workshops: Bangladesh (1), Cambodia (1), China (1), India (1), Indonesia (3), Lao PDR (1), the Philippines (4), Myanmar (2), Sri Lanka (1), and Vietnam (4).

The IRRC newsletter, *RIPPLE* (Rice Research for Intensified Production and Prosperity in Lowland Ecosystems), was launched in 2006 to foster better communication at a regional level and among practitioners from different disciplines. Initially, 400 copies were distributed across 25 countries. The newsletter generated so much interest that since October 2006 it has also been distributed as an insert in IRR's quarterly magazine *Rice Today* and in

December 2006 the newsletter had a print run of 3,000.

Many extension and training materials were produced, including posters, brochures, and flip charts. A brochure on weedy rice—describing weedy rice's traits, the problems it causes, and its preventive measures and control—attracted much interest. Other major extension activities included

- A glossy brochure on the IRRC entitled *Improving farmer livelihoods in Asia: knowledge-intensive crop management for irrigated rice*;
- A poster on the IRRC displayed at the 2006 International Rice Congress;
- Major improvements to the IRRC Web site (www.irri.org/irrc);
- A new Web site on SSNM (www.irri.org/irrc/ssnm) that presents SSNM principles and practices that are relevant for rice in all irrigated and favorable rainfed systems, as well as specific recommendations at a country level;
- Translation of English-language postproduction training materials into Khmer (all postharvest operations), Vietnamese (grain and seed quality, moisture meter, superbag), Myanmar (quality, drying, storage), and Bahasa Indonesia (superbag, moisture meter, hermetic storage); and
- Publication and broadcast of 24 news items in magazines, on electronic media, and on Web sites.

Work continued to promote the adoption of IRRC technologies and baseline studies for impact assessment were carried out. Two national outreach programs that focused on the extension of a collection of IRRC technologies



to farmers and the private sector were instigated in Myanmar and the Philippines. These have resulted in demonstration sites being established in five divisions in Myanmar and five regions in the Philippines. Baseline household surveys that captured the knowledge, attitudes, and practices of farmers and their economic inputs and outputs were completed in these countries in 2006. Follow-up surveys are planned for 2008.

Direct-seeded rice proved to be successful in northern India and Bangladesh, with extension activities strengthening in 2006 and impact surveys planned for 2007. A national program on nutrient management was rolled out in Indonesia based on recommendations from the IRRC. There was strong interest in adopting alternate wetting and drying (water conservation) in new regions in the Philippines and Vietnam. Collection of baseline surveys on postproduction technologies in eight villages in Cambodia and at four sites in Vietnam were completed. In addition, pilot sites were established and baseline household surveys conducted in two regions in both Indonesia and Vietnam for sustainable implementation of ecological rodent management at a village level.

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Program 3

Improving productivity and livelihood for fragile environments

Many diverse rice-farming environments are unfavorable for high levels of production—in-fertile uplands, rainfed lowlands subject to frequent droughts and submergence, and deepwater and coastal areas that suffer from flooding, strong winds, sa-

linity, and other soil-related problems. Rice farmers working in these ecosystems suffer from low farm income and high incidence of poverty. In addition to the farmers, more than 700 million of Asia's poor depend on rice grown in unfavorable environments. Many of these

people receive 50–80% of their calories from rice alone. As well as accounting for more than half of the land used to grow rice, fragile ecosystems are home to the majority of Asia's rural poor.

Farmers in these fragile ecosystems tend to be resource-poor and, consequently, risk-averse. Farmers subject to major environmental constraints are unwilling to invest adequately in inputs such as fertilizer. Yields in unfavorable areas therefore average less than 2 tons per hectare, compared with more than 5.5 tons per hectare in favorable irrigated lowlands. New higher yielding varieties are a part of the solution, but they must possess cooking and eating qualities comparable with those of traditional varieties. If combined with appropriate and efficient crop management practices, modern varieties—which need to be tolerant of drought, submergence, and problem soils—can help reduce the risk in rice cultivation that contributes to socioeconomic in-



equity, and can help increase both yield and farm income.

The past few years have seen advances in the identification, marking, and characterization of genes, and transfer of genes between species. Consequently, the ability to develop high-yielding rice varieties suitable for

unfavorable ecosystems has also been boosted. The diverse nature and wide geographical spread of these environments make local knowledge essential for this sort of research to succeed. It must therefore be undertaken in partnership with NARES, and must draw on local scientific expertise and farmers' indigenous knowledge.

IRRI coordinates the Consortium for Unfavorable Rice Environments (CURE, Project 9) to develop and implement the research agenda to tackle problems in unfavorable rice environments. The Consortium emphasizes the development and delivery of technologies and knowledge to farmers, and works with them to adapt these technologies to specific needs, conditions, and livelihood strategies. The research and related activities of Program 3 are grouped into three projects, which focus on genetic enhancement, natural resource management, and the activities of CURE.

PROJECT 7

Genetic enhancement for improving productivity and human health in fragile environments

Important gains in food security, human nutrition, poverty reduction, and environmental protection are emerging from rice breeding activities for fragile environments. These are the cropping areas that serve the majority of the rural poor and they are characterized by reliance on rainfall rather than irrigation and by dependence on problem soils affected by flooding, salinity,

aluminum toxicity, and deficiency of phosphorus and other plant nutrients. It is crucial that we tailor rice varieties for these unfavorable ecosystems by selecting them under conditions resembling the target environments. Such varieties should continue to provide the consumer-preferred grain type of traditional varieties but combine that with higher and more stable yields and traits

such as enhanced seedling vigor, greater tolerance for drought and submergence, improved ability to grow in problem soils, and strengthened resistance to pests and diseases. Molecular tools are already being deployed to enhance tolerance for submergence, salinity, aluminum toxicity, and acid sulfate soils, and new advances in drought tolerance are emerging.

Higher, more reliable yields will offer more calories, but there is also potential to improve poor consumers' diets beyond simply increasing food consumption. As the dominant staple in the Asian diet, rice often provides between half and three-quarters of people's calories. Improving the nutritional status of rice can therefore benefit huge numbers of malnourished people. Consequently, IRRI is developing improved rice varieties that contain increased levels of provitamin A, lysine, iron, and zinc.

IRRI is a focal point for international rice research. The Institute alone can consolidate research from

across both the globe and the scientific spectrum—from industrialized countries' advanced research institutes and private sectors to developing countries' NARES. In this way, we can use the best of both worlds to create varieties for rice farmers in highly diverse rainfed ecosystems.

The impact of Project 7 is further boosted by gene discovery using functional genomics (Project 2); NARES-IRRI breeding networks, farmer participatory selection that recognizes the central role of women, new crop management protocols for unfavorable ecosystems (Project 8); and

linkages with the International Network for Genetic Evaluation of Rice (Project 1) and the Consortium for Unfavorable Rice Environments (Project 9). The outputs of the breeding programs for the irrigated ecosystem and hybrid rice (Project 3) can also be valuable if screened under unfavorable conditions. The Asian Rice Biotechnology Network (Project 2), which facilitates the development and dissemination to NARES of germplasm and databases, ensures that NARES scientists are trained in new breeding, selection, and evaluation techniques.

Output 1: Superior germplasm developed for rainfed lowlands

One significant IRRI success in 2006 was the transfer of submergence tolerance to three major rice varieties. Submergence tolerance in the genetic background of two major varieties was developed by introgressing the *Sub1* gene through marker-assisted selection into popular varieties Swarna, Samba Mahsuri, and IR64. The addition of *Sub1* allows survival of 10–14 days of submergence with up to three times the yield of the same genotypes lacking the *Sub1* gene. Seed of these varieties was sent to NARES in Bangladesh, India, Indonesia, Lao PDR, and Myanmar, and promises greater productivity and more secure livelihoods in areas subject to flash flooding.

As part of our efforts to develop drought-tolerant rice, IRRI researchers identified drought sensitivity at flowering in 10 major Asian varieties. This offers improved focus for gene discovery—and therefore improved efficiency in breeding—for enhanced drought tolerance at flowering in popular varieties. Rice plants are particularly sensitive to drought stress at the

flowering stage, when insufficient water can devastate an entire crop. We also established and tested a high-throughput phenotyping protocol for drought based on controlled irrigation, remote sensing (infrared thermal imaging), and carbon isotope discrimination. Further, researchers conducted field phenotyping of 50 parents of mapping populations (which have been extensively used to identify quantitative trait loci [QTLs] associated with performance under drought stress) and rice megavarieties under drought stress for reproductive-stage processes.

IRRI identified short-duration lines and hybrids with yield at least 50% higher than that of popular high-yielding variety IR64 under severe reproductive-stage stress. These were distributed for adaptive testing and use as parents by NARES breeders in drought-prone areas and farmers are likely to use some in the field.

At least five lines and hybrids yielding 3 tons per hectare under lowland stress (in trials in which IR64 and IR72 yield less than 2 tons per hectare) have been distributed to collaborators, who recorded improved yields in recent severe drought events. The lines will be further distributed in India via the IRRI-India Drought Breeding Network, leading to higher yields in severe drought years in the stress-prone upper and middle terraces of river valleys in eastern and southern India.



In 2006, IRRI began development of new genotypes with tolerance for delayed transplanting and stagnant water to depths of 0.5 meter. These new lines will combine tolerance for submergence, transplanting delay, and stagnation, and will be distributed to NARES for adaptation testing. Screening protocols are already in place both at IRRI and with NARES, and the first set of lines was screened at the Cuttack Rice Research Institute (India) and the Bangladesh Rice Research Institute during the 2006 wet season. Eventually, these lines will offer greater productivity and more secure livelihoods to farm communities in poorly drained areas.

Promising hybrid lines were identified for drought-prone rainfed lowlands. NARES are using the parental lines to breed hybrid rice varieties with increased rice yield in rainfed lowlands. Two hybrids were identified as drought tolerant, yielding more than 3 tons per hectare or almost triple the yield of an inbred variety under the same conditions. Experiments showed that hybrid rice generally outyielded inbred varieties in a drought-stress environment.

Output 2: Superior germplasm developed for flood-prone and infertile lowlands

With six NARES partners, IRRI tested elite salt-tolerant lines at nine locations in Bangladesh, Egypt, India, Iran, and Vietnam, allowing the identification of better adapted and stable salt-tolerant lines for coastal and inland salinity. A special nursery for salt stress was subsequently developed, comprising three modules: for coastal saline areas, for inland saline and sodic soils, and for specific plant-type requests from NARES. Twenty-seven sets, each comprising 40 genotypes, were distributed to 23 NARES in 17 Asian and African countries. The overall result of this activity will be improved productivity

and food security in fragile salt-affected environments.

Researchers developed and validated genetic markers associated with the *Saltol* gene, which confers salt tolerance to rice. These markers allow faster breeding of salt-tolerant varieties, which can improve and stabilize productivity in salt-affected areas. The *Saltol* gene was fine-mapped and about 30 simple sequence repeats (SSRs; a form of marker) and other gene-specific markers were identified in the *Saltol* region. More than 140 background markers were also developed. Crosses were made using selected popular varieties, and advanced through marker-assisted breeding. Three SSR markers were identified as the most closely linked markers for the *Saltol* region of rice chromosome 1.

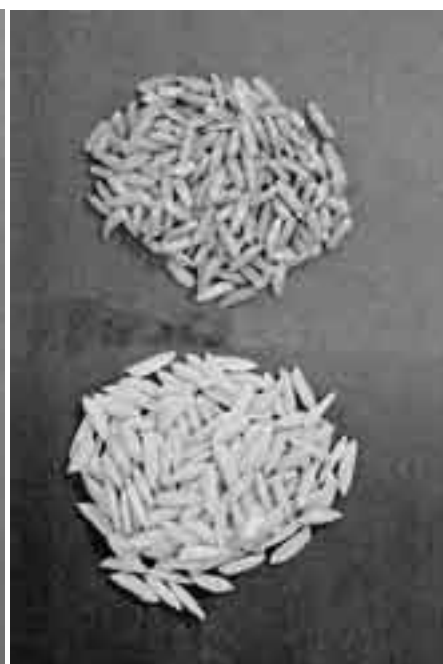
Several new breeding lines with new sources of stress tolerance were developed and shared with NARES. These are being used to breed varieties tolerant of acidity (one line), aluminum and iron toxicity (four lines), and phosphorus deficiency (two lines), allowing greater productivity under toxic soil conditions.



In an effort to improve productivity and food security in zinc-deficient rice-growing ecologies, germplasm tolerant of zinc deficiency was supplied to and tested by NARES. Elite lines for sodicity tolerance, along with 12 recombinant inbred lines (RILs), were also tested. In addition to the elite lines, two RILs developed from a cross between varieties IR74 and Jalmagna were highly tolerant of zinc deficiency and sodicity. Good progress was made in understanding the physiology of tolerance and four reasonably large QTLs—areas of the genome that increase or decrease a trait, such as drought tolerance, to a particular degree (compared with simply turning something on or off)—were mapped.

Output 3: Superior germplasm developed for infertile uplands

With NARES, we tested early- to medium-duration breeding lines with drought tolerance and weed competitiveness. Outstanding materials are now being used in national breeding and testing programs to develop varieties that offer stable yield under unfavorable upland conditions. Specifically, a major QTL affecting upland drought tolerance



was confirmed on chromosome 12 and four highly drought-tolerant upland genotypes have been developed and are being evaluated in the Indian Upland Rice Shuttle Breeding Network.

Output 4: Aerobic rice germplasm developed for water-scarce tropical environments

IRRI researchers are developing a new generation of aerobic-adapted rice cultivars with improved quality and yield in dry soils, which have been distributed to national programs for evaluation. Aerobic rice can grow in conditions too dry for commonly grown modern varieties and this is useful when rice fields cannot be flooded at all. High-yield aerobic varieties will increase yields and reduce drought risk in drought-prone rainfed uplands and lowlands. In 2006, we developed three lines with high yield in dry soil, one of which had a yield potential of 5 tons per hectare and tolerance for soil health problems. These have already been distributed to national programs. On the technical side, major QTLs affecting aerobic adaptation were confirmed in a mapping population derived from a cross between popular varieties Apo and IR64 on chromosomes 1, 4, 8, and 9. In addition, a single large-effect QTL, accounting for 50% of phenotypic variation under aerobic management, was identified in a mapping population derived from a cross between Apo and Swarna. Several hybrid lines that show good potential for the development of aerobic rice were also developed and are scheduled for testing in 2007.

To help breeders developing cultivars for dry direct-seeded systems, we developed and validated a low-cost selection index, based on easily scored vegetative traits for weed competitiveness. For example, selection for early vegetative vigor was validated as a method for improving weed competi-



tiveness. This will be used routinely in the IRRI breeding program and will be extended to NARES. Further, this practical selection tool permits breeders to incorporate weed competitiveness as a selection criterion in aerobic rice cultivar development.

Output 5: Micronutrient-enriched rice developed to combat malnutrition in fragile environments

Diverse germplasm was evaluated for high iron and zinc content in the polished grain. We identified four promising donor parental lines, which NARES and IRRI breeders can use in systematic breeding to improve rice's nutritional quality.

Output 6: NARES-IRRI partnerships in rice breeding enhanced

Participatory varietal selection (PVS) enabled male and female farmers to evaluate new promising lines tolerant of drought, submergence, sodicity, and salinity, and resistant to blast in target rainfed environments. Involving the farmers themselves is crucial to ensuring that new varieties are acceptable in terms of criteria ranging from yield to cooking and eating quality. Breeding strategies are subsequently refined based on farmers' preferences. In sodic fields in Faizabad and Sultanpur districts of the Indian state of Uttar Pradesh, two bold-grained varieties and one fine-grained variety proved

particularly popular. Seeds of these varieties were distributed to 80 men and women farmers in 10 villages. In the flood-prone district of Siddharthnagar in Uttar Pradesh, PVS results revealed that four varieties could survive three spells of submergence of 1–2 weeks and still produce yields of 2.9–5.0 tons per hectare. In Faizabad, which is prone to both drought and flooding, two varieties performed well. In 2006, 75 farmers in Siddharthnagar and Faizabad tested a range of lines, including popular variety Swarna and its IRRI-developed submergence-tolerant counterpart, SwarnaSub1. In drought-prone areas in the state of Chhattis, farmers tested three promising varieties. In Lampung, Indonesia, four varieties met with farmers' approval.

Low-cost PVS methods have been documented and distilled into training materials suitable for integration into rainfed breeding programs. This is leading to faster identification and deployment of improved rainfed varieties. In this light, a CD on the *Rice breeding for impact* training course, which includes practical methods for PVS and working with farmers, is ready for distribution. Further, a draft of a practical guide on participatory research in varietal improvement and crop resource management and gender analysis was completed.

IRRI developed a scheme for mixed planting of traditional and improved

varieties, with the aim of increasing yield and income, reducing pesticide use, and promoting *in situ* conservation of traditional germplasm. In the Philippines, rice diversification and mixed cropping practices were scaled up for traditional variety Dinorado and modern variety UPL Ri5. Thirty-two farmers adopted these practices in their fields. In Indonesia, the modern variety Sirendah (moderately resistant to blast) was interplanted with modern varieties

Cirata (highly susceptible) and Wayrare (moderately susceptible). The effect of the planting ratio varied according to cultivar. Interplanting two rows of Wayrare with one row of Sirendah resulted in significantly lower neck blast incidence than planting Wayrare only.

In 2006, we assessed the impact of the Eastern India Rainfed Lowland Shuttle Breeding Network in order to formally document a successful model for serving unfavorable rainfed systems.

Replication of the Shuttle Breeding Network model is already increasing the impact and efficiency of rainfed rice breeding.

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PROJECT 8

Natural resource management for rainfed lowland and upland rice ecosystems



Rice yields in unfavorable ecosystems are generally low and unstable. Farmers in these environments are completely reliant on rain. If rains bring insufficient or too much water, or are poorly timed, the resultant crop suffers accordingly. The farm families who live and work in unfavorable ecosystems—80 million of them in Asia alone, who farm a total of 60 million hectares—are among the world's poorest. This poverty makes farmers unable or unwilling to invest in improved rice production and resource management strategies, thereby entrenching inappropriate farm practices that degrade natural resources. Poor farm families, living a hand-to-mouth existence, are in a precarious position. A season or two of poor conditions can drag people deeper into poverty. Many of the people living in unfavorable areas belong to ethnic

minorities and their plight is often compounded through social and political marginalization. By offering easily and cheaply adopted solutions based on improved crop and natural resource management (CNRM) practices, and finding innovative and effective ways to communicate these solutions to the people who need them most, Project 8 seeks to help resource-poor farmers improve their CNRM practices and overcome the problems faced by farm families in unfavorable environments.

Project 8 also applies ecoregional approaches at selected sites to demonstrate the use of systems models for improving rural livelihoods through efficient management of natural resources and aims to improve rural livelihoods by enhancing the sustainability of supporting ecosystems. This systems approach draws on diverse expertise

to integrate the many dimensions of CNRM across disciplines, geography, time, and the research-development-policy continuum, and to generate integrated CNRM knowledge as well as the tools with which to use such knowledge. Successful integrated CNRM allows stakeholders at all levels to make informed resource management choices through an improved ability to articulate objectives, to negotiate demands, and, subsequently, to better use the resources themselves. The research is conducted in pilot regions representing the various agroecosystems where rice is a major crop, with emphasis on less productive fragile environments.



Output 1: Crop and natural resource management practices for improved livelihood in rainfed lowlands developed and evaluated

In 2006, we completed a comparative study of livelihoods in the saline and nonsaline ecosystems in coastal Bangladesh, leading to improved understanding of the effect of expansion of shrimp farming on poverty and the environment in this region.

To gain an understanding of the context of livelihood systems in regions for which improved rice technologies are being developed, IRRI scientists reported on changes in agriculture and livelihoods in the unfavorable ecosystems in Bangladesh. This report was based on analysis of data generated from surveys of 62 villages (including 16 coastal villages) in 2004, and is scheduled for publication in 2007.

A research monograph was compiled to improve understanding of drought-coping mechanisms of rice farmers within different socioeconomic contexts. The monograph, which was published by IRRI in early 2007, shows the increased relevance of technology and policy for drought mitigation. The

economic cost of drought is substantial, with production losses during drought years in eastern India as high as 40% of the value of output. The total economic cost of drought in the three states of eastern India studied (Chhattisgarh, Jharkhand, and Orissa, which account for about 10 million hectares of rice) is around US\$400 million per year. Farmers' coping mechanisms are generally inadequate to prevent a shortfall in consumption during drought years. The incidence and severity of poverty increase during drought years as people "fall back" into poverty and those who are already below the poverty line fall deeper into poverty. In the three states of eastern India alone, as many as 13 million people fall back into poverty during drought years. The poverty impact of drought mitigation could hence be substantial. Household-level consequences of drought depend on the structure of the production system and dominant livelihood strategies. The immediate impact of drought is less when agriculture is diversified and market-oriented, and rural incomes are diversified. Technologies and policies that promote income diversification

thus help reduce the household-level impact of drought. An invited paper was presented on this important topic at the 26th conference of the International Association of Agricultural Economists in Gold Coast, Australia, on 12-18 August 2006.

Through analysis of relevant literature and on-farm and on-station data from nutrient experiments in rainfed lowland rice, we developed new approaches for site-specific CNRM for rice-based drought-prone rainfed lowlands. One achievement was the basic outline of a novel framework for nutrient management in this environment, which promotes flexible site- and system-specific nutrient management options over uniform recommendations. The concept was applied and tested at key sites and in key systems. The resultant increased knowledge and understanding of how to address the variability of soil and water resources in rainfed systems open the way for higher nutrient-use efficiency and system productivity in this environment. The most important conclusion from this work was that fertilizer use in rainfed systems (including those in

drought-prone areas) can be almost as beneficial as in irrigated environments provided that site- and even field-specific adjustments are practiced. Further insight into the interaction of water and nutrient resources on crop growth and grain yield is expected from simulation approaches using IRRI's ORYZA2000 model. We evaluated the model for rainfed lowland conditions and explored a range of management scenarios. This technique can also be used to extrapolate results beyond experiment sites and we are continuing work on estimating water-limited attainable rice yields in Asia's rainfed lowlands.

We also investigated the possibility of using nutrient management technologies developed for irrigated environments in rainfed lowland systems. A successful tool for this purpose is the leaf color chart (LCC), which helps rice farmers to optimize their nitrogen management (the LCC allows estimation of N levels in the rice plant). The target environments for this tool are the favorable to moderately unfavorable rainfed lowlands, which are frequently affected by various abiotic stresses that may interfere with LCC use. The effects of drought, salinity, phosphorus deficiency, and sulfur deficiency on leaf N estimates by the LCC and soil plant analysis diagnostic (SPAD) readings, which measure chlorophyll levels, were tested in a greenhouse experiment. Linear relations between chlorophyll concentration and leaf N concentration, and leaf-thickness-adjusted LCC scores and leaf N concentration were confirmed for all treatments and varieties used. We concluded that LCC readings are not greatly affected by frequent abiotic stresses, and therefore can be used for real-time N management in the target domain. The LCC and SPAD are therefore potentially useful tools for improved, more efficient N management in moderately unfavorable rice systems.



Promising results were achieved with biochar technology, a completely new approach to improving the productivity of rainfed rice, especially on poor soils. Biochar—incompletely burned organic matter such as charcoal, which is incorporated into soils—can easily be produced from rice residues and has been shown to improve soil physical and chemical properties in other crops. On-station experiments with three residue treatments (no application, fresh residues, and charred residues) and two inorganic fertilizer treatments (no and medium—that is, lower than the generally high to very high rates used in irrigated environments—inorganic fertilizer rate) were established in a variety of rice-growing environments including irrigated lowlands, rainfed uplands (both in the Philippines), rainfed lowlands (northeastern Thailand), and the rice-wheat system (India). Results showed a considerable yield increase resulting from biochar application on

poor soils but no or little effect on good soils. In Thailand, yield increased from 2.3 to 2.8 tons per hectare (without fertilizer, using fresh residue and biochar, respectively) and from 2.9 to 3.3 tons per hectare (with fertilizer, using fresh residue and biochar, respectively).

The effects on soil characteristics were more consistent and major effects included an increase in cation exchange capacity, a decrease in soil bulk density, and a stable increase in soil organic carbon (biochar is not, or is very slowly, decomposed in soils). Incubation experiments confirmed the high stability of biochar, and carbon dioxide and methane emissions of the control treatment (no residue application) and the biochar treatment were identical. Therefore, the biochar technology can be used to improve the productivity of rice-based systems in regions dominated by poor soils. Biochar could also be used to sequester carbon and reduce the emission of greenhouse gases from

rice-based systems in general. It is readily available, especially in the form of rice residue, although at present much residue is otherwise used. Biochar production from rice husks can already be achieved with an improved rice husk furnace, which produces carbonized rice husks as a byproduct of the paddy drying process.

The major recommendation from the Livelihood Improvement Through Ecology (LITE) project in Bangladesh was that insecticides (as currently used by farmers) should not be applied, regardless of the type of crop in the neighboring field. The type of neighboring crop had an effect on the diversity of pests, but this did not translate into an effect on yield. There was no evidence of farmers' sprays increasing yields or profits. On the contrary, there was evidence that farmers spending the highest amounts on insecticides were not gaining any benefit and therefore had reduced profits. The improved understanding of the ability of farmers to maintain yields without insecticides has led to a reduced use of insecticides in rice in Bangladesh.

The Fish and Rice Management System to Enable Agricultural Diversification (FARMSTEAD) project in Cambodia examined the effects of rice intensification on crop loss. These studies were completed in 2006 and showed that intensification of rice production in rainfed environments resulted in greater measurable crop loss due to insect pests. Despite this, yields, profits, and production from intensified systems surpassed farmers' previous results, leading to recommendations for intensifying rainfed rice production. This also improves the potential for crop diversification. Recommendations included growing Paka Romdul, a medium-duration variety that matured faster and had higher yields and higher market value than the farmers' variety;

leveling the land; applying adequate mineral fertilizer (application rates depend on soil characteristics); thorough weeding of the field before panicle initiation; preparing thick bunds to prevent water leakage; and not allowing the field to dry out completely before adding supplemental water.

We conducted 200 farmer participatory trials in the rice-wheat system of the Indo-Gangetic Plains of Nepal and eastern India and evaluated integrated crop and resource management practices—such as land leveling, tillage and crop establishment, nutrient management, and pest management—that enhance crop performance, resource-use efficiency, and farmers' income. The trials showed that the management strategies did indeed increase both yield and farmers' benefit-cost ratio. Large-scale adoption is anticipated in the coming years and can increase rice-wheat productivity by 0.5–1.0 ton per hectare. To facilitate adoption, we organized cross-site visits across networks of on-farm demonstrations aimed at

promoting exchange of experience and knowledge among farmers and research and development workers.

In Bangladesh and eastern India, crop establishment and weed management methods have been evaluated as alternatives to the traditional practices of transplanting and *biasi* systems. *Biasi*, a traditional method of weed control, involves farmers running a narrow plow through the mix of crop and weeds around 30–50 days after sowing. It is heavily dependent on sufficient rain to impound about 10–15 cm of water at the right time. Although disruptive for seedlings, *biasi* keeps weeds under control, and allows farmers to redistribute seedlings and fill any gaps. The studies completed in 2006, however, have indicated potential advantages (improved farm labor productivity and timing, for example) for farmers adopting the alternative options of row seeding followed by either interrow cultivation or the use of herbicides.

Researchers substantially completed a study of livelihood strategies



(including gender roles) and farming practices in drought-, submergence-, and sodic-prone rice environments in eastern India. Reports on the baseline socioeconomic surveys in sodic- and salinity-affected areas in eastern Uttar Pradesh, Lucknow, and Cuttack were completed. Reports on the baseline socioeconomic study in drought- and drought-/submergence-prone villages in eastern Uttar Pradesh, Chhattisgarh, Jharkhand, Cuttack, and Assam were also completed. The study has resulted in improved understanding of farm households' livelihood strategies and the identification of technology options to improve and stabilize crop productivity, as well as the identification of improved CNRM options on the basis of farmers' needs and resources. Some of these options follow.

- *Drought-prone environment.* In collaboration with NARES partners, we developed a package of site-specific crop management practices that can improve rice performance under drought stress and permits an earlier harvest for timely sow-

ing of a nonrice sequence crop in drought-prone lowlands. This package includes modern varieties and improved weed and nutrient management, which farmers can adapt according to their socioeconomic situation and the biophysical requirements of local ecosystems. For drought-prone uplands, we developed several direct-seeding practices that improve upon the traditional *tewai* establishment system of Jharkhand State, India. The practices—seeding behind the plow and broadcast seeding into furrows, depending on farmers' preference—allow earlier rice establishment and better weed control, and optimize the performance of new early-duration germplasm developed for this ecosystem. Earlier rice establishment allows farmers to harvest earlier and take advantage of residual soil moisture to plant a sequenced nonrice crop, which diversifies the cropping system.

- *Submergence-prone lowlands.* New nursery management practices

allow farmers to grow stronger seedlings that are better able to survive and recover from submerged conditions after transplanting in the main field, and consequently enhance yield. The practices are lower seeding rate, nutrient management in the nursery, and nutrient management in the main field. Furthermore, after the first year's tests in farmers' fields, the new variety, *SwarnaSubi*, was optimized and proved better able to cope in flooded conditions.

- *Salt-affected environments.* In Faizabad, Uttar Pradesh, India, where sodic soils are a problem, the use of *Sesbania* as green manure and pressmud (a combination of straw, cow dung, and sugarcane residue from sugar mills, which is used as a manure) were tested by farmers in their fields. These simple improved practices enhanced soil fertility, improved rice yields, and are acceptable for poor farming households. In Orissa, India, where coastal salinity is a problem, farmers can now intensify their cropping system for year-round production with a package of new crop management practices for coastal saline ecosystems. Wet-season practices include nursery nutrient management and transplanting older seedlings closer together in the main field. For the dry season, farmers can avoid seasonal intrusion of saltwater by early transplanting (before mid-January). Combining these practices with new germplasm, farmers can optimize yield potential for this difficult environment. New nutrient management practices involve *Sesbania* green manure and *Azolla* biofertilizer, which can be adopted at very little expense. At both sites, men and women farmers were trained on seed selection and proper processing and storage, after



which the seeds they produced were sold to other farmers.

Current advances and recent activities involving CNRM practices in unfavorable environments were presented and discussed after the CURE Steering Committee meeting in Dhaka, Bangladesh (8-9 March 2006). A total of 19 presentations covering work in the various unfavorable environments represented in the six CURE working groups were made and will be published in 2007 in a proceedings.

Output 2: Crop and natural resource management practices for improved livelihood in upland rice ecosystems developed and evaluated

New approaches to stabilize soil quality and increase the productivity of rice-based uplands were developed. We investigated the options to use biochar from rice residues for soil improvement in rice-based systems. Important preliminary results are that biochar can be easily produced from rice residues and can improve crop productivity on poor soils. Therefore, it can be used as a soil amendment and contribute to increased productivity, especially in poor environments.

IRRI researchers conducted an economic analysis of patterns of change in upland systems of China's Yunnan Province, leading to more effective strategies for upland development. PhD research on this topic was successfully completed. A scientific research report is now under preparation.

Studies of livelihood strategies (including gender roles) and farming practices at key sites in Lampung, Indonesia, and the Arakan Valley, Mindanao, in southern Philippines, were completed. Two specific reports were completed: on the participatory rural appraisal and baseline socioeconomic surveys in the uplands in the Arakan Valley and on the



participatory rural appraisal of livelihood strategies (including gender roles and farming practices) in the uplands in Lampung. These studies have led to improved understanding of farm households' livelihood strategies and the identification of technology options to improve and stabilize crop productivity, as well as the identification of improved CNRM options on the basis of farmers' needs and resources. For example, crop diversification practices were developed, which include interplanting two rice varieties to manage disease and mixed cropping of rice with nonrice crops to enhance food security and household livelihood. In Lampung, interplanting a susceptible improved variety with a resistant traditional variety can reduce blast damage. In the Arakan Valley, a rice-mungbean pattern allows harvesting mungbean to provide food when shortages occur 1 month before rice harvest, and the legume's nitrogen fixation improves soil conditions. Other options include rice-peanut and rice-maize. Seed health management practices have been institutionalized into a farmers' network of seed producers known as a community seed bank (CSB) in Arakan Valley and Lampung. Men and women farmers are trained in proper seed selection, processing, and

storage methods, while follow-up monitoring evaluates their compliance. The outcome is a reliable supply of good-quality seed available to local growers.

Studies were undertaken to determine the impact on weed growth and species composition of improved fallows and alternative crop management practices in the uplands of Lao PDR and across a toposequence (a descending series of adjacent rice paddies that drain into each other) in Java, Indonesia. The studies showed that, in the Lao uplands, the establishment of pigeon pea as a crop to succeed rice could reduce weed growth, but this was not enough to prevent a decline in rice yields due to intensified cultivation. Soil pests, including soil aphids and nematodes, are thought to be contributing to this decline. In Java, the weed flora after farmer weeding was diverse, with more than 100 plants per square meter being recorded at some sites. Species composition was affected by soil properties (pH and cation exchange capacity). Farmers were achieving good weed control through hand weeding and gains through additional weeding were small. No simple relationship was found between toposequence position and yield.

Output 3: Ecological sustainability enhanced and livelihoods improved through ecoregional approaches to integrated natural resource management

In recent years, extension workers and land-use planners have changed their perceptions from single-commodity to diversified farming and are looking

at brackish water as a resource rather than a constraint to production. IRRI researchers have therefore started to carry out farm surveys with a view to developing credible information and knowledge explaining the impact of regional- and farm-level resource management on the livelihood of farmers in the coastal zones of the Mekong

Delta, Vietnam, and Bangladesh. Surveys of smallholders (Bangladesh) and farming systems (both Bangladesh and Vietnam) were completed in 2006.

Project leader

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PROJECT 9

Consortium for Unfavorable Rice Environments (CURE)

Low and unstable yields are a feature of rice farming in rainfed unfavorable environments, which are also characterized by poverty and high population density in both rural and urban areas. Difficult conditions and heavy

reliance on unpredictable rains have meant that, in the past, farmers have been averse to risk and either unwilling to grow modern high-yielding rice varieties or unwilling to use sufficient inputs if they do try modern varieties.

Hence, productivity gains have been incremental and small. It is essential, if we are to meet the challenges posed by unfavorable ecosystems, to develop a well-structured strategic research approach to address key constraints.

The Consortium for Unfavorable Rice Environments (CURE) offers a strong framework within which researchers, extension workers, policymakers, and farmers can tackle key problems.

Increasing and stabilizing rice productivity in unfavorable rice environments will help reduce risk in rice cultivation for risk-averse subsistence farmers. The flow-on effects of improved productivity include improved household food security and livelihood without harming the environment or depleting available natural resources. Throughout the highly diverse unfavorable environments, CURE's strategy involves on-site work with our NARES partners and a multidisciplinary approach to technology development and dissemination.

CURE fosters cooperation in research and development between NARES and IRRI, who jointly identify strategic problems through collaborative research at NARES sites. CURE was created in 2002 following the restructuring and consolidation of the Rainfed Lowland Rice Research Consortium and the Upland Rice Research Consortium into a single entity. NARES membership in the Consortium involves 10 countries: Bangladesh, Cambodia, India, Indonesia, Lao PDR, Myanmar, Nepal, the Philippines, Thailand, and Vietnam. The research activities are described in projects 7 and 8.

Output 1: A planning and management network to prioritize research needs and to implement interdisciplinary research in partnership with NARES nurtured and sustained

The fifth annual meeting of the CURE Steering Committee, held in Dhaka, Bangladesh, 6-7 March 2006, reviewed research reports given by its six sub-ecosystem-based working groups. The Steering Committee appraised the progress of the working groups, approved



2006 work plans, and made strategic decisions regarding future research in rainfed ecosystems.

Drought-prone lowlands. CURE has developed a package of site-specific crop management practices that can improve rice performance under drought stress and that permits an earlier harvest for a timely sowing of a nonrice sequence crop. This package includes modern varieties and improved weed and nutrient management, which farmers can adapt according to their socioeconomic situations and the biophysical requirements of the local ecosystems.

Submergence-prone lowlands. The submergence-tolerant variety SwarnaSub1 demonstrated its survival ability and yield performance under flash-flood conditions in on-station and on-farm tests at CURE sites. New crop management practices can optimize SwarnaSub1's performance and further enhance its ability to cope with uncertainties of flood-prone environments. Other popular varieties have been introgressed with the submergence-tolerance Sub1 gene and will be tested for performance and farmer acceptability.

Salt-affected environments.

Through CURE's efforts, saline coastal communities in India have access to improved varieties developed decades ago for this ecosystem. Farmers can now intensify their cropping system for year-round production by employing these varieties in a package of new crop management practices for coastal saline ecosystems. These varieties considerably improve rice productivity in both wet and dry seasons, leading to better food security for communities in coastal saline areas.

Shifting rotational upland systems. Promising rice varieties for upland conditions have been identified through participatory varietal selection trials in remote areas of the five northern provinces of Lao PDR. The seeds have been further distributed to local agricultural officers for scaling out to resource-poor households through an IFAD investment loan program for Lao PDR. These varieties are suited for either the rotational cropping systems on sloping lands whose fallow has been reduced by population pressure, or lowland paddy where improved rice



production could relieve pressure of growing crops in sloping fields.

Drought-prone plateau uplands. A moderate drought-tolerant variety with good blast resistance, Anjali, is gaining farmer acceptability for upland fields in Jharkhand State, India. The shorter duration allows farmers to establish a postrice sequence crop to intensify system productivity. The working group has engaged 20 nongovernment

organizations to disseminate the new variety across six northern districts of Jharkhand.

Intensive uplands with long growing season. A community seed bank (CSB) is a network of farmers who have been trained in seed health management practices in order to produce a reliable supply of good-quality seed for rural householders. A CSB has been successfully established in Arakan Valley,

Mindanao, in southern Philippines, and is also being adapted to CURE's key site in Lampung, Indonesia. Local government units in Arakan Valley have also adopted the CSB model, which will institutionalize this organization beyond CURE sites.

A training course on community-based participatory research for technology validation and upscaling was organized for NARES partners and held at IRRI headquarters on 7-18 August 2006. Eight staff members from seven of CURE's nine key sites successfully completed the course, entitled *Participatory approaches to agricultural research and extension*. Including the staff participating in the 2005 workshop, all key sites have at least one person, if not more, trained in participatory research methods, resulting in strengthened capacity of national programs for linking research with development.

We held an international workshop, *Natural resource management for poverty reduction and environmental sustainability in fragile rice-based systems*, to review past achievements in natural resource management research in NARES participating in CURE. The workshop was conducted on 8-9 March 2006, in conjunction with the annual CURE Steering Committee meeting in Dhaka, Bangladesh, and plans are under way to publish the proceedings in 2007. The 35 participants from CURE's 10 host countries and IRRI are now able to refine NARES plans for natural resource management research under CURE.

Project leader

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Program 4

Strengthening linkages between research and development

IRRI understands the need to involve all levels of the rice production system, from farmers to policymakers, in research planning and prioritization. An inclusive interactive approach helps to improve our understanding of farmers' and consumers' needs and how farmers evaluate scientific knowledge in the context of their traditional knowl-

edge. This, in turn, improves the probability of research success. This approach also helps to improve efficiency in the allocation of research resources, thus reducing the chance of technologies and scientific outputs remaining unused or used only for academic purposes. In this context, one of IRRI's key responsibilities beyond research is to help national

and international agencies engaged in socioeconomic development to disseminate new knowledge and technologies.

Program 4 incorporates some of the ongoing socioeconomic research on understanding rural livelihoods, assessing technology needs of farmers, and validating technologies through farmer participatory experiments. This

program includes two projects. The first deals with research prioritization and impact assessment based on understanding farmers' needs and livelihood strategies, and interactions among technologies, infrastructure, and institutions. The second aims to understand the pathways of technology dissemination, and validate and adapt promising

technologies through farmer participatory research conducted in partnership with nongovernment organizations, the private sector, and other extension agencies. This requires assessments of needs and opportunities along with innovative approaches to information dissemination and knowledge management.

PROJECT 10

10 Understanding rural livelihood systems for rice research prioritization and impact assessment

To effectively plan and prioritize rice research, it is essential to have a comprehensive understanding of the socioeconomic factors that influence rice producers' and consumers' circumstances and drive their decisions. Access to and use of resources—natural, physical, financial, human, and social—are key factors determining people's actions. The main focus of Project 10 is to develop and refine this understanding of rural livelihood systems.

To design and implement a successful research program, we also need to comprehend the influence and role of institutions that can affect people's lives, such as government agencies, nongovernment organizations, and international research institutions and our national agricultural research and extension partners. If IRRI is to develop strategies and technologies that can improve people's livelihoods, we must understand farmers' current practices, constraints to the adoption of improved

technologies in different agroecosystems, how components of farming systems and livelihood strategies interact, and how farmers evaluate scientific knowledge. Through this understanding, we can help develop improved research strategies and policies.

To meaningfully assess progress toward meeting the objectives of rice research, it is crucial that research managers and policymakers know how policies and technologies affect various socioeconomic groups, poverty rates, and natural resource use. Understand-

ing the factors that drive decisions at the household level and the patterns that operate on larger geographic and time scales—such as trends in production, pricing, and trade—can shed light on emerging rice supply-and-demand balances, competition for resources by alternative economic activities, and



constraints to improvements in rice production.

Output 1: Rice-sector analysis conducted and rice statistics database maintained and shared with NARES

In 2006, we updated the electronic version of the Rice Statistics Database, which includes basic data on rice production, yield, and area at subnational levels. The database is useful for promoting improved understanding of developments in the rice sector and thus facilitating more effective planning of rice research and the design of agricultural development policies.

We compiled subnational-level poverty maps for rice-producing countries in Asia and East Africa. The underlying data will be used to better understand spatial variation in poverty and the implications for rice research. This work has helped us to illustrate the relationships among rainfed lowland rice, drought stress, and poverty in eastern India. In the Lao PDR and Vietnam, high poverty incidence is associated with mountainous areas and upland rice production.

To facilitate gender-responsive policies and technologies, we compiled a macro database on gender-related indicators in Southeast and South Asia and related them to poverty and female participation in agriculture. Countries with low and medium achievements in human development and gender development indices tend to be low-income food-deficit countries, and have a larger share of women in agriculture. These countries also have a large proportion of rainfed agriculture.

We collected micro data (including male and female literacy rates, gender-differentiated labor use in rice operations, and male and female participation in decisionmaking) in eastern



India, the Philippines, Thailand, and Vietnam from selected rice-growing villages. Among the countries where rice is the major crop, female labor participation is highest in eastern India, which has vast rainfed rice environments prone to abiotic stresses, where poverty is pervasive, and where the majority of females have not attended school. In contrast, female labor participation in rice production is lowest in the Philippines due to higher literacy rates, greater mobility, and more opportunities for nonfarm employment for women. They have greater decision-making authority in household- and agriculture-related matters compared with rural women in eastern India. The overall analysis indicates that persisting indifference to rural women's contribution to agriculture (especially to rice production) and the constraints to women's access to productive resources can impede the achievement of food-security goals. The knowledge gained from these studies facilitates the development of policies and research strategies that provide men and women with equal access to technical knowledge, skills, and opportunities to enable their families to improve income and reduce drudgery for female rice farmers.

Output 2: Rural livelihood systems studied and the interaction among technology, infrastructure, and institutions analyzed

Researchers collected baseline information on the occurrence and extent of male out-migration and off-farm work in major rice- and mixed-cropping production environments in the Philippines, Thailand, and Vietnam. Australia was also included in this study because it provides the perspective of a country with a strong agricultural sector that has undergone changes in labor patterns, and where strong global competition in agricultural markets is pushing a change in the ways farms are being managed. Just as in developing countries, economic pressures—especially in the light of severe drought in recent years—push members of farm households, who normally work on the farm, to seek off-farm work, leaving one partner to look after the farm. Reports on village-level surveys to establish the incidence and patterns of labor out-migration were completed, as were surveys of 800 farming households with and without migrants in Australia, the Philippines, Thailand, and Vietnam.

Results from the Philippines, Thailand, and Vietnam indicate that, aside



from their traditional roles as unpaid family workers, women have additional responsibilities, including hiring and supervising laborers, and managing the farm. However, without new knowledge on improved rice varieties and associated crop management technologies, they are less able than men—who tend to have better access to information—to make sound decisions on agriculture-related matters. Women often receive advice from neighbors, friends, and input salespeople, but rarely from extension workers. These findings highlight the need to provide technical knowledge and skills to female farmers to enable them to make sound farm management decisions. Such a strategy is expected to contribute toward improvements in labor productivity and income, and a reduction in drudgery for women farmers. The preliminary findings were presented at the Women Unite conference in Perth, Australia, on 25-27 August 2006. A synthesis paper was also presented at the International Rice Congress (IRC) on 9-13 October 2006 in New Delhi, India. This paper will be published by IRRI in the IRC proceedings.

Progress continued on a book on changes in the livelihood systems in Bangladesh. Aimed at development practitioners in Bangladesh and abroad,

the book will increase knowledge on factors influencing recent changes in the Bangladeshi rural economy and improve understanding of the operation of the Bangladeshi rural economy and the context of poverty. Survey data for 2004 were analyzed, and eight out of 15 chapters of the draft report were updated and revised. One chapter of the book was presented at the 26th conference of the International Association of Agricultural Economists in Gold Coast, Australia, on 12-18 August 2006. This was accepted for publication in the journal *Agricultural Economics* and is scheduled for publication in 2007.

We undertook a case study of a Philippine farming village to analyze the effects of personal networks on rural villagers' access to nonagricultural occupations and the terms of employment given to them, using data from a village that has been surveyed by IRRI over three decades. A key finding was that the role of personal networks is changing along with economic and social modernization. We found that, when villagers are employed in unskilled work in small enterprises, those who are employed by, or gain employment via referral from, a family member receive higher wages. Contrary to the case of small enterprises, unskilled

workers' wages at large enterprises were not much affected by personal networks but were largely determined by schooling years and work experience. Although personal networks were still important for the livelihood of rural people, the recent development of large-scale enterprises in the Philippines showed the diminishing importance of personal networks in unskilled labor markets. This study emphasizes the growing importance of education with economic and social modernization. If poor people have limited access to higher education—as is generally the case—poverty alleviation will occur slowly at best. There is therefore a need for policies that facilitate better educational opportunities for rice-farming communities.

We examined income dynamics in Tamil Nadu, India, in 1971-2003, concentrating on the changing roles of land and human capital. The results show that income growth from the 1970s until the early 1990s can be attributed to the rice Green Revolution and the associated development of the nonrice farm sector. Rice income grew by about 35% during this period. A moderate level of human capital was important in the early 1970s to take advantage of Green Revolution technologies. However, once the new technologies became standard among farmers in the 1980s, the contribution of human capital declined. Meanwhile, the contribution of physical capital (access to irrigation) increased throughout the Green Revolution period until the 1990s. Human capital has again become important in recent years as farm management has become more knowledge-intensive in the face of increasing scarcity of labor and water. This study stresses the importance of education for income growth not only during the initial period of the rice Green Revolution, but also more recently. The policy implication here is

that increased investment in providing education to rice-farming communities will accelerate poverty alleviation.

Output 3: Constraints to the adoption of improved rice technologies assessed

Analysis of constraints to the adoption of improved rice technologies in rainfed environments of eastern India was completed and the farm-level impacts of technologies assessed. Biophysical factors such as land type and irrigation availability are important determinants of farmers' decisions to adopt modern improved varieties. Adoption rate was found to be higher in fields with access to reliable irrigation and in villages with proportionately more lowland fields. Rice varieties with superior grain quality, such as Mahsuri, were found to substantially boost farmers' income due to their higher prices. This overall finding is expected to contribute toward changes in policy and technology design to facilitate wider adoption of improved technologies by rainfed farmers. A paper and poster on this topic were presented at the IRC.

Output 4: Impact of rice research on poverty alleviation and sustainable management of natural resources assessed

We developed a research-to-impact pathway framework that allows for some of the complexities inherent in assessing the outcomes and impacts of natural resource management (NRM) research. The purpose of the research-to-impact pathway framework is to enhance the operational processes and procedures for ex post assessment of the impact of rice research on the sustainable management of natural resources and poverty reduction. This is also expected to help improve the process of priority setting and allocation of research resources. The research-to-impact

pathway approach will be refined and implemented using IRRI's site-specific nutrient management research as a case study.

In 2001-02, IRRI invested in demonstration trials, with around 950 farmers, of *Three Reductions, Three Gains* (locally called *Ba Giam, Ba Tang*) technology across 11 provinces of the Mekong Delta region. The *Ba Giam, Ba Tang* campaign advised farmers, via a range of communication methods, to reduce their nitrogen-fertilizer rates, seed rates, and pesticide applications. Immediately after these trials, the local government in the target provinces adopted the program by training extension and technical staff, who in turn introduced the technology to rice farmers in their areas of jurisdiction. In June 2006, this program was launched nationally. The aim of the impact assessment being undertaken during 2006 and 2007 is to measure the economic returns of the research project and subsequent dissemination activities of this technology in the Mekong Delta region. Specifically, the analysis will assess the levels and rates of adoption, on-farm cost reductions, yield gains, and changes in farmer profits, and quantify the flow and distribution of benefits using the concept of consumer surplus. During 2006, around 400 farming households were surveyed in Can Tho and An Giang provinces. In 2007, a further 200 farmers will be surveyed in Soc Trang or Dong Thap provinces.

A research evaluation and impact assessment training workshop entitled *Concepts and tools for agricultural research evaluation and impact assessment* was held at IRRI on 24 July-4



August 2006. Twenty participants came from NARES in Bangladesh, Cambodia, China, India, Indonesia, Laos, Nepal, the Philippines, Thailand, Uzbekistan, and Vietnam. In addition, five IRRI national staff attended the workshop, which focused on providing participants with the knowledge and skills necessary to undertake ex ante and ex post economic impact assessments of agricultural research and development, and to become proficient in the use of an impact assessment software package called DREAM (Dynamic Research EvaluAtion for Managers). Priority setting and within-project evaluation were also covered, highlighting the importance of orienting and designing impact-focused research proposals, and planning for monitoring and evaluation activities from the start of the project. The main outputs were increased capacity of the participants to undertake qualitative and quantitative impact assessment, a comprehensive set of resource materials, and a detailed workshop report.

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PROJECT 11

Facilitating rice research for impact

Farmer feedback and participation in identifying, validating, adapting, and promoting potentially useful technologies is crucial. New technologies and information aimed at farmers need to be packaged for easy and effective implementation. To achieve this, the farmers themselves must contribute to the process from the very beginning. An institute can develop the best rice technologies in the world—from new varieties for cultivation through to better ways to manage a crop—but unless they can be and are adopted by farmers, their value is unlikely to be realized. Research and development are thus only part of the job of making rice farming more productive, more environmentally

sustainable, more profitable, and less tedious for poor farmers.

Hundreds of millions of rice farmers across the world stand to benefit from improved technologies. How can we reach the greatest number possible? Project 11 meets this challenge by examining fundamental issues of information and technology dissemination: the problems and opportunities faced by farmers and researchers, and the best way to package and present necessary and relevant messages. By understanding key communication and extension issues, IRRI's research remains focused on what is truly relevant and helpful.

The national agricultural research and extension systems (NARES) also

play an essential role in this process. Our NARES partners have invaluable, local on-the-ground knowledge and are at the point of transfer of new technologies to farmers. IRRI's partnerships with nongovernment organizations and private-sector specialists further boost our dissemination efforts. It is crucial that NARES maintain the capabilities needed to develop, distill, and deliver research products. IRRI therefore runs strong training programs for NARES partners on research and delivery methodologies. In this way, we ensure that new improved technologies are appropriately disseminated and used by the people who really need them: the farmers.



Output 1: Delivery strategies and devices developed

In 2006, enhanced communication strategies, including delivery methodologies and case studies, were collated for uploading to IRRI's Rice Knowledge Bank (RKB, www.knowledgebank.irri.org)—a comprehensive digital service containing information on rice production and associated training and extension methodologies. An e-learning course covering postharvest issues was developed and tested in Myanmar and Lao PDR. Additional needs-based information for improving extension capacity in meeting farmers' needs was updated, translated, and uploaded to the RKB. This is now available online through the RKB and on a CD. Policymakers have been approached to

provide more computers and training for improving extension capacity. An online version, outlining 10 successful technology scaling-up case studies, was assembled and will be completed in 2007.

Enhanced communication strategies for technology validation and scaling up were tried. Good examples include drum seeder imports and local manufacturing, and up-scaling for direct wet seeding of rice, in Bangladesh. The involvement of policymakers and media right from the validation stages led to appropriate policy support. Dialogues among research teams, the extension system, and state government policymakers in the Indian states of Chhattisgarh, Jharkhand, and West Bengal fostered greater political will to support wider scale validation and uptake of technologies.

In Vietnam, simple messages were disseminated through the *Ba Giam, Ba Tang* project, which teaches farmers to reduce their nitrogen-fertilizer rates, seed rates, and pesticide applications via various communication methods (such as entertainment-education) following dialogues with policymakers. The Ministry of Agriculture's extension budget allocated US\$230,000 for *Ba Giam, Ba Tang*. In April 2006, the minister of agriculture issued a policy letter to the agricultural sector to adopt *Ba Giam, Ba Tang* as a national policy. Provincial committees were established to provide training and report their progress to the ministry. In September 2006, a *Ba Giam, Ba Tang* implementation committee was formed with the vice-minister as chair.

Output 2: Promising technologies evaluated by farmers

The IRRI project *Accelerating technology adoption to improve rural livelihoods in the rainfed eastern Gangetic Plains*, funded by IFAD, operated in



12 sites across Bangladesh (two sites), India (nine sites), and Nepal (one site). IRRI is implementing activities at seven rice-rice and rice-legume sites, the International Maize and Wheat Improvement Center (CIMMYT) at four rice-wheat system sites, and the World Agroforestry Center (ICRAF) at one hill slope agricultural site. Based on the farmers' needs assessment, one to three potential technologies per site were selected from and validated through participatory farmer-managed trials over 2 years starting in 2004. In 2006, the project began scaling up activities on several technologies, including crop establishment methods (direct wet seeding of rice by plastic drum seeder, zero-tillage wheat in rice-wheat system); farming systems (rice-chickpea system for rainfed environments, quality protein maize hybrid intercropping with improved potato varieties); crop management (real-time nitrogen management in rice, biofertilizer-based integrated nutrient management in dry-season rice); superior rice varieties; and supplementary livelihood support systems (cultivating mushrooms, cultivating elephant-foot yams).

Direct wet seeding of rice by plastic drum seeder. Currently, Bangladeshi manufacturers are making plastic drum seeders and the technology is becoming mainstream. About 10,000 drum seeders are in the field and, in the 2006-07 boro (dry) season, more than 70,000 farmers adopted direct wet seeding of rice technology covering about 20,000 hectares. In the Indian state of West Bengal in 2006, demonstrations were conducted in the *kharif* (wet) season in three districts (Nadia, Hooghly, and Burdwan). However, in the current boro season, the Department of Panchayat and Rural Development is validating the technology in four districts (Purulia, Malda, Dashin Dinajpur, and Murshidabad) through 85 demonstration-cum-validation trials. There are 200 Vietnamese-made plastic drum seeders in the state and a Kerala-based company has started manufacturing and marketing plastic drum seeders in India. A few validation trials were conducted in the 2006 kharif season in India's Jharkhand State. The performance of direct wet seeding of rice created enthusiasm among research and extension officials and local farmers.

Currently, there are 50 drum seeders with Birsa Agricultural University at Ranchi and large-scale validation in the *aus* (summer) rice season is in progress.

Rice-chickpea system for rainfed environments. This system—line-sown short-duration rice followed by chickpea—has shown great potential to boost yields and income in rainfed environments of Chhattisgarh, India. In 2006-07, line-sown rice covered 480 hectares in two intervention villages (where potential technology was validated through farmer participatory, farmer-managed research) and approximately 390 hectares in adjoining nonintervention villages. To extend the technology in the state, dynamic leadership, linkage between governmental and nongovernmental sectors, and appropriate policy support for extension and creation of service providers for line seeding will be needed. Validation of the rice-chickpea system using a short-duration rice variety in Jharkhand did not succeed mainly because chickpea failed to germinate in extreme drought conditions.

Real-time nitrogen management in rice. Leaf color chart (LCC) use to manage nitrogen fertilizer applications in Nadia District of West Bengal has led to an average savings of 900 rupees (US\$20) per hectare (11.2% of the average profit) and the environmental benefit from reduced nitrogen and insecticide use has been enormous. In trials up to 2006, LCC adopters reduced nitrogen application by about 19% (25 kg per hectare) and insecticide sprays by 50% without affecting yields. LCCs are now being produced and marketed by a Chennai-based company at 25 rupees (\$0.56) per piece. Proper promotion and availability of the LCC at the grassroots level are necessary for wider adoption.

Biofertilizer-based integrated nutrient management in dry-season rice. Additional income generated by

biofertilizer-based integrated nutrient management (*Azospirillum* and phosphate-solubilizing bacteria) was 9,800 rupees (\$220) per hectare over the farmers' practice and 700 rupees (\$16) per hectare over recommended fertilizer management. However, availability and promotion of biofertilizer have not progressed sufficiently for adoption by farmers.

Superior rice varieties. Work on scaling up the adoption of superior varieties continued in 2006. The varieties promoted were BRRI dhan 44 (used in tidal wetlands of Bangladesh; superior to the currently grown rice varieties in terms of yield, grain type, and market price; being used by several hundred farmers of at least 50 villages); Anjali (short-duration variety developed for fragile rainfed bounded uplands of Jharkhand; scaling up adoption of Anjali through farmer-to-farmer seed exchange and through nongovernment organizations is in progress, but involvement of the state agricultural

department in seed production and extension is lacking or limited); Durga and Gayatri (high-yielding varieties released to replace low-yielding traditional varieties in the submergence-prone rainfed lowlands of Orissa, India; adoption is increasing through farmer-to-farmer seed exchange but effective research and extension—governmental and nongovernmental—linkage and policy support for adoption beyond the intervention villages appears lacking); and Joymati, Joytiprasad, Kanaklata, Basudev, and Padmanath (adoption of modern boro varieties Joymati, Joytiprasad, and Kanaklata, and improved deepwater varieties Basudev and Padmanath, is increasing through farmer-to-farmer seed exchange but effective research and extension linkage and policy support for adoption are needed).

In 2006, we identified farmers' needs in several target countries, and tested appropriate technologies that had potential to address high-priority needs. Needs assessments and baseline



studies were conducted in four villages in the Vietnamese provinces of Long An and Nam Dinh, and in eight villages in the Cambodian provinces of Battambang and Prey Veng. Postharvest needs assessments were also conducted in Myanmar. The results of the studies guided the development of curricula for farmers' training, the selection of improved postharvest technology options for target villages, and the participatory verification of hermetic storage systems, rice dryers, and quality evaluation tools in the target villages.

We began field testing of hermetic storage systems (the superbag) for farmers, seed producers, and millers in Myanmar, Indonesia, Lao PDR, Cambodia, and Vietnam. Use of the superbag results in higher income through better quality seeds and reduced losses, and also increases milling quality.

In Myanmar, Cambodia, and Lao PDR, evaluations of drying systems were ongoing. Preliminary results indicated farmers could achieve higher income through better quality grain, fewer losses due to improper sun-drying, and reduced weather risk.

Laser leveling of rice fields was demonstrated in Vietnam and Myanmar. Field trials have indicated that this technology is contributing to higher income from higher yields due to better water control and more even ripening of the crop. In Vietnam, the promotion of laser leveling was included in a government program in An Giang Province.

A number of promising rice lines, including an iron-rich line, were prepared for release (scheduled for early 2007) due to their excellent performance in farmers' fields. In 2006, integrated crop management was implemented on 500,000 hectares in Indonesia, covering 130 districts of 22 provinces. In 2007, this is set to expand to 1.0 million hectares covering 135



districts. The Indonesian government ordered more than 60,000 LCC, which were to be distributed in early 2007. The government plans to order another 50,000 in 2007.

Output 3: Human capital developed

Several hundred researchers and extension officers were trained in priority topics using appropriate educational methodologies. Following this, RKB country sites were established and increasingly used. English versions of postharvest training materials (fact sheets, reference manuals, and PowerPoint presentations) were completed. Farmer intermediaries are accessing these through the RKB (online and on CD). Hands-on postharvest management and grain quality training for farmer intermediaries was conducted in Indonesia (35 participants), Lao PDR (18 participants), Myanmar (23 participants), Vietnam (25 participants), and Cambodia (28 farmer intermediaries and 691 farmers). Laser-leveling training was conducted in Myanmar (12 participants) and private-sector contractors

were taught how to provide laser-assisted leveling services to farmers.

Over 100 researchers and extension agents from Myanmar, Laos, Cambodia, Vietnam, and China were trained on the use of the RKB (online and on CD). Around 40 researchers from Bangladesh, Burundi, Indonesia, Iran, Japan, Myanmar, Nepal, the Philippines, Sri Lanka, and Vietnam received training on statistics and experimental design at IRRI headquarters. Around 100 researchers and extension workers received training on site-specific nutrient management. Twenty-seven researchers and extension agents from Bangladesh, Cambodia, India, Indonesia, Lao PDR, Nepal, the Philippines, Thailand, and Vietnam were trained on participatory approaches to research and extension, also at IRRI headquarters.

Project leader

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FINANCIAL SUPPORT AND SPECIAL-FUNDED PROJECTS THAT STARTED IN 2006

Summary of financial support to IRRI research agenda, 2006 (in US \$'000).^a

Asian Development Bank	1,133
Australia	1,006
Canada	996
Challenge Programs	
Generation	1,585
Harvest Plus	594
Water and Food	2,480
China	140
Denmark	481
European Commission	210
Food and Agriculture Organization of the United Nations	10
France	483
Germany	
Federal Ministry for Economic Cooperation and Development	381
Federal Ministry for Economic Cooperation and Development /German Agency for Technical Cooperation	861
Global Crop Diversity Trust	217
Grain Biotech Australia	20
Grand Challenges in Global Health through Albert-Ludwigs University of Friedburg	167
India	450
International Fertilizer Industry Association, International Plant Nutrition Institute, and International Potash Institute	198
International Fund for Agricultural Development	681
Iran	62
Japan	2,430
Korea	843
Malaysia	32
Mexico	10
Monsanto Fund	6
Netherlands	410
Norway	323
Nunhems B.V.	32
Philippines	145
Rockefeller Foundation	477
Sweden	478
Switzerland	1,806
Thailand	40
United Kingdom	2,268
United States of America	
United States Agency for International Development	3,679
United States Department of Agriculture	94
Vietnam	15
World Bank	2,626
Others	41
Total	27,910

^a See Appendix 3 for audited financial statements.

● Agriculture Network Information Center

- Enabling open access to IRRI-assisted theses and dissertations (DPPC2006-72), 2006/09/30 - 2007/09/30

● Asian Development Bank

- Development and dissemination of water-saving rice technologies in South Asia (DPPC2005-38), 2006/01/01 - 2009/05/31

● Australian Centre for International Agricultural Research

- Implementation of rodent management in intensive irrigated rice production systems in Indonesia and Vietnam (DPPC2005-67), 2006/04/01 - 2009/09/30
- Training workshop on Evaluation Training for Agricultural Research Projects for Papua New Guinea researchers and officials responsible for planning, implementing and evaluating research programs in Papua New Guinea (DPPC2006-49), 2006/04/24 - 2006/06/01
- Training Workshop on Application of Participatory Approaches to Agricultural Research and Extension (DPPC2006-74), 2006/07/20 - 2006/09/18
- Workshop on Leadership for Asian Women in Agriculture R & D and Extension (DPPC2006-119), 2006/11/27 - 2007/01/08

● Bureau of Agricultural Research–Philippines

- Improving knowledge exchange and decision making among rice stakeholders through ICT-based technology promotion and delivery systems (DPPC2005-27), 2006/01/01 - 2008/12/31

● Gangwon Agricultural Research and Extension Services

- Major characteristics evaluation of early maturing japonica rice (DPPC2006-136), 2006/12/26 - 2007/11/30

- **Generation Challenge Program: Cultivating Plant Diversity for the Resource-Poor**
 - Creation of institutional bioinformatics capacity (DPPC2006-07), 2006/01/01 - 2006/12/31
 - Developing strategies for allele mining within large collections (DPPC2005-87), 2006/01/01 - 2007/12/31
 - Development of an integrated GCP information platform (DPPC2005-88), 2006/01/01 - 2006/12/31
 - A dataset on allele diversity at orthologous candidate genes in GCP crops (ADOC) (DPPC2006-17), 2006/01/01 - 2006/12/31
 - GenerationCP data quality improvement and assurance (DPPC2005-89), 2006/01/01 - 2007/12/31
 - SNP analysis of the genetic diversity along the rice genome (HAPLORYZA) (DPPC2005-91), 2006/01/01 - 2007/12/31
 - Data analysis support for existing projects in SP2 with emphasis on integrating results across gene expression and QTL mapping experiments (DPPC2006-77), 2006/08/01 - 2007/07/31
- **Global Crop Diversity Trust**
 - Development of a global strategy for the ex situ conservation of rice (DPPC2006-21), 2006/04/01 - 2007/03/31
 - Long-term funding of the ex-situ collection of rice germplasm held by the International Rice Research Institute (DPPC2006-115), 2006/11/01 -
- **International Atomic Energy Agency**
 - Dissecting drought tolerance mechanisms in rice through gain-of-function deletion mutants (DPPC2006-42), 2006/06/15 - 2007/06/14
- **International Plant Nutrition Institute (formerly Potash and Phosphate Institute/Potash and Phosphate Institute of Canada)**
 - Reaching toward optimal productivity in intensive, irrigated rice systems: the development, evaluation, and delivery of site-specific nutrient management in Myanmar (activities for 2006) (DPPC2005-94), 2006/01/01 - 2006/12/31
- **Japan International Cooperation Agency**
 - Training course on Upland Rice Variety Selection Techniques for African Countries (DPPC2006-83), 2006/09/15 - 2006/11/30
- **Malaysian Agricultural Research and Development Institute**
 - Genetic enhancement for high-quality rice (DPPC2005-64), 2006/01/01 - 2008/12/30
- **Nunhems B.V.**
 - Further development of ICIS in collaboration with Nunhems -Phase II (DPPC2006-35), 2006/04/01 - 2010/03/31
- **Plan International**
 - Poverty reduction options validated in drought environments (DPPC2005-30), 2006/09/01 - 2007/03/31
- **Rural Development Administration**
 - RDA-IRRI cooperative research projects (2006-2007) (DPPC2006-64), 2006/01/01 - 2007/12/31
 - RDA-IRRI special collaborative research projects (1. Functional genomics approach to identification of broad-spectrum resistance genes against rice blast disease in Korean germplasm; 2. Broadening gene pool of rice: Wild species introgression and marker (DPPC2006-67), 2006/09/01 - 2009/08/31
- **Swiss Agency for Development and Cooperation**
 - Lao PDR -IRRI Rice Research and Training Project (LIRRTP) transition phase (DPPC2006-100), 2006/10/01 - 2007/09/30
- **University of California-Berkeley**
 - BioGeomancer project (collaboration of biodiversity and geospatial data experts (DPPC2006-36), 2006/05/15 - 2007/03/01
- **United States Department of Agriculture**
 - Cold stress response gene regulon in rice (DPPC2005-32), 2006/06/01 - 2009/05/31
- **Value Added Wheat CRC**
 - Further development of ICIS by collaboration of IRRI with Value Added Wheat (DPPC2006-58), 2006/07/01 - 2008/06/30

MEMORANDA OF AGREEMENT: PARTNER INSTITUTIONS IRRI ENTERED INTO AGREEMENTS WITH IN 2006

Australia

- Australian Centre for International Agricultural Research (ACIAR). Variation No. 1 relating to Project No. PLIA/2000/039 *Impact of migration and/or on-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems*, extending the project until 31 December 2007 (DPPC2001-06). 10 Feb 2006
- Australian Centre for International Agricultural Research (ACIAR). Deed of Agreement between ACIAR and IRRI for the project *Implementation of rodent management in intensive irrigated rice production systems in Indonesia and Vietnam* (DPPC2005-67). 01 Apr 2006 – 30 Sep 2009
- Australian Centre for International Agricultural Research (ACIAR). Contract (No. C2006/058) between ACIAR and IRRI for the project *Workshop on Leadership for Asian Women in Agriculture R & D and Extension* (DPPC2006-119). 10 Oct 2006
- Australian Centre for International Agricultural Research (ACIAR). Contract (No. C2005/147) between ACIAR and IRRI for the project *Training workshop on Evaluation Training for Agricultural Research Projects for Papua New Guinea researchers and officials responsible for planning, implementing, and evaluating research programs in Papua New Guinea* (DPPC2006-49). 24 Apr 2006
- Australian Centre for International Agricultural Research (ACIAR). Contract (No. C2005/222) between ACIAR and IRRI for the project *Training Workshop on Application of Participatory Approaches to Agricultural Research and Extension* (DPPC2006-74). 20 Jul 2006
- Australian Centre for International Agricultural Research (ACIAR). Contract (No. L2005109) between ACIAR and IRRI re: *Publication of Rice in Laos* (DPPC2006-75). 28 Jun 2006
- BCM Software Tools PTY Ltd. Software License-Services Agreement between BCM Software Tools PTY Ltd. and IRRI relative to the Shadow Planner Business Continuity Software for the project *ICT-KM Project on Security and Business Continuity* (DPPC2005-31). 13 Nov 2006
- Charles Sturt University (CSU). Memorandum of Agreement between the Charles Sturt University and IRRI for the supervision of Doctor of Philosophy students. 27 Jan 2006 – 26 Jan 2009
- The Cooperative Research Centre for Value Added Wheat (Value Added Wheat CRC). Project agreement between Value Added Wheat CRC and IRRI for the collaborative project *Further development of ICIS* (DPPC2006-58). 01 Jul 2006 – 30 Jun 2008
- New South Wales Department of Primary Industries for and in behalf of the State of New South Wales (NSW DPI). Memorandum of Understanding between the New South Wales Department of Primary Industries and IRRI to further strengthen cooperation in relevant areas of collaboration among IRRI and NSW DPI scientists and professional and technical staff, and in the training of graduate students. 10 Apr 2006 – 09 Apr 2011

Austria

- International Atomic Energy Agency (IAEA). Renewal of Technical Contract No. 13099/Ro between IAEA and IRRI for the project *Selection for greater agronomic water-use efficiency in wheat and rice using carbon isotope discrimination* (DPPC2002-51). 15 Dec 2006 – 14 Dec 2007
- International Atomic Energy Agency (IAEA). Technical Contract No. 13776 between IAEA and IRRI for the project *Dissecting drought tolerance mechanisms in rice through gain of function deletion mutants* (DPPC2006-42). 15 Jun 2006 – 14 Jun 2007

Bangladesh

- Agricultural Advisory Society (AAS). Letter of Agreement between AAS and IRRI for the collaborative project *Experimentation on ways of using the Bangladesh Rice Knowledge Bank (BRKB)* (DPPC2006-61). 09 Jun 2006
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between BRRI and IRRI for the purpose of implementing the research activities of the project *Development of rice with elevated iron and zinc in the polished grain: Phase 1 – understand and exploit G × E interactions for high iron/zinc in the polished grain*, a subproject of the HarvestPlus Challenge Program-funded project *Micronutrient-dense rice to reduce malnutrition* (DPPC2003-70). 22 Sep 2006
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between BRRI and IRRI for the ADB-funded project *Development and dissemination of water-saving rice technologies in South Asia* (DPPC2005-38). 20 Sep 2006
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between BRRI and IRRI for the collaborative project *Improved nutrient management options in drought-prone rainfed rice in northwest Bangladesh* (DPPC2006-81). 28 Jul 2006
- Rural Development Academy (RDA), Bogra. Letter of Agreement between RDA, Bogra and IRRI for the ADB-funded project *Development and dissemination of water-saving rice technologies in South Asia* (DPPC2005-38). 27 Sep 2006

Belgium

- Bayer Bioscience, N.V. (BAYER). Agreement between BAYER and IRRI for the project *Development of ICIS in collaboration with Bayer-Phase 1* (DPPC2006-45). 26 Dec 2006

Benin

- Africa Rice Center (WARDA). Memorandum of Understanding between IRRI and WARDA to strengthen collaboration in order to help resolve high-priority rice research problems in Africa. 27 Mar 2006

Cambodia

- Battambang Provincial Department of Agriculture (BBPDA). Letter of Agreement between BBPDA (AEU:9:2006:C) and IRRI for the project *Improving poor farmers' livelihoods through post-harvest technology* (DPPC2002-37). 13 Jul 2006
- Battambang Provincial Department of Agriculture (BBPDA). Letter of Agreement between BBPDA (AEU:7:2006:C) and IRRI for the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Cambodia Agricultural Research and Development Institute (CARDI), Royal University of Agriculture (RUA), Prek Leap National School of Agriculture (PNSA), and the Department of Agricultural Extension (DAExt). Memorandum of Agreement among IRRI, CARDI, RUA, PNSA, and DAExt on the *Implementation of linking extension and research needs through information technology* (LEARN-IT) project in Cambodia (DPPC2002-36). 13 Jun 2006
- Cambodian Agricultural Research and Development Institute (CARDI). Letter of Agreement between CARDI and IRRI for the purpose of implementing research with the Consortium for Unfavorable Rice Environments (CURE). 28 Mar 2006 – 27 Mar 2009
- Cambodian Agricultural Research and Development Institute (CARDI). Letter of Agreement between CARDI and IRRI extending the Memorandum of Agreement for Scientific and Technical Collaboration in Rice and Rice-based Farming Research and Training signed on 27 Jun 2001. 20 Jun 2006 – 19 Jun 2011
- Cambodian Agricultural Research and Development Institute (CARDI). Letter of Agreement between CARDI and IRRI for the project *Improving poor farmers' livelihoods through rice information technology* (LEARN-IT) (DPPC2002-36). 28 Aug 2006
- Cambodian Agricultural Research and Development Institute (CARDI). Letter of Agreement between CARDI (AEU:11:2006:C) and IRRI for the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 13 Jun 2006
- Cambodian Agricultural Research and Development Institute (CARDI). Letter of Agreement between CARDI

for the collaborative project *Socioeconomic analysis on impact of social capital to solve conflicts for water usage groups in different modes of irrigation systems in Cambodia* (DPPC2006-98). 06 Oct 2006

- Crenn and Associates. Letter of Agreement between Crenn and Associates (AEU:5:2006:C) and IRRI for the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Department of Agricultural Extension (DAE). Letter of Agreement between DAE-Cambodia and IRRI for the project *Improving poor farmers' livelihoods through rice information technology (LEARN-IT)* (DPPC2002-36). 28 Aug 2006
- Ministry of Agriculture, Forestry and Fisheries (MAFF) of the Kingdom of Cambodia. Letter of Agreement extending the Memorandum of Understanding for Scientific and Technical Collaboration in Research and Training on Rice and Rice-based Farming systems between MAFF and IRRI. 13 Sep 2006 – 12 Sep 2011
- Plan International. Memorandum of Understanding between Plan International and IRRI to improve the livelihood of the population of the rice-growing countries in Asia. 26 Jan 2006 – 25 Jan 2011
- Plan International. Service Agreement between Plan International and IRRI for the project *Poverty reduction options validated in drought environments (PROVIDE)* (DPPC2005-30). 2006 Sep – 2007 Mar
- Prek Leap National School of Agriculture (PNSA). Letter of Agreement between PNSA and IRRI for the project *Improving poor farmers' livelihoods through rice information technology (LEARN-IT)* (DPPC2002-36). 28 Aug 2006
- Prey Veng Provincial Department of Agriculture (PVPDA). Letter of Agreement between PVPDA (AEU:13:2006:C) and IRRI for the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 31 Aug 2006
- Royal University of Agriculture (RUA). Letter of Agreement between RUA and IRRI for the project *Improving poor farmers' livelihoods through rice information technology (LEARN-IT)* (DPPC2002-36). 28 Aug 2006
- Srer Khmer. Letter of Agreement between Srer Khmer and IRRI for the project *Improving poor farmers' livelihoods through rice information technology (LEARN-IT)* (DPPC2002-36). 28 Aug 2006

China

- Guangdong Academy of Agricultural Sciences (GAAS). Letter of Agreement between GAAS and IRRI for the

project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 01 Sep 2006

- Guangdong Academy of Agricultural Sciences (GAAS). Letter of Agreement between GAAS and IRRI for the collaborative project *Site-specific nutrient and crop management for achieving healthy rice*, a project under the Irrigated Rice Research Consortium-Phase III - Productivity Workgroup (DPPC2005-02). 01 Dec 2006 – 31 Dec 2007
- Guangxi Academy of Agricultural Sciences (GAAS). Memorandum of Agreement between Guangxi Academy of Agricultural Sciences and IRRI on *Studying the insect ecology of wild rice in southern China*. 11 Apr 2006 – 10 Apr 2011
- Huazhong Agricultural University (HAU). Letter of Agreement between HAU and IRRI for the project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 01 Sep 2006
- Hunan Agricultural University (HAU). Letter of Agreement between HAU and IRRI for the project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 01 Sep 2006
- Hunan Agricultural University (HAU). Letter of Agreement between HAU and IRRI for the collaborative project *Site-specific nutrient and crop management for achieving healthy rice*, a project under the Irrigated Rice Research Consortium-Phase III - Productivity Workgroup (DPPC2005-02). 01 Dec 2006 – 31 Dec 2007
- Northeast Agricultural University (NEAU). Letter of Agreement between NEAU and IRRI for the collaborative project *Developing a site-specific nutrient management (SSNM) recommendation for rice in Heilongjiang province, China*, a project under the Irrigated Rice Research Consortium-Phase III - Productivity Workgroup (DPPC2005-02). 31 Aug 2006
- Wuhan University (WU). Letter of Agreement between WU and IRRI for the project *The role of water institutions and policies for efficient water use in China* (DPPC2006-129). 04 Dec 2006
- Yangzhou University (YU). Letter of Agreement between YU and IRRI for the BMZ-funded project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 01 Sep 2006
- Yangzhou University (YU). Letter of Agreement between YU and IRRI for the collaborative project *Site-specific nutrient and crop management for achieving healthy rice*, a project under the Irrigated Rice Research Consortium-Phase III - Productivity Workgroup (DPPC2005-02). 01 Dec 2006 – 31 Dec 2007

- Yunnan Agricultural University (YAU). Letter of Agreement between YAU and IRRI for the collaborative project *Field performance evaluation and selection of GUYA elite lines in the tropics* (DPPC2006-39). 12 Oct 2006
- Zhejiang Academy of Agricultural Sciences (ZAAS). Letter of Agreement between ZAAS and IRRI for the SIF-funded project *Induced plant responses: a potential approach for managing insect pests* (DPPC2004-98). 27 Jun 2006
- Zhongnan University of Economics and Law. Letter of Agreement between Zhongnan University of Economics and Law and IRRI for the project *Study on upland rice systems and farmer livelihoods in China* (DPPC2006-127). 27 Nov 2006

Colombia

- Centro Internacional de Agricultura Tropical (CIAT). Memorandum of Agreement between CIAT and IRRI on scientific and training collaboration in the development of a core INGER germplasm pool for Latin America and the Caribbean and the development of an initial Spanish-language version of the Rice Knowledge Bank. 03 Aug 2006 – 02 Aug 2011
- Centro Internacional de Agricultura Tropical (CIAT) and International Food Policy Research Institute (IFPRI) on behalf of the HarvestPlus Challenge Program. Amendment No. 3 to HarvestPlus Contract #5007 relative to the extension of the project end date to 31 December 2006 of the project *Micronutrient-dense rice to reduce malnutrition* (DPPC2003-70). 22 Feb 2006
- Centro Internacional de Agricultura Tropical (CIAT) and International Food Policy Research Institute (IFPRI) on behalf of the HarvestPlus Challenge Program. Amendment No. 4 to HarvestPlus Contract #5007 relative to the increase in the contract value of the project *Micronutrient-dense rice to reduce malnutrition* (DPPC2003-70). 02 Jun 2006
- Centro Internacional de Agricultura Tropical (CIAT) and International Food Policy Research Institute (IFPRI) on behalf of the HarvestPlus Challenge Program. Amendment No. 3 to HarvestPlus Contract #7007 relative to the extension of the project end date to 30 June 2006 of the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (DPPC2004-16). 10 Feb 2006
- Centro Internacional de Agricultura Tropical (CIAT) and International Food Policy Research Institute (IFPRI) on behalf of the HarvestPlus Challenge Program. Amendment No. 4 to HarvestPlus Contract #7007 relative to the extension of the project end date to 31 December 2006 of the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (DPPC2004-16). 19 Oct 2006
- Centro Internacional de Agricultura Tropical (CIAT). Amendment No. 1 to Contract #-071-05 on the extension of the project *Developing biofortified iron-dense rice for India* (in collaboration with the HarvestPlus Challenge Program) with no additional cost (DPPC2004-43). 01 Jul 2006 – 31 Dec 2006

Egypt

- Rice Research and Training Center (RRTC). Letter of Agreement between RRTC and IRRI for the CPWF-funded project *Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong, and Nile River basins* (DPPC203-21). 04 Jul 2006

France

- Centre de coopération internationale en recherche agronomique pour le développement (CIRAD). Protocol of Agreement between CIRAD and IRRI for the services of Dr. Damien Jourdain to participate in the CPWF-funded project *Rice landscape management for raising water productivity, conserving resources, and improving livelihoods in upper catchments of the Mekong and Red River basins* (DPPC2003-23). 26 Apr 2006 – 25 Apr 2009
- L'Institut de recherche pour le développement (IRD). Amendment No. 5 for the year 2006 to the Protocol of Agreement between IRD and IRRI to pursue the activities of Dr. Georges Reversat to develop a joint IRD-IRRI shuttle project (in English and French versions). 09 Feb 2006 – 08 Feb 2007

Germany

- Forschungszentrum Karlsruhe GmbH. Memorandum of Agreement between Forschungszentrum and IRRI for research collaboration in the area of sustaining productivity in intensive rice systems: rice and environment (appointment of Dr. Reiner Wassman as Rice and Climate Change Consortium [RCCC] coordinator). 01 Oct 2006 – 30 Sep 2009
- University of Hamburg. Letter of Agreement between the University of Hamburg and IRRI for the project *Carbon-*

ized organic matter as soil amendment and for carbon sequestration in rainfed lowland rice (DPPC2005-76). 01 Aug 2006

- UFZ Centre for Environmental Research Leipzig-Halle GmbH. Amendment to the Research Agreement between UFZ and IRRI for the project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 26 Apr 2006

India

- Anand Agricultural University (AAU). Letter of Agreement between AAU and IRRI for the BMZ-funded project *Applying genetic diversity and genomic tools to benefit rice farmers at risk from drought* (DPPC2003-41). 27 Nov 2006
- Anand Agricultural University (AAU). Letter of Agreement between AAU and IRRI for the RF/GCP-funded project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 27 Nov 2006
- Assam Agricultural University (AAU). Letter of Agreement between AAU and IRRI for the project *Managing rice landscapes in marginal uplands for household food security and environmental sustainability* (DPPC2003-08). 17 Jul 2006
- Assam Agricultural University (AAU). Letter of Agreement between AAU and IRRI for the project 2006 *Program of the Eastern Indian Rainfed Lowland Rice Shuttle Breeding Network (EIRLSBN)* (DPPC2006-133). 13 Nov 2006
- Birsa Agricultural University (BAU). Letter of Agreement between BAU and IRRI for the BMZ-funded project *Applying genetic diversity and genomic tools to benefit rice farmers at risk from drought* (DPPC2003-41). 27 Nov 2006
- Birsa Agricultural University (BAU). Letter of Agreement between BAU and IRRI for the RF/GCP-funded project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 27 Nov 2006
- Central Rainfed Upland Rice Research Station (CRURRS). Letter of Agreement between CRURRS and IRRI for the BMZ-funded project *Applying genetic diversity and genomic tools to benefit rice farmers at risk from drought* (DPPC2003-41). 27 Nov 2006
- Central Rainfed Upland Rice Research Station (CRURRS). Letter of Agreement between CRURRS and IRRI for the RF/GCP-funded project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 14 Jun 2006
- Central Rice Research Institute (CRRI). Letter of Agreement between CRRI and IRRI for the RF/GCP-funded project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 10 Jan 2006
- Central Rice Research Institute (CRRI). Letter of Agreement between CRRI and IRRI for the project 2006 *Program of the Eastern Indian Rainfed Lowland Rice Shuttle Breeding Network (EIRLSBN)* (DPPC2006-133). 13 Nov 2006
- Govind Ballabh Pant University of Agriculture and Technology (GBPUAT). Amendment No. 1 to the Letter of Agreement between GBPUAT and IRRI for the collaborative project *Dissemination of SSNM in rice-wheat systems in northern India*, a project under Irrigated Rice Research Consortium-Phase III - Productivity Workgroup (DPPC2005-02). 21 Jun 2006
- Govind Ballabh Pant University of Agriculture and Technology (GBPUAT). Letter of Agreement between GBPUAT and IRRI for the project *Impact of male labor out-migration on rice household economy and changes in gender role in Uttaranchal, India and Seed health improvement for women farmers in Uttaranchal, India* (DPPC2006-38). 14 Mar 2006
- ICAR Research Complex for NEH Region. Letter of Agreement between ICAR Research Complex for NEH Region and IRRI for the RF/GCP-funded project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 27 Nov 2006
- The Energy and Resources Institute (TERI). Letter of Agreement between TERI and IRRI for the BMZ-funded project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 23 Feb 2006
- The Energy and Resources Institute (TERI). Letter of Agreement between TERI and IRRI for the project *Collaborative research on soil quality in rice-based system* (DPPC2006-126). 09 Nov 2006
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- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between VIAEP and IRRI to collaborate with Mr. Nguyen The Truong (AEU:8:2006:V) on the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
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- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between VIAEP and IRRI to collaborate with Dr. Tran Thi Mai (AEU:6:2006:V) on the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between VIAEP and IRRI to collaborate with Mr. Nguyen Van Con (AEU:5:2006:V) on the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between VIAEP and IRRI to collaborate with Mr. Nguyen The Truong (AEU:4:2006:V) on the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between VIAEP and IRRI to collaborate with Mr. Vu Cong Khanh (AEU:3:2006:V) on the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between VIAEP and IRRI to collaborate with Mr. Tran Phuong Nga (AEU:2:2006:V) on the project *Improving poor farmers' livelihoods through postharvest technology* (DPPC2002-37). 04 Apr 2006
- Vietnam Agricultural Science Institute (VASI). Letter of Agreement between VASI and IRRI for the project *Managing rice landscapes in marginal uplands for household food security and environmental sustainability* (DPPC2003-08). 10 Jul 2006
- Vietnamese Academy of Agricultural Sciences (VAAS), Ministry of Agriculture and Rural Development (MARD). Letter of Agreement between IRRI and VAAS-MARD for the project *Improving poor farmers' livelihoods through rice information technology (LEARN-IT)* (DPPC2002-36). 21 Jun 2006
- Voice of Ho Chi Minh (VOH). Letter of Agreement between VOH and IRRI for the collaborative project *Environmental radio soap opera for rural Vietnam* (DPPC2005-18). 27 Mar 2006
- World Vision-Vietnam (WVV). Letter of Agreement between IRRI and WVV for the project *Improving poor farmers' livelihoods through rice information technology (LEARN-IT)* (DPPC2002-36). 21 Jun 2006

HONORS, AWARDS, AND APPOINTMENTS FOR IRS, NRS, AND BOT IN 2006

Adelaida A. Alcantara, Roniela H. Prantilla, Ma. Corina Habito, Flora de Guzman, Thomas Metz, and Nigel Ruaraidh Sackville Hamilton, PBGB

- Won the Best Poster Extension (Education Category), *Management of the world's largest rice collection through information technology*, 36th Conference, Crop Science Society of the Philippines Palawan, May.

Adam Barclay, international research fellow, CPS

- Won a Gold Award (1st place) in writing (Magazine Category), *Dreams beyond drought*, Association for Communications Excellence Annual International Meeting, Quebec, Canada, June.
- Won first prize, *Direct success*, 2006 CGIAR photo competition, Washington, D.C., USA, December.

L.M. Borines (Leyte State University), S.A. Ordoñez (PhilRice), M.P. Natural (UPLB), B.W. Porter (Kansas State University), F. White (KSU), C.M. Vera Cruz (IRRI), H. Leung (IRRI), and E.D. Redoña (PhilRice)

- Won the Best Paper Award (Upstream Category), *Development of bacterial blight-resistant hybrid rice parental lines through bi-directional marker-aided selection*, 36th Conference, Crop Science Society of the Philippines, Palawan, May.

Darshan Brar, senior scientist, PBGB

- Named Fellow and Honorary Fellow of the National Academy of Agricultural Sciences and Punjab Academy of Sciences, India, 9th Punjab Science Congress, Suman, India, February.

Roland Buresh, soil scientist, CESD

- Presented with a merit medal for his long-term efforts in support of Vietnamese agriculture and rural development, Ministry of Agriculture and Rural Development, Vietnam, August.

- Received an Achievement Award for his notable achievements in research on soil and nutrient management and in actively collaborating with soil scientists from Asian and African countries, particularly the Philippines, 9th Annual Meeting and Scientific Symposium, Philippine Society of Soil Science and Technology, June.

Maria Gay C. Carillo, PhD research scholar, PBGB

- Awarded as one of five student speakers, 6th I. E. Melhus Graduate Student Symposium. She presented *Integrating phenotypic, molecular, and in silico approaches for quantitative resistance to rice blast*, 98th Annual Meeting, American Phytopathological Society, Quebec City, Canada, July.

Gelia T. Castillo, national scientist/IRRI consultant

- Conferred with a Doctor of Science (Rural Sociology, honoris causa) for outstanding contributions as a rural sociologist and first social scientist to raise the level of research as a tool for development studies, De La Salle University, Manila, June.

K.L. Heong, deputy division head, CESD

- Appointed adjunct professor, Fujian Agriculture and Forestry University, China, August.
- Named recipient of the Third World Academy of Science (TWAS) Prize in Agricultural Sciences 2006, TWAS 10th General Conference, Brazil, September.

IRRI

- Named among CIO 100 Honorees for 2006 as one of Asia's top strategic users of IT, CIO Asia, April.

IRRI Emergency Brigade

- Received a commendation for quick response to a dormitory fire on 5 February, Municipal Government of Los Baños, Laguna, Philippines, March.
- Received the IRRI Award for Outstanding Support of IRRI's Mission, NRS Awards Ceremony, April.

Ariel Javellana, officer-photography, CPS

- Won third prize, *Reflection of a farmer transplanting HYVs on a paddy field*, 2006 CGIAR photo competition, Washington, D.C., USA, December

Gurdev Khush, former principal plant breeder

- Conferred an honorary degree of Doctor of Science (honoris causa), Ohio State University, USA, March.

Tanguy Lafarge, Crisanta S. Bueno, and Estela Pasuquin, CESD

- Won the Best Poster Award in the Plant Traits and Physiology of Crop Adaptation Session, International Workshop on Gene-Plant-Crop Relations, Scale, and Complexity in Plant Systems Research, Wageningen University, The Netherlands, April.

Jan E. Leach, IIRRI adjunct scientist, Colorado State University

- Took over as president of the American Phytopathological Society for 2006-07, July.

Hei Leung, senior scientist, EPPD

- Recognized as Fellow of the American Association for the Advancement of Science (AAAS), Fellows Forum, Annual Meeting of the AAAS, St. Louis, USA, February.

David Mackill, head, PBGB

- Named Honorary Fellow, Crop Science Society of the Philippines (CSSP), for his contributions to the rice varietal improvement programs in the Philippines and other rice-growing countries, 36th Conference, Crop Science Society of the Philippines, Palawan, May.

A. Colin McClung (former associate director, IIRRI)

- Received the 2006 World Food Prize for his contribution to the significant increase in the quality, quantity, or availability of food in the world, U.S. State Department, June.

Angelita M. del Mundo and Angelina dR. Felix (UPLB), Glenn B. Gregorio, Dante L. Adorada, and Cristina B. Sison (IRRI), Jere D. Haas (Cornell University), and John L. Beard and Laura E. Murray Kolb (Pennsylvania State University, USA)

- Won the Philippine Agriculture and Resources Research Foundation, Inc. R&D Award under the 2006 Los Baños Science Community Foundation, Inc. R&D Award for Agriculture and Forestry (research category) for the

scientific paper, *Rice biofortification as a viable approach towards improved human nutrition*, July.

William G. Padolina, deputy director general for Operations and Support Services

- Named editor-in-chief of the *Philippine Journal of Science*, a technical journal on natural sciences, engineering, mathematics, and social sciences accredited by the Institute for Scientific Information and managed by the Science and Technology Information Institute of the Philippine Department of Science and Technology, July.

Florencia Palis, postdoctoral fellow, EPPD

- Received the Director General's Award for Outstanding Scientific Achievement for her independent ethnographic research that encompassed many community settings and IIRRI projects, including her research for the advancement of knowledge, April.
- Received the Best Paper Award for *The social and cultural dimensions of rodent pest management*, 3rd International Conference on Rodent Biology and Management, Vietnam, August.

Mirasol Pampolino, Roland Buresh, and Efren Laureles (IRRI), and H.C. Gines (PhilRice)

- Received the Best Paper Award, *Long-term dynamics of soil carbon and nitrogen in lowland rice cropping systems*, 9th Annual Meeting and Scientific Symposium, Philippine Society of Soil Science and Technology, June.

Mila Ramos, head, LDS

- Received the Outstanding Academic/Research Librarian of the Year Award for 2005, 33rd Annual General Assembly, Philippine Association of Academic and Research Librarians, Manila, January.

Guo-Liang Wang, former IIRRI scholar

- Received the Syngenta Award for outstanding contribution to teaching, research, or extension in plant pathology, 98th Annual Meeting of the American Phytopathological Society, Quebec City, Canada, July.

Negussie Shoatatek Zenna, PhD scholar, EPPD

- Conferred lifetime membership by the Gamma Sigma Delta Honor Society of Agriculture for his outstanding academic achievement and his continued interest in advancing agriculture and allied disciplines, University of the Philippines, March.

PUBLICATIONS AND SEMINARS IN 2006

Journal articles (refereed)

- Alam MJ, Saha SB, Islam ML, Tuong TP. 2006. Potential of rice-fish integration in south-west coastal environment of Bangladesh. *Progr. Agric.* 17(1):189-199.
- Alam MM, Ladha JK, Foyjunnessa S, Rahman Khan S, Harun-ur-Rashid, Khan AH, Buresh RJ. 2006. Nutrient management for increased productivity of rice-wheat cropping system in Bangladesh. *Field Crops Res.* 96:374-386.
- Ali AJ, Xu JL, Ismail AM, Fu BY, Vijaykumar CHM, Gao YM, Domingo J, Maghirang R, Yu SB, Gregorio GB, Yanagihara S, Cohen M. 2006. Hidden diversity for abiotic and biotic stress tolerances in the primary gene pool of rice revealed by a large backcross breeding program. *Field Crops Res.* 97:66-76.
- Ali MA, Ladha JK, Rickman J, Lales JS. 2006. Comparison of different methods of rice establishment and nitrogen management strategies for lowland rice. *J. Crop Improv.* 16:171-187.
- Amiraju JSS, Luo N, Coicoechea JL, Wang W, Kudrna D, Mueller C, Talag J, Kim H, Sisneros NB, Blackmon B, Fang E, Tomkins J, Brar DS, Mackill DJ, McCouch S, Kurata N, Lambert G, Galbraith DW, Arumuganathan K, Rao K, Walling JG, Gill N, Yu Y, San Miguel P, Soderlund C, Jackson S, Wing RA. 2006. The *Oryza* bacterial artificial chromosome library resource: construction and analysis of 12 deep-coverage large-insect BAC libraries that represent the 10 genome types of the genus *Oryza*. *Genome Res.* 16:140-147.
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- Angeles OR, Johnson SE, Buresh RJ. 2006. Soil solution sampling method comparison for organic acid studies in rice paddy soils. *Soil Sci. Soc. Am. J.* 70:48-56.
- Arumugam K, Lafitte HR, Chen J, Mansueto L, Bruskiwich R, Bennett J. 2006. Gene expression microarrays and their application in drought stress research. *Field Crops Res.* 97:101-110.
- Atlin GN, Lafitte HR, Tao D, Laza M, Amante M, Courtois B. 2006. Developing rice cultivars for high-fertility upland systems in the Asian tropics. *Field Crops Res.* 97:43-55.
- Baisakh N, Rehana S, Rai M, Oliva N, Tan J, Mackill DJ, Khush GS, Datta K, Datta SK. 2006. Marker-free transgenic (MFT) near-isogenic introgression lines (NILs) of 'golden' indica rice (cv. IR64) with accumulation of provitamin A in the endosperm tissue. *Plant Biotechnol. J.* 4:467-475.
- Banik P, Midya A, Fajardo S, Kam SP. 2006. Natural resource inventory of Luppi Village, Eastern Plateau of India: implications for sustainable agricultural development. *J. Sustainable Agric.* 28:85-100.
- Bhandari H, Pandey S. 2006. Economics of groundwater irrigation in Nepal: some farm-level evidences. *J. Agric. Appl. Econ.* 38(1):185-199.
- Bonman JM, Bockelman HE, Goates BJ, Obert DE, McGuire PE, Qualset CO, Hijmans RJ. 2006. Geographic distribution of common and dwarf bunt resistance in landraces of *Triticum aestivum* subsp. *aestivum*. *Crop Sci.* 46: 1622-1629.
- Bouman BAM, van Laar HH. 2006. Description and evaluation of the rice growth model ORYZA2000 under nitrogen-limited conditions. *Agric. Syst.* 87:249-273.
- Bouman BAM, Yang Xiaoguang, Wang Huaqi, Wang Zhimin, Zhao Junfang, Chen Bin. 2006. Performance of aerobic rice varieties under irrigated conditions in North China. *Field Crops Res.* 97:53-65.
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- mixed agroecosystem in Vietnam. *Ecol. Appl.* 16:2000-2010.
- Bruskiewich R, Davenport G, Hazekamp T, Metz T, Ruiz M, Simon R, Takeya M, Lee J, Senger M, McLaren G, Van Hintum T. 2006. The Generation Challenge Programme (GCP)-standards for crop data. *OMICS J. Integr. Biol.* 10(2):215-219.
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- Chancellor TCB, Holt J, Villareal S, Tiongco ER, Venn J. 2006. Spread of plant virus disease to new plantings: a case study of rice tungro disease. *Adv. Virus Res.* 66:1-29.
- Chen M, Ye GY, Liu ZC, Yao HW, Chen XX, Shen SZ, Hu C, Datta SK. 2006. Field assessment of the effects of transgenic rice expressing a fused gene of *cry1Ab* and *cry1Ac* from *Bacillus thuringiensis* Berliner on nontarget planthopper and leafhopper populations. *Environ. Entomol.* 35(1):127-134.
- Chen YH, Romena A. 2006. Feeding patterns of *Scirpophaga incertulas* (Lepidoptera: Crambidae) on wild and cultivated rice during the booting stage. *Environ. Entomol.* 35(4):1094-1102.
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- Chu ZH, Fu BY, Yang H, Xu CG, Li ZK, Sanchez A, Park YJ, Bennetzen JL, Zhang QF, Wang SP. 2006. Targeting *xa13*, a recessive gene for bacterial blight resistance in rice. *Theor. Appl. Genet.* 112(3):455-461.
- Chu ZH, Yuan M, Yao J, Ge X, Yuan B, Xu C, Li X, Fu B, Li Z, Bennetzen JL, Zhang Q, Wang S. 2006. Promoter mutations of an essential gene for pollen development result in disease resistance in rice. *Genes Dev.* 20:1250-1255.
- Collard BCY, Thomson MJ, Penarubia M, Lu X, Heuer S, Wissuwa M, Mackill DJ, Ismail AM. 2006. SSR analysis of rice near-isogenic lines (NILs) for P-deficiency tolerance. *SABRAO J. Breed. Genet.* 38:131-138.
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Thursday rice research seminars (<http://Bulletin.irri.cgiar.org>)

- Effects of consuming biofortified rice on human iron status: the facts behind the trends. Dr. Angelina Felix, Institute of Human Nutrition and Food, College of Human Ecology, University of the Philippines Los Baños. The IRRI-CIMMYT Crop Research Informatics Lab. Dr. Graham McLaren.
- Targets and priorities for biodiversity conservation in natural and agricultural landscapes. Dr. Thomas Brooks, The Conservation Synthesis Department, Center for Applied Biodiversity, Science Conservation International.
- Surprising consequences of putting architecture into crop models: developmental biology provides concepts for enhancing crop growth. Dr. Michael Dingkuhn, French Agricultural Research Centre for International Development (CIRAD), France.
- IRRI information products as global public goods. Dr. Thomas Metz.
- Simulation of plant breeding programs. Prof. Ian DeLacy, School of Land and Food Sciences, University of Queensland.
- Isolation of agriculturally important genes and their utilization for rice breeding. Dr. Moto Ashikari, BioScience and Biotechnology Center, Nagoya University, Japan.
- Insect immune defenses. Dr. Norman A. Ratcliffe, personal chair, University of Wales, Swansea, UK.
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- Brar DS. 2006. Wide hybridization and alien gene introgression for rice improvement. Presented at the Cuu Long Delta Rice Research Institute, Omon, Cantho, Vietnam, 22 Sep.
- Gummert M, Rickman J. 2006. Reducing postharvest losses and adding value to farmers' grain crops. Presentation given at the Agriculture and Natural Resource Sector

The Australian rice industry: a grower's perspective. Dr. Leigh Vial, Australian rice farmer.

Applications of thermal imaging in plant stress physiology. Prof. Hamlyn Jones, University of Dundee, Scotland.

Transgenic breeding for biotic and abiotic stresses: the Indonesian experience. Dr. Inez H. Slamet-Loedin.

IRRI's strategic plan for 2007-2015: what we did and what we produced. Dr. Robert S. Zeigler.

QA at IRRI: reflections and directions. Dr. Edgar F. Paski, British Columbia Institute of Technology, Burnaby, B.C., Canada.

Green Revolution in the mountains of Vietnam: old or new recipes. Dr. Francois Affholder, agronomist/Cropping System Diagnosis and Modelling SAM, VASI-NOMARC/IRRI/CIRAD/IRAD Project.

The role of the general public in national development—why a country needs good citizens. Atty. Alexander Lacson, MALCOLM Law Office, Makati, Metro Manila.

Genomic approach for the improvement of water and nutrient use efficiency in rice. Dr. Huixia Shou, College of Life Science, Zhejiang University, China.

Yield gaps in irrigated rice: experiences from long-term experiments and implications for future research. Dr. Roland J. Buresh.

ALARM—a system to assess risks to biodiversity loss. Dr. Josef Settele, UFZ, Centre for Environmental Research, Germany.

Improving performance in water-limited environments—maintenance of growth under stress. Dr. Jill Cairns.

Submerged at IRRI: development of water-proof rice. Dr. David J. Mackill.

The BIOS Initiative: biological open source; patent transparency and distributive innovation for the future of agricultural research. Dr. Richard Jefferson, CEO, CAMBIA, Australia.

Breeding rice cultivars for water-limited environments: progress and prospects. Dr. Gary Atlin.

Ecosystem services as a framework for agriculture and resource management. Dr. Steven Cork, EcoInsights, Canberra, Australia.

Submergence tolerance: physiology of water-proof rice. Dr. Abdel Ismail.

Submergence tolerance: molecular mechanisms in water-proof rice. Dr. Sigrid Heuer.

Division seminars

Crop and Environmental Sciences

Phenotyping with plant/crop growth models—new needs for new scientific challenges: case of Ecomeristem model. Dr. Delphine Luquet, CIRAD, France.

Possibility of abiotic factors on the gradual yield decline under continuous aerobic rice cropping system. Dr. Yuka Sasaki, Faculty of Agriculture, Yamagata University, Japan.

Nitrogen cycle in a tropical watershed with predominant land use of paddy field. Dr. Sho Shiozawa, Department of Biological and Environmental Engineering, Graduate School of Agriculture and Life Sciences, The University of Tokyo, Japan.

Yield performance of hybrid and NPT rice varieties. Dr. Woon-Ho Yang.

Recent research in rice-based cropping systems in India: aerobic rice, SSNM, rice-maize and more. Dr. S.K. Sharma, Project Directorate of Cropping Systems Research, India.

Rice resistance to insect pests: old challenges and new directions. Dr. Yolanda Chen.

Update on IRRI-CIMMYT Alliance for rice-maize production systems. Dr. Roland Buresh.

Drought resistance in rice: insights toward an integrated crop improvement strategy. Dr. Rachid Serraj.

Lodging characteristics and crop management for improving lodging resistance of hybrid rice. Mr. Md Sirajul Islam.

Effect of blue green algae (*Nostoc* sp.) on soil characteristics, plant growth, and nutrient uptake. Mr. Shohei Obana, Chiba University, Japan.

Methane production and community structure of methanogenic archae in Indonesian paddy soil. Mr. Tsubasa Shimonishi, Chiba University, Japan.

Cotton resistance to bacterial blight. Dr. Michel Nicole, Research Unit—Plant Resistance to Pathogens, Institut de recherche pour le développement, Montpellier, France.

Yield failure of aerobic rice and the possible role of root-knot nematodes and fungal pathogens. Dr. Christine Kreye.

Rice nematodes: fundamentals and recent advances. Dr. Georges Reversat.

Entomology and Plant Pathology

IPM in rice mixtures and rice-vegetable cropping systems. Dr. Karen Garrett, Kansas State University, USA.

Plant Breeding, Genetics, and Biotechnology

QTL mapping and identification of beneficial alleles from *Oryza rufipogon*. Dr. Endang Septiningsih.

Evolution of rice invertase gene family and its regulation under drought stress. Dr. Xuemei Ji.

A rice gene activation/knockout mutant library and its utilization in breeding. Dr. Yue-le Hsing, Academia Sinica, Taiwan.

A tour from mapping QTLs, comparative genomics, artificial micro RNAs and back. Dr. Norman Warthmann, Max Planck Institute, Germany.

Biotechnological strategies to manipulate micronutrients in rice. Dr. Susanna Poletti, ETH Zurich, Switzerland.

Detecting useful QTLs quickly and cheaply. Dr. Gary Atlin.

Breeding rice for drought tolerance: response to selection and QTL identification. Dr. Arvind Kumar.

Marker-assisted salinity tolerance breeding: validation of *Saltol* QTL in rice. Mr. Rafiqul Islam.

Mapping QTLs for cold tolerance in rice. Dr. Hee-Jong Koh, Seoul National University, Korea.

Rice LTR retrotransposons: their impact on genome structure, expression, and evolution. Dr. Olivier Panaud, University of Perpignan, France.

Breeding for yield under drought stress in rice: response to selection and allele effects. Dr. Venuprasad Ramaiah.

Transbacker: open source gene transfer technology in rice. Mr. Richard Jefferson, CEO, CAMBIA, Australia.

Molecular understanding of drought responses in rice. Dr. Muthurajan Raveendran.

Genetic studies for resistance to green rice leafhopper (*Nephotettix cincticeps* Uhler) in rice. Dr. Daisuke Fujita.

Transgenic approaches for enhancing nutritional quality of rice. Dr. Gerard Barry.

Social Sciences

Channels of agricultural innovations within a structured space. Dr. Florencia Palis.

Project research evaluation and impact assessment: the dream model. Dr. Deborah Templeton and Ms. Lorena Villano.

Trends of poverty in rural Bangladesh, 1988-2004: Objective estimates and people's perception. Dr. Mahabub Hossain.

New wine in an old bottle. Dr. Monina Escalada.

Transforming research to benefit millions: the case of the Three Reductions–Three Gains Program in Vietnam. Dr. K.L. Heong.

Impact of micro-credit on the livelihood of the poor: the case of the Center for Agriculture and Rural Development (CARD) in the Philippines. Ms. Mary Charlotte Hanley, World Food Prize intern, Xavier High School, Iowa.

STAFF CHANGES IN 2006

January

- Dr. Rachid Serraj joined as senior scientist, crop physiology, Crop, Soil, and Water Sciences Division.
- Mr. Ian Wallace, director for administration and human resources, left.
- Dr. Samart Wanchana joined as postdoctoral fellow, Biometrics and Bioinformatics Unit.
- Dr. Madhusudan S. Kundu joined as consultant, Social Sciences Division.
- Dr. Bijay Singh joined as consultant, Crop, Soil, and Water Sciences Division.
- Dr. Joong-Hyoun Chin joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.
- Dr. Binying Fu joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.
- Mr. San-Jin Han joined as consultant, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.
- Mr. Woo-Tack Hyun joined as consultant, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.
- Dr. Manoranjan K. Mondal joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.
- Dr. Yuichiro Furukawa joined as project scientist, Crop, Soil, and Water Sciences Division.
- Mr. Doh-Won Yun, visiting research fellow, Entomology and Plant Pathology Division, left after completion of his assignment.
- Prof. Guoan Lu, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

- Mr. Orlando Santos, consultant, Office of the Deputy Director General for Partnerships, died.
- Dr. Humnath Bhandari, visiting research fellow, Social Sciences Division, left after completion of his assignment.

February

- Dr. Hari Gurung joined as international research fellow (farming systems), Social Sciences Division.
- Dr. Rubenito Lampayan joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.
- Mr. Yong-Hee Jeon, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Dr. Jung-Phil Suh joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.
- Dr. Jae-Hwan Roh joined as visiting research fellow, Entomology and Plant Pathology Division.
- Dr. Walter Roeder joined as consultant, Lao-IRRI project.
- Dr. Jeong-Eung Gi joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.
- Dr. Hatsadong joined as consultant, Lao-IRRI project.
- Dr. Yongming Gao, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Dr. Young-Chan Cho, visiting research fellow, Entomology and Plant Pathology Division, left after completion of his assignment.
- Dr. Yuka Sasaki, project scientist, Crop, Soil, and Water Sciences Division, left after completion of her assignment.

Dr. Bijay Singh, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

March

- Dr. Inez H. Slamet-Loedin joined as shuttle scientist, Intellectual Property Management Unit.
- Dr. Zahirul Islam joined as international research fellow, Social Sciences Division
- Dr. Seepana Appa Rao joined as consultant, Genetic Resources Center.
- Dr. Florencia Palis joined as postdoctoral fellow, Entomology and Plant Pathology Division.
- Mr. Geert Claessens joined as consultant, Agricultural Engineering Unit.
- Mr. A.K.M. Alamgir Chowdhury joined as consultant, Social Sciences Division.
- Mr. Sam Bona joined as consultant, Agricultural Engineering Unit.
- Ms. Fatema Zohora joined as consultant, Social Sciences Division.
- Dr. Walter Roeder, consultant, Lao-IRRI project, left after completion of his assignment.
- Dr. Jung-Hoon Kang, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Ms. Karen McAllister joined as consultant, Lao-IRRI project, and left after completion of her assignment.
- Dr. Hatsadong, consultant, Lao-IRRI project, left after completion of his assignment.
- Mr. Chang-Sik Oh, collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Dr. Jung-Phil Suh, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

April

- Mr. Abu Nasar Md. Mahfuzur Rahman joined as consultant, Social Sciences Division.
- Dr. Madhusudan S. Kundu, consultant, Social Sciences Division, left after completion of his assignment.
- Dr. Len Wade joined as consultant, Crop, Soil, and Water Sciences Division.
- Dr. Zenaida Sumalde joined as consultant, Social Sciences Division.
- Dr. David Edwards joined as consultant, Crop Research Informatics Laboratory, and left after completion of his assignment.

Mr. Michael Janich joined as consultant, Crop Research Informatics Laboratory, and left after completion of his assignment.

- Dr. Zoe Lawson joined as visiting research fellow, Genetic Resources Center.
- Dr. Jian-Long Xu joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.
- Mr. A.K.M. Alamgir Chowdhury, consultant, Social Sciences Division, left after completion of his assignment.
- Dr. Jin-Il Choung, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Dr. Kyu-Seong Lee, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Mr. O-Young Jeong, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Mr. Jong-Cheol Ko, collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.
- Dr. Madhusudan S. Kundu, consultant, Social Sciences Division, left after completion of his assignment.
- Dr. Binying Fu, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

May

- Dr. Benjamin Samson joined as scientist, agronomy, for the Highland Systems of the Greater Mekong Subregion, Crop, Soil, and Water Sciences Division.
- Dr. Kei Kajisa joined as scientist, agricultural economics, Social Sciences Division.
- Dr. Inez H. Slamet-Loedin, shuttle scientist, Intellectual Property Management Unit, left after completion of her appointment.
- Dr. Hao Chen joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division
- Mr. Jonas Rune joined as consultant, Crop, Soil, and Water Sciences Division.
- Dr. Daisuke Fujita joined as project scientist, Plant Breeding, Genetics, and Biotechnology Division.
- Dr. Bertrand Collard, postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division, resigned.
- Dr. Chitra Raghavan, postdoctoral fellow, Entomology and Plant Pathology Division, resigned.
- Dr. Phan Hieu Hien joined as consultant, Agricultural Engineering Unit.

Dr. Hong-Kyu Park joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Dr. Edgar Paski joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Zenaida Sumalde, consultant, Social Sciences Division, left after completion of her appointment.

June

Dr. Peter Mitchell joined as consultant, Crop and Environmental Sciences Division.

U Ba Hein joined as consultant, International Programs Management Office.

Dr. Nigar Nargis joined as consultant, Social Sciences Division.

Dr. Bhanudeb Bagchi joined as consultant, Social Sciences Division.

Dr. Edgar Paski, consultant, Crop and Environmental Sciences Division, left after completion of his assignment.

Dr. Eufemio Rasco, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Dr. Jeom-Ho Lee, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Mr. Shabaz Mustaq, consultant, Social Sciences Division, left after completion of his assignment.

Dr. Liu Bin, postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Mr. Jonas Rune, consultant, Crop and Environmental Sciences Division, left after completion of his assignment.

Ms. Fatema Zohora, consultant, Social Sciences Division, left after completion of her assignment.

Mr. Oeun Sophath joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Ms. May Ann Sallan joined as consultant, Crop Research Informatics Laboratory.

Mr. Cao Van Hung joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Mr. Ahmad Salahuddin joined as consultant, International Programs Management Office.

Dr. Dongcheng Liu joined as visiting research fellow, Crop and Environmental Sciences Division.

Dr. Huixia Shou joined as consultant, Plant Breeding, Genetics, and Biotechnology Division.

Mr. James Denver joined as consultant, Operations Management.

Mr. Nguyen Van Doan joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Mr. Vu Cong Khanh joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Ms. Ho Thi Tuyet joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Mr. Oeun Sophath, consultant, Grain Quality, Nutrition, and Postharvest Center, left after completion of his assignment.

Dr. Nigar Nargis, consultant, Social Sciences Division, left after completion of her assignment.

Dr. Arvind Kumar, postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Dr. Jian-Long Xu, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Ms. May Ann Sallan, consultant, Crop Research Informatics Laboratory, left after completion of her assignment.

Ms. Yoke Sau Metz, consultant, Training Center, left after completion of her assignment.

Mr. Tim Overett, consultant, Information Technology Services, left after completion of his assignment.

Dr. Peter Mitchell, consultant, Crop and Environmental Sciences Division, left after completion of his assignment.

Dr. Md. Rafiqul Islam joined as visiting research fellow, Social Sciences Division.

July

Dr. Jill Cairns, postdoctoral fellow, Crop and Environmental Sciences Division, resigned and then was appointed international research fellow in the same division.

Dr. Damien Jourdain joined as senior scientist, agricultural economics, Social Sciences Division.

Dr. Dule Zhao joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

August

Mr. Joseph F. Rickman, senior scientist and head, Agricultural Engineering, and acting head, Operations Management, appointed as IRRI representative in East and Southern Africa Region and leader, Program 3.

Mr. Terry Jacobsen joined as head, Operations Management.

Dr. Edwin L. Javier, senior scientist, plant breeding and coordinator, INGER, Plant Breeding, Genetics and Biotechnology Division, left after completion of his assignment.

Dr. Vethaiya Balasubramanian, senior scientist, agronomy, Training Center, retired.

Dr. Francois Affholder, IRS seconded from CIRAD, left after completion of his assignment.

Dr. Usha Palaniswamy joined as visiting research fellow, Social Sciences Division, and left after completion of her assignment.

Dr. Sant S. Virmani joined as consultant, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Hong-Kyu Park, visiting research fellow, Crop and Environmental Sciences Division, left after completion of his assignment.

Mr. James Denver, consultant, Operations Management, left after completion of his assignment.

Dr. Abdul Bayes joined as consultant, Social Sciences Division.

Dr. V. Balasubramanian joined as consultant, International Programs Management Office.

Dr. Hong-Soo Choi joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Dr. Minu Joseph joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Ms. Daniele Marechal, consultant, Grain Quality, Nutrition, and Postharvest Center, left after completion of her assignment.

September

Dr. Edilberto Redoña joined as senior scientist, plant breeding and coordinator, INGER, Plant Breeding, Genetics and Biotechnology Division.

Dr. Mohammed Zainul Abedin joined as IRRI representative in Bangladesh and leader, FoSHoL.

Dr. Reiner Wassmann joined as coordinator of Rice and Climate Change Consortium, Crop and Environmental Sciences Division.

Dr. Elizabeth Humphreys joined as international research fellow and leader for Theme 1 of the Challenge Program on Water and Food.

Dr. Kaijun Zhao, liaison scientist for China, International Programs Management Office, left after completion of his assignment.

Mr. Nguyen Nang Nhung joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Mr. Tim Overett rejoined as consultant, Information Technology Services.

Mr. Duncan Graham joined as consultant, Communication and Publications Services, and left after completion of his assignment.

Dr. Ramil Mauleon joined as postdoctoral fellow, Crop Research Informatics Laboratory.

Dr. Susanna Poletti joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Un-Sang Yeo joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Dr. Young-Seop Shin joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Dr. Jeong-Kwon Nam joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Mr. Jonas Rune rejoined as consultant, Crop and Environmental Sciences Division.

Dr. Xiaoli Sun joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Deepinder Grewal joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Yongming Gao rejoined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Sant S. Virmani, consultant, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Dr. S. Appa Rao, consultant, Genetic Resources Center, left after completion of his assignment.

Dr. Bhanudeb Bagchi, consultant, Social Sciences Division, left after completion of his assignment.

Dr. Md. Rafiqul Islam, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Dr. Huixia Shou, consultant, Plant Breeding, Genetics, and Biotechnology Division, left after completion of her assignment.

October

Dr. Zhao Ming joined as part-time liaison scientist for China, International Programs Management Office.

Dr. Noel Magor was appointed head of the Training Center.

Mr. Chua Gia Thuy joined as consultant, Crop and Environmental Sciences Division.

Dr. Abdul Bayes, consultant, Social Sciences Division, left after completion of his assignment.

Dr. Joong-Hyoun Chin, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, resigned and then rejoined as postdoctoral fellow in the same division.

Dr. Steven Cork joined as consultant, Crop and Environmental Sciences Division.

Dr. Shengxiang Tang joined as consultant, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Yunlong Xia joined as consultant, Genetic Resources Center.

Dr. Jingsheng Zheng, postdoctoral fellow, Crop and Environmental Sciences Division, left after completion of his assignment.

Mr. Chua Gia Thuy, consultant, Crop and Environmental Sciences Division, left after completion of his assignment.

Dr. Zoe Lawson, visiting research fellow, Genetic Resources Center, left after completion of her assignment.

Dr. Md. Rafiqul Islam, visiting research fellow, Social Sciences Division, left after completion of his assignment.

November

Mr. Hector V. Hernandez joined as head of Human Resources Services, Office of the Director for Management Services.

Mr. Paul O’Nolan, head of Information Technology Services, left after completion of his assignment and then was appointed IT adviser to the director general.

Mr. Marco van den Berg joined as head of Information Technology Services.

Dr. Gary Atlin, senior scientist, plant breeding, Plant Breeding, Genetics and Biotechnology Division, resigned.

Dr. Kyeong-Ha Kang, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Dr. Binying Fu rejoined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Kyu-Seong Lee rejoined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Dr. Myung-Kyu Oh joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Mr. Robert Hill joined as consultant, Visitors and Information Services.

Mr. Diwan Gupta joined as visiting research fellow, Social Sciences Division.

Dr. V. Balasubramanian, consultant, International Programs Management Office, left after completion of his assignment.

Mr. Oeun Sophath rejoined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Dr. Muthurajan Raveendran, visiting research fellow, Crop Research Informatics Laboratory, left after completion of his assignment.

Dr. Mark Bell joined as consultant, International Programs Management Office, and left after completion of his assignment.

Mr. Khuon Kompheak joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Dr. Subir Kumar Bardhan Roy joined as visiting research fellow, Social Sciences Division.

December

Mr. Paul O’Nolan, IT adviser to the director general, left after completion of his assignment.

Dr. Monina Escalada, international research fellow, development communications, Social Sciences Division, left after completion of her assignment.

Mr. Isaiah Mukema, international research fellow, GIS specialist, Genetic Resources Center, left after completion of his assignment.

Dr. Impa Somayanda joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Olivier Panaud joined as collaborative research scientist, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Jong-Hee Lee joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Ms. Subramaniam Geethanjali joined as collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Mr. Young-Bok Lee joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Mr. Kwang-Sub Yoon joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Mr. Prom Chan Rasmey joined as consultant, Grain Quality, Nutrition, and Postharvest Center.

Dr. Min-Kyu Choi joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment.

Dr. Sang-Su Kim joined as visiting research fellow, Crop and Environmental Sciences Division, and left after completion of his assignment.

Mr. O-Young Jeong rejoined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Zenaida Sumalde rejoined as consultant, Social Sciences Division.

Dr. Subir Kumar Bardhan Roy, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Mr. Diwan Gupta, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Dr. Yongming Gao, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Dr. Nguyen Hong Thuy, postdoctoral fellow, Crop and Environmental Sciences Division, left after completion of her assignment.

Mr. Geert Claessens, consultant, Agricultural Engineering Unit, left after completion of his assignment.

Mr. Martin Senger, consultant, Crop Research Informatics Laboratory, left after completion of his assignment.

Mr. Jonas Rune, consultant, Crop and Environmental Sciences Division, left after completion of his assignment.

Dr. Shengxiang Tang, consultant, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Ms. Alma Redillas-Dolot, consultant, Office of the Director for Program Planning and Communications, left after completion of her assignment.

Dr. Tapash Biswas, postdoctoral fellow, International Programs Management Office, left after completion of his assignment.

Dr. Phan Hieu Hien, consultant, Grain Quality, Nutrition, and Postharvest Center, left after completion of his assignment.

RESEARCH SUPPORT SERVICES

ANALYTICAL SERVICE LABORATORIES

As the centralized analytical service facility for the Institute, the Analytical Service Laboratories (ASL) continues to provide routine analyses in plant, soil, and water samples to various clients within IRRI and outside collaborators and to UPLB. It also provides liaison-related services to projects involving use of radioactive materials.

Analytical services

ASL completed a total of 55,463 analyses for routine plant, soil, and water samples. Plant samples accounted for 65% of the completed analyses with N, Fe, and Zn as the most requested determinations (ASL Table 1). About 83 % of the total samples received came from Crop and Environmental Sciences Division (CESD); the rest came from Plant Breeding, Genetics, and Biotechnology Division (PBGB), Grain Quality,

ASL Table 1. Analyses completed in 2006.

Analysis	ASL Section		Total	Percent
	PSL ^a	MSL ^b		
Plant	28,646	7,633	36,279	65.41
Soil	14,919	1,068	15,987	28.82
Water	3,197	0	3,197	5.76
Total	46,762	8,701	55,463	100.00

^aPlant and Soil Laboratory. ^bMass Spectrometry Laboratory.

ASL Table 2. Profile of samples and analyses completed in 2006, by OU.

OU	Samples (no.)	Percent	Analyses (no.)	Percent
CESD	17,806	82.98	44,778	80.73
PBGB	2,983	13.90	8,785	15.84
GQNPC	50	0.23	140	0.25
SSS	4	0.02	4	0.01
IPMO	72	0.34	72	0.13
ICRAF	61	0.28	61	0.11
UPLB	451	2.10	1,591	2.87
PHILSURIN	32	0.15	32	0.06
Total	21,459	100.00	55,463	100.00

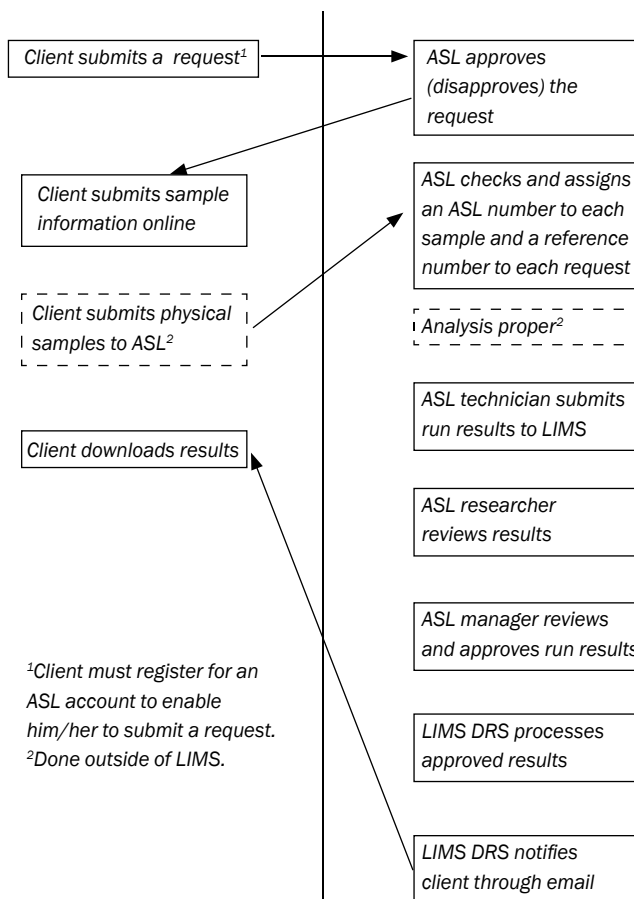
Nutrition, and Postharvest Center (GQNPC), Safety and Security Services (SSS), International Programs Management Office (IPMO), World Agroforestry Centre (ICRAF), University of the Philippines Los Banos (UPLB), and the Philippine Sugar Research Institute (PHILSURIN) (ASL Table 2).

Laboratory information management system

Information management and automated data processing are important functions of ASL. A commercial laboratory information management system (LIMS) is very expensive and requires significant customization for the type of work done at ASL. The cost of a commercial system would easily exceed several hundred thousand dollars and this may greatly exceed potential benefits. The ASL LIMS project with the UPLB-FI through the Institute of Computer Science developed a new ASL LIMS web site at <http://swsdsrv1/lims/index.jsp>. ASL clients are now provided with a web application that manages all information and requests related to their

experiments. ASL clients can send online requests for analysis, facilities, and services as well as submit sample information that will be used in processing and tracking the status of their requests. LIMS uses an email notification system to alert both ASL and clients on any changes in request status.

The chart at right shows the steps involved in processing a request for analysis. LIMS requires that all clients register for an account to avail of ASL's online services. When making requests for sample analysis, the client submits a request using his/her account. ASL reviews and approves the request online. Once the request is approved, the client submits sample information online and physical samples are sent to ASL for analysis. Chemical processes then begin in the respective laboratories. Once analyses are done, results are submitted by the technician in a format suitable for LIMS for review and assessment of quality of results by a researcher. The ASL manager does the final review and approval. Afterward, LIMS processes the results and saves the data for the online data retrieval system (DRS). Clients are notified of the availability of their results, which can be downloaded using their accounts.



The process of analysis using LIMS.

New inductively coupled argon plasma

As endorsed by the Advisory Committee (AC), through the recommendations of the ASL resource person, Dr. Sarah Johnson-Beebout, and the ASL ICP Selection Committee, ASL purchased a new Perkin Elmer Optima 5300 dual-view inductively coupled argon plasma (ICP) in November 2006 and the unit arrived at IRRRI on 22 Dec 2006. This very important acquisition for IRRRI has an expected useful life of about 15 years. The new ICP will enable the unit to perform multielement, heavy-metal, and total-arsenic determinations to meet the Institute's future strategic need for such analyses.

ASL's operational plan for the new ICP-optical emission spectrometer (OES) is presented in ASL Figure 1. Multinutri-

ent analysis with its new ICP was endorsed by the AC, with priority given to the analysis of plant samples for elements already determined on the current ICP plus arsenic and cadmium. IRRRI scientists will be asked whether additional priority elements need to be considered for method development. The old ICP will be retained until the new ICP is fully operational, and a decision on the fate of the old ICP will then be made.

Order	Shipment	Installation & commissioning	Training	Method development	Cross calibration & transitioning	New ICP fully operational	Revisit plan for old ICP
2 wk	6 - 8 wk	4 wk	2 wk	3 - 4 mo	1 - 2 mo		
Oct 06	Nov - Dec 06	Jan 07	Feb 07	Mar - Jun 07	July - Aug 07	Sep 07	Oct 07

ASL Fig. 1. Timeline for operating the new ICP-OES.

Radioisotope Laboratory

Ms. Lilia R. Molina was designated as IRRI's radiological health and safety officer (RHSAO) on 6 Feb 2006 by the Philippine Nuclear Research Institute (PNRI). The following projects were assisted through the use of radioisotope laboratory facilities and liaison services of the PNRI:

- Identification and characterization of RTSV-responsive gene in rice
- Identification and characterization of small RNA-related genes in rice
- Sulfur cycling in rice-maize cropping systems
- Analysis of gene expression in response to rice tungro virus infection in rice plants
- Southern blotting and hybridization
- Applying genetic diversity and genomic tools to benefit rice farmers at risk from drought
- Fertilization-independent formation of embryo, endosperm, and pericarp for apomictic hybrid rice

A new document, *Security measures for IRRI*, was prepared and submitted to PNRI on 3 Mar 2006, in compliance with security provisions in IAEA-TECDOC-1355 to ensure security of its radioactive sources to prevent unauthorized access, as well as loss, theft, and unauthorized transfer of sources for possible malevolent use.

A radiation safety course for IRRI staff was conducted by PNRI trainers from 31 Jul to 4 Aug 2006. Five scholars and seven staff members participated in the training.

Training

All ASL staff participated in the institutewide quality assurance training by Dr. Edgar Paski from the British Columbia Institute of Technology (29-31 May 2006). All technicians also attended the glass blowing training (hands-on) with Mr. Robert Jimenez of DOST (24-27 Apr 2006) and glass blowing (lecture) with Engr. Perfecto Braganza, also of DOST (5 Jun 2006). Ms. Molina participated in a short postgraduate course on soil and plant analysis and data handling in Wageningen University, The Netherlands, 6-30 Jun 2006, while Mr. Chavez attended the 12th Canadian CF-IRMS Workshop in the University of Victoria, Victoria, BC, Canada on 11-14 Jun 2006.

CROP RESEARCH INFORMATICS LABORATORY

The new Crop Research Informatics Laboratory (CRIL) and its associated research program were officially launched via a video conference link between IRRI and CIMMYT in January 2006. This is the first major output of an Alliance between IRRI and CIMMYT that was formally established. The centers see several areas where this unified facility will help build a

sufficient critical mass to accomplish previously unattainable goals and help establish a more powerful platform for synergizing progress across cereal species.

A primary pillar of the CRIL vision is the integration and comparative analysis of data across disciplines (within the germplasm enhancement value chain) and across species (within the well-studied cereal crops). By capturing synergies and harnessing complementarities across both institutes; by developing improved scientific data management systems (including genebank, plant breeding, agronomy, socio-economic, and GIS data), including harmonizing data standards across disciplines and institutions; by supporting crop research (especially comparative biology and genomics across cereals); by providing training in scientific informatics; and by developing increasingly powerful decision-support tools for plant breeding; the CRIL will contribute to the common IRRI and CIMMYT institutional mission of promoting food security and material livelihoods of resource-poor farmers and consumers with reference to the production, distribution, and consumption of the world's three main staple cereals rice, maize, and wheat that collectively represent more than half a billion hectares of global food and feed production.

Biometrics consultation

Statistical consultation was provided by CRIL statistics staff to 110 clients in 2006 and several papers were reviewed for *International Rice Research Notes* and international refereed journals.

Organizational unit	Clients (no.)
CESD	46
PBGB	35
GRC/CPS/SSD/GQNPC/AEU	10
Others	19
Total	110

Statistical software

Statistical models have been developed to incorporate knowledge of the coefficient of parentage between lines into the estimation of breeding values and additive by additive genetic components and their interaction with environments. This will enhance the efficiency of breeding evaluations and should lead to improved genetic gains in breeding programs.

Simulation of top-cross strategies to simultaneously capture favorable allele combinations of nine marker-linked genes from three parental wheat lines were studied with the

QuCim/QuLine simulation package. Results offer opportunities for improving efficiency of marker-assisted breeding programs. The simulation package has been enhanced and is now available to simulate alternative breeding strategies for almost any crop. The package has also been linked to a physiological model so that genetics and physiology can be integrated into the same simulation environment.

CRIL has continued the development of IRRISTAT to handle logistic regression and log-linear modeling and further development of REML to allow multiplicative covariance structures, fixed symmetric covariance structures, and sections of error covariance with structures and/or parameters.

Biometrics training and workshops

CRIL conducted four in-house (85 participants) and two in-country (48 participants) trainings. Three of these courses were newly developed and were offered only during this period. These were *Analysis of Experimental Data Using the SAS System*, *Introduction to Data Quality Management*, and *Introduction to SPSS and Analysis of Categorical Data*. It has also participated in two IRRI-based workshops (37 participants).

Course/workshop	Date	Participants (no.)
<i>In-house training</i>		
Introduction to the SAS System	7-11 Nov 2005	22
Basic Experimental Design and Data Analysis Using IRRISTAT	17-21 Apr 2006	21
Analysis of Experimental Data Using the SAS System	10-14 Jul 2006	19
Introduction to Data Quality Management	24-28 Jul 2006	23
<i>Other short-term course/workshop</i>		
Interpretation of Research Results from Experiments on Crop Residue Management	9-20 Jan 2006	15
Increasing the Impact of Rice Breeding Programs	17-18 Apr 2006	22
<i>In-country training/workshop</i>		
Introduction to SPSS and Analysis of Categorical Data, RNR-RC, The Kingdom of Bhutan	4-8 Apr 2006	20
International Crop Information System (ICIS) Training Course, El Batan, Mexico	8-12 May 2006	28

Database development and deployment—International Rice Information System (ICIS)

1. ICIS development (released ICIS 5.3)
2. Implementation of the Genetic Resources Information Management System (GRIMS) of ICIS is progressing well and scheduled for completion in 2007
3. ICIS sample tracking implemented for the wheat genebank of CIMMYT and ICIS inventory management set up and awaiting stock-taking and bar-coding exercise with Dr. Payne, CIMMYT
4. Wheat breeding information system at CIMMYT integrated with ICIS (IWIS3) and available for deployment in wheat breeding projects of CIMMYT and partners. IWIS3 published on the Web using ICIS technology
5. Strategy developed for integrating Maize Fieldbook and Maize Finder database with ICIS. Programming started on capturing maize pedigrees into ICIS GMS with Dr. Vivek (Zimbabwe)
6. Further development of ICIS breeder application with Nunza and GBA to support traditional and molecular breeding. ICIS 5.3 released
7. Refinement of the ICIS browse application to allow rapid computation of large COP matrices for use in modeling evaluation data from crop improvement

Bioinformatics

Bioinformatics activities in 2006 focused primarily on the work related to two projects: the Generation Challenge Program (GCP) and the Perlegen SNP Discovery Project.

For the GCP, IRRI staff convened back-to-back scientific consultations on IRRI-led GCP projects for platform software and the GCP scientific domain model development, in partnership with the African Centre for Gene Technology, in Pretoria, South Africa. Following these review meetings, the domain models and platform technologies were developed further, resulting in new Web-based tools for accessing GCP research data across local and internet-dispersed databases (prototype site at <http://rice.generationcp.org>).

Complementary to these GCP software development activities, two postdoctoral scientists, Dr. Samart Wanchana of Thailand and Dr. Ramil Mauleon of the Philippines joined CRIL in 2006 as bioinformatics data curators on two GCP-funded projects: a comparative stress gene catalog (see <http://dayhoff.generationcp.org>) and comparative microarray data analysis, respectively.

Concurrently, the CRIL bioinformatics team, led by NRS team leader Victor Jun Ulata, was engaged in bioinformatics analysis of rice genome sequences for the IRRI-hosted

Perlegen germplasm resequencing experiment. This experiment, whose data are expected to be delivered in the spring of 2007, is undertaking to perform DNA-DNA hybridization of 100 million base pairs of relatively unique Nipponbare reference sequence against 19 other *Oryza sativa* landraces representing a broad spectrum of biological diversity in rice. The aim of the experiment is to construct a valuable new whole genome mapping resource of rice DNA polymorphism markers (so-called “single nucleotide polymorphisms” or SNPs) for use in association genetics analysis, classical genetic mapping, and marker-assisted selection in plant breeding.

Research data management

- An IRF position with the major focus on research data management and data quality was established at IRRI.
- As part of the CRIL MTP, the work will be conducted at IRRI and CIMMYT. During a visit to CIMMYT, initial discussions and consultations mainly on crop management and socioeconomic data took place.
- At IRRI, work has started on socioeconomic data, climate records, and several experimental data sets.
- IRRI has continued to lead a GCP-commissioned research project on data quality improvement and assurance.

Collaboration systems

As part of a GCP project, Web-based collaborative systems are maintained to support software development and textual content development. The use of these systems has expanded in 2006 as follows:

- The use of the Wiki system (<http://cropwiki.irri.org>) was extended to host the internal collaboration space as well as the external Web site of CRIL. The GCP and the ICIS development communities have continued to be the main users of this system.
- The use of the collaborative software development system (<http://cropforge.org>) has increased from 49 hosted projects in 2005 to 67 projects in 2006. The projects are related to the development of software, mainly from the GCP and the ICIS communities. Other projects hosted include IRRISTAT (IRRI), DIVA (CIP), MGIS (INIBAP), and ICRISAT LIMS (ICRISAT).

Open source/open content licensing

After approval by the BOT, IRRI's intellectual property policy for information products was changed. The default is now open source and open content licensing and efforts are under way to put the new policy into practice for software and the content of collaborative (Wiki) sites.

COMMUNICATION AND PUBLICATIONS SERVICES

Publications and publishing

Through CPS, IRRI produced 14 titles in 2006, including seven scientific books, four issues of *Rice Today*, the Annual Report of the Director General 2005-06, and IRRI's strategic plan, *Bringing hope, improving lives*. Also produced were two issues of the *International Rice Research Notes (IRRN)* and three issues of *Rice Research for Intensified Production and Prosperity in Lowland Ecosystems (RIPPLE)*. Currently, 26 titles are in the production queue for 2007 and beyond.

In the area of copublishing, the Chinese version of *Breeding rice for drought-prone environments*, published by the Shanghai Agrobiological Gene Center, has become the model for such translation projects with such outside publishers in the future. Also, Sid Harta Publishers in Australia published *Sharing rice for peace and prosperity in the Greater Mekong Subregion*, by Peter Fredenburg and Robert Hill. This title, also advertised on Sid Harta's Web site, follows the same style and format as *The burning of the rice*, by Don Puckridge, and serves as the second installment of a popularly written book series on IRRI's impact that CPS is establishing with Sid Harta. CPS also collaborated with CABI to produce *Environment and livelihoods in tropical coastal zones: managing agriculture-fishery-aquaculture conflicts*.

We are collaborating with the science publisher World Scientific Publishing Co. (WSPC), based in Singapore. In 2007, WSPC and IRRI will copublish the proceedings of *Rice genetics V* as an e-proceedings, a hard copy print-on-demand (POD) book, and as part of a CD to be called *The rice genetics collection* that will contain the searchable files of all past rice genetics symposium proceedings and other historical publications on rice genetics and cytogenetics from 1964 through 2006.

IRRI on the Web

New features added to the IRRI intranet in 2006 included links to tracking Pacific tropical cyclones, the IRRI announcements Wiki, the Los Baños Wiki, the Strategic plan 2007-15, the Medium-term plan 2007-09, latest earthquakes in the world, a searchable IRRI staff list for 1961-2005, IRRI Alumni.net, and planning for pandemic flu. Rice News Worldwide (available internally and externally at <http://ricenews.irri.org> and RSS compatible) has become a very useful current summary (and archival listing dating back to 15 Apr 2005, now containing more than 1,350 news and feature stories) of links to stories and features about rice from around the world.

We also continue to add articles and audio feeds at www.irri.org/media/articles.asp that quote IRRI staff via other Web sites such as *SciDevNet*, *Science*, *Washington Post*, *Time Asia*, *BBC News*, *ABC Radio Australia*, *Reuters*, and *Discovery Channel*. This collection of now more than 110 features and audio feeds dates back to June 1968.

Google Custom Search using Google Co-op is now the featured search engine on the IRRI external Web site (www.irri.org). Also, a pilot donor page set up at www.irri.org/donors/SDC/index.asp for the Swiss Agency for Development and Cooperation can be used as a model for uploading similar materials related to funded projects for other key donors. And, as IRRI approaches its 50th anniversary in 2010, the Web page on Significant dates in IRRI history at www.irri.org/about/history.asp is continually being updated as new events occur and more past historical events are added.

New IRRI photo bank

IRRI's 2nd-generation, user-friendly photo bank at www.ricephotos.org went online in early January 2007. At its debut, the bank contained around 1,000 new images in this bank with more to be added monthly. However, until a critical mass of new photos is added and classic photos from IRRI's first photo bank are transferred, the classic photo bank will remain online at <http://rice-photos.irri.org>. Special features of the new facility include

- New breath-taking images of rice landscapes, farmers, children, events, research, and other related subjects;
- Fresh images added monthly;
- Advanced keyword search;
- All images at high resolution (300 dpi);
- Instant downloads via a special link;
- Image slideshow feature for a category; and
- Share alike Creative Commons License Deed.

When using the new photo bank for the first time, users need to register one time only if they want to download images. In its debut, the front page of the new photo bank featured images of the Mayon Volcano in July and November 2006 tied to the *Rice Today* feature, *Once were rice fields*, showing the before-and-after effects of the devastating mud flows that rushed down the mountainside with the passing of Typhoon Durian.

CPS and Information Technology Services (ITS) are also running a parallel photo distribution experiment by putting selected IRRI images on Flickr, a Yahoo company, that provides online photo management and sharing applications.

A trial version of these IRRI rice images on Flickr can be found at www.flickr.com/photos/ricephotos. Anyone can view and there is no need to sign up. Persons with a (free) Flickr/Yahoo account can also leave comments about the images.

IRRI Digital Publications Project and the Rice Thesaurus Project

CPS funded both phases 1 and 2 of these projects, managed by Library and Documentation Services (LDS). Phase 2 was completed 31 May 2006. As stated in the terminal report, as more publications are digitized, so must the database be updated along with the Rice Thesaurus. Subject access is very important in information retrieval. New keywords must be generated as the database grows. These keywords will be important in the metadata for both the IRRI Photo Bank and the IRRI Publication Archives. The comprehensive Rice Thesaurus now has 2,479 terms with subject trees related to rice.

Communications support

CPS continues to provide communication support for the entire Institute, including editing, graphic design, art and illustration, audiovisual, photography, video, and advice on printing.

On 1 Mar 2006, the IRRI print shop was closed permanently to make way for a new digital copy center, managed by ITS, that officially opened on this same date. Since 1985 when records were first kept until its closing, the print shop had produced approximately 174 million impressions for a wide array of IRRI publications and forms. Truly, this date marked the end of an era and the beginning of a new one. ITS reports that the new copy center generated 202,864 copies in 2006 between 1 Mar and 31 Dec.

In 2006, approximately 26,351 new digital photographs were produced. Eighteen video programs were produced and 131 shorter clips were provided for the *Bulletin* (IRRI's weekly newsletter for staff, BOT, and alumni; <http://bulletin.irri.cgiar.org>) and PowerPoint presentations.

Graphic artists produced 60 illustrations, laid out 2,252 pages for publications, and prepared and printed 151 posters.

IRRI editors worked on more than 900 pages appearing in refereed journal articles, 1,495 pages appearing in IRRI's scientific books, plus 123 pages for the *International Rice Research Notes*, and more than 500 pages of additional conference papers, abstracts, proposals, and other documents.

EXPERIMENT STATION

The Experiment Station (ES) provided support services to a total of 325 field and greenhouse experiments. Of this, the Field Operations Unit served 163 field experiments, while the Controlled Plant Growth Facilities and Grounds Unit (CGFG) supported 64 experiments in the Phytotron and CL4 transgenic greenhouse facilities and 98 experiments in all other greenhouses. A total of 9,083 maintenance and service requests were served by the various support units of the ES during the year.

Land use

A total of 312.28 ha were used in 2006. ES was the biggest user of the farm with the utilization of some 144.06 ha for field demonstration, seed increase, and rice production purposes. PBGB, the second biggest user, planted a total of 127.91 ha.

Seedling requirements of the various field experiments were established and maintained by the ES in 5.72 ha of dry and wet nursery beds, using field nurseries covering 3.72 ha and 2 ha, respectively. The rest of the seedling requirements were grown on a 40-m × 10-m pavement using modified dapog nurseries.

Division	Dry season (ha)	Wet season (ha)	Total
CSWS	14.16		14.16
CESD		8.82	8.82
EPPD	2.99		2.99
ES	56.72	87.34	144.06
GRC	10.17	2.92	13.09
PBGB	83.35	44.56	127.91
TC	1.25		1.25
Total	168.64	143.64	312.28

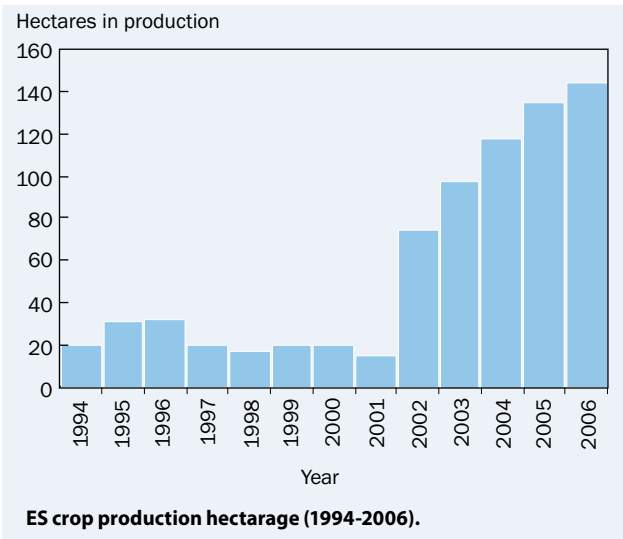
Crop production operations

ES seed increase and rice production operations in 2006 reflected a 7% increase in cropped area compared with the 2005 cropping of 134 ha and a 60% increase over the annual target of 90 ha of rice production crop.

More than 43% of all rice field crops were established mainly by direct seeding through manual broadcasting of pregerminated seeds, drum seeding on wet fields and by seed drilling on dry-prepared areas, whereas the rest were established using manual and mechanical transplanting methods, particularly in deep plots and during the wetter periods of the year when weather and field conditions did not favor direct seeding operations.

ES harvested 326 t of paddy from ES-managed production plots. The highest yield noted in ES-managed production plots was 5 t ha⁻¹ from blocks 1002 to 1005 planted to NSIC122

in the 2006 dry season. Another 168 t of mixed varieties were harvested from researchers' excess materials and border rows. Harvesting in large plots was mainly done with the use of mechanical combine harvesters.



Agrochemical applications and crop protection services

A total of 96 t of different kinds of fertilizers were served to various users of the farm in the form of ammonium sulfate, complete, muriate of potash, solophos, urea, zinc oxide, and zinc sulfate. This total amount reflected a 17% reduction in fertilizer application as compared with the previous year.

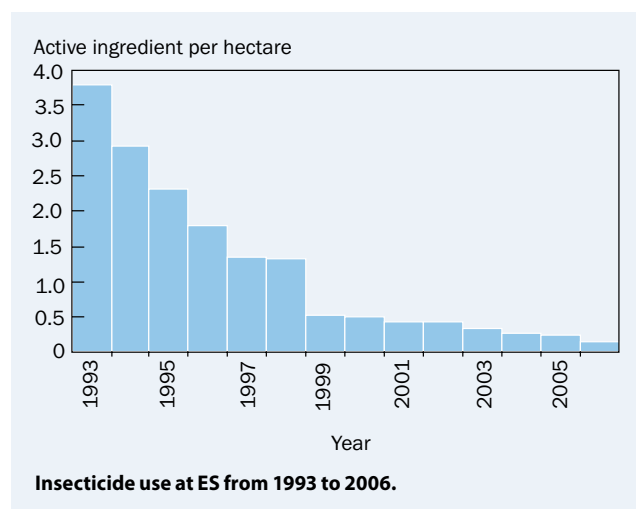
Sustained pesticide use reduction efforts resulted in 36% and 4% reduction in insecticide and molluscicide use, respectively, compared with 2005 levels. Use of resistant varieties and zero insecticide application in most ES-managed production plots, as well as reduced use in researchers' plots and reduced insect pressure about the fields, contributed to the decrease in insecticide use. Routine manual snail and snail egg collections in the fields and greenhouses, on the other hand, contributed to the reduction in molluscicide use.

Herbicide use, however, increased by 10%. This can be attributed to the predominantly wet weather during the year that enhanced weed growth, as well as to the increased preference for chemical weed control in view of reduced operating budgets and rising costs of manual and mechanized weed control using mowers and grass cutters. Manual weed control remains to be the single most costly, labor-intensive field maintenance operation at the farm. Herbicide use has been a more cost-effective option. While preference to herbicide use in field experiments is gradually growing, the bulk is still in the application of nonselective herbicide in maintaining production plots, perimeter areas, fallow fields, and levees. Integrated pest management practices, combined

with the use of machines and chemical applicators, helped reduce the cost of pest control as well as improve the safety of field operations.

For the nonchemical control of avian pests, manual bird scaring remains the preferred method, while bird nets and bird tapes were installed on 3.56 and 16 ha, respectively.

Current rat management practices, which mainly include trap barrier systems, maintenance of fallow areas, burrow destruction, flame throwing, field sanitation and hygiene, and closed seasons, resulted in zero incidence of severe rat damage in all rice crops. Rat control services included the installation of 250 baiting stations, 37.83 ha of active barrier systems, and 227 live traps. This reflected a reduction of 15.2%, 40.9%, and 72.7%, respectively, compared with 2005 installations. The rat traps yielded a total of 877 live catches for 2006.



Irrigation and drainage services

Irrigation requirements of all field experiments were met and maintained through staggered work schedules by ES research technicians. Sprinkler and perforain irrigation systems were set up on 8.4 ha in blocks UZ, UQ, UM, UP1, UR, D24, and B2 during the 2006 dry season and on 13.3 ha in blocks UO, UW, UP1, D24, and in the UN and UX seedling nurseries during the wet season. Portable pipes equipped with overhead sprinklers were used to supply the water requirements in most upland blocks, including blocks B, D, the 833 series, the 900 series, UD, UJ, UI, UP, UO, UQ, UW, UX, UR, UL, UM, UN, UMN, UV, UW, and in the dry bed nurseries. Ten units of drainage outlets at the old area, new lowland, and upland area were developed and constructed. Major irrigation repair work involved the extraction, repair, and reinstallation of malfunctioning submersible pumps in block UW, UK, C1, UT, and the 2000 series and three main gate valves in the

lowland, upland, and old areas. Minimum downtime of damaged pumps was maintained up to only a maximum of 3 d in allowable delay. An automated water level sensor control system was installed and tested in block C1 reservoir. The new setup can potentially save on pumping costs as well as avoid irrigation water wastage and over-pumping and help improve the reliability of water supply in the reservoirs.

Land development and civil works

More than 2 ha of upland fields were converted to lowland fields in blocks UG, UL, UR1, UR2, UR3, the 900 series, and the 2000 series. One hectare in block UI and another hectare in upper MN were reworked to improve hard pan and field levels. Some 20 km of farm access roads were rehabilitated and developed from the main ES building. The rest of the 44 km of farm roads were routinely maintained through scraping, backfilling, road patching, and compaction using the road roller. Routine civil maintenance work done included rice straw collection, regular mowing of 15 farm water reservoirs, weekly bulldozing of garbage into excavated pits of the dumpsite area, and roadside mowing. Heavy equipment operations done involved the regular maintenance of some 44 km of farm road network through surface scraping, backfilling, patching, and compaction. As part of the continuous farm perimeter fence improvement plan, an additional 150 m of concrete wall was put up along the perimeter areas in block 1000, whereas more than 100 m of wire fence were repaired in perimeter areas from block 100 to block 800. Floodwaters and strong winds of typhoon “Milenyo” in September caused severe damage to more than half of all perimeter fences of the institute, including over 100 m of concrete wall. These were all repaired toward the end of the year.

Equipment fabrication, repair, and maintenance services

The ES Mechanical Shop provided repair, fabrication, and maintenance services for the tractors, farm equipment, implements, machineries, and irrigation facilities. Requests for repair and maintenance of light and heavy equipment and farm implements from the different units and research divisions (total of 1,224) were accomplished. Defective and malfunctioning vertical motors and submersible pumps in blocks UW, UK, C1, UT, and the 2000 series were extracted and repaired with minimum downtime. Fifty units of different types of threshers and 32 units of different dryers were also repaired and maintained. Routine maintenance and repair services were also provided to the Rice Mill Unit. A strip tillage machine was designed and fabricated for use by the CESD.

Postharvest services and rice mill operations

Postharvest support services provided by ES included threshing, cleaning, drying, and storage, among others. Majority of the drying requirements of researchers for plant samples and harvested grains were accommodated using the oven dryers and flatbed dryers being maintained by the station. Two typhoons caused significant damage to the drying and milling facilities in May and September of 2006, affecting crop yield and milled rice output as well, in terms of timeliness, quality, and quantity of the produce.

From 494 t of dried (at 14% moisture) rice paddy intended for milling in 2006, the Rice Mill Operations Unit produced 290 t of milled rice. About 16 t were issued in response to various requests from different organizational units for milled rice, while 5 t were sold to the highest bidder via sealed public bidding process organized by the Materials Management (MM) unit. The rest of the milled rice, equivalent to some 272 t, was issued to the MM unit for distribution to nationally recruited staff's (NRS) monthly rice entitlement. The Rice Mill output for 2006 was able to meet 8 months' supply of milled rice for all IRRI NRS.

The byproducts of the milling operations totaled 21 t of broken rice, 57 t of rice bran, and some 12,000 sacks of rice hulls. The broken rice was sold through a bidding process, while the rice hulls were sold to regular buyers who use hulls for insulation, animal beddings, and landscaping/composting purposes. Set aside were 37 t of rice bran used as fish feed in the fish production project of the ES; another 20 t were sold to the highest bidder.

Phytotron/CL4 services

Basic research support services were provided by the Phytotron/CL4 unit to all experiments conducted in the Phytotron and transgenic greenhouse facilities. Some 186 maintenance and service requests were served during the year. The main bulk of manual operations at the CL4 involved the autoclaving of incoming and outgoing soil and plant materials. A significant increase in autoclaving operations was noted, along with the increased frequency of breakdown of the pass-through autoclave, further highlighting the need to upgrade the old autoclave unit and augment the setup with an additional autoclaving machine. The staggered annual preventive maintenance shutdown of each transgenic greenhouse bay in the CL4 facility was implemented one bay at a time throughout the year, while the annual preventive maintenance shutdown operations for the Phytotron were done in November. Phytotron users consumed a total of 25,280 gallons of reverse-osmosis grade water for their experiments. Improvements done in 2006 for the Phytotron

cooling system included the replacement of the old controllers in the glasshouse bays with new upgraded models, the installation of a new air compressor and upgrade of the memory card and hard disk of the central computer. Installation of a new centralized and energy efficient setup to replace the old cooling system of the transgenic greenhouses was initiated during the year. Sustained efforts toward efficient energy utilization at the Phytotron helped achieve a 17% reduction in total kwh used compared with the previous year's electricity consumption.

The demand for the use of Phytotron facilities almost doubled this year. Several waitlisted requests were not accommodated due to lack of available space.

Greenhouse services

The Greenhouse Unit provided basic support services to all experiments conducted in the glasshouses, screenhouses, and associated facilities. This included the servicing of 318 maintenance requests, provision of 3,355 assorted pots, and delivery of 735 t of ground soil to support the soil requirements of greenhouse experiments and some field requirements for soil cover on seedbeds as well. Routine operations of the Greenhouse Unit included soil hauling, grinding and delivery, glass roof cleaning, and overall upkeep and maintenance of greenhouse surroundings and landscapes. Staggered 1-mo greenhouse shutdown operations in most greenhouse facilities facilitated unhampered annual preventive maintenance operations. The procedure helped reduce pesticide applications by providing a long break in the crop, pest, and disease cycles inside these facilities. Shutdown operations included general clean-up, surface wash down, and repair of roofing and all support structures. Some researchers though have opted to forego the shutdown operations in some glasshouses and screenhouses in view of special requirements to continuously use available space. Increased frequency of pesticide applications, buildup of pest populations, and recurring pest-related problems were noted in such facilities that did not have the standard shutdown period.

Two strong typhoons caused extensive damage to the greenhouses. Worst hit by typhoon Caloy in May 2006 were greenhouses CS01 to CS04, CS09, CS10, US01, US02, AG01, BGO2, and CG01. Relatively minor damage was noted in MGO1 and AG02. In September, typhoon Milenyo wreaked havoc on AS01, BS05, BS07, CS05, CS06, CS08, OS02, OS03, MS01, US03, AG01, BGO1, BGO2, BG13, BG14, CG01, NGO3, MGO1, and NS02. Repair work in the typhoon-damaged greenhouse facilities was the main activity in the last quarter of 2006. The last quarter also saw the upgrading and modification of transgenic screenhouses CS01, CS02, and

CS07 to enable implementation of new procedures/protocols and to meet work requirements of the PBGB and CESD.

Grounds services

The Grounds Services Unit served 253 requests for plant decorations, landscape maintenance and development, and other services. Service requests from office staff at the research center and from residents at the staff housing included indoor plant decorations and outdoor landscaping support services for various residential areas, offices, the auditorium, and building halls and during seminars, workshops, and special events conducted at IRRI. Routine operations mainly included lawn maintenance and regular mowing services, road sweeping, brush cutting, and garbage collection in the research center, meteorological stations, reservoirs, and various staff housing units of the institute. Areas that were improved and landscaped in 2006 included the old IRRI marker in Tabon gate, the main entrance gate, the board room, Rice World Museum, Staff Housing swimming pool surroundings, and house numbers JH10, JH12, JH13, JH26, JH37, PD5C, and PV11. The waste segregation schemes in the greenhouse area and staff housing were also continuously implemented. Trimming of trees and clearing operations on perimeter fence areas were done at the IRRI Staff Housing as part of the annual clearing program. Old hedges in several locations around the institute were removed to lower landscape maintenance costs. The Grounds Unit also managed the fish production project in the farm reservoirs. Low-cost maintenance operations included periodic pond clean-up, weekly harvesting, and regular feeding of the fish with rice bran from the rice mill. Some 949 kg of fresh fish were harvested and sold to IRRI staff. New equipment acquisitions for the year included a new electric boom machine, three brush cutters, five push mowers, one pressure washer, a new mower attachment, assorted tools and gadgets, one telescopic tree pruner, and personal protective gears. Forty worn-out trash bins were also replaced with new units, while eight segregation bins were rehabilitated during the year.

Kabesilya labor services

Performance monitoring of kabesilya services was continuously implemented by the ES Administrative Unit. The summary of performance data taken from the job completion feedback forms revealed very high annual total acceptability values of 99.9% for bird-scaring services and 99.7% for the other contractual labor services in 2005. Feedback ratings given by endusers ranged from good to excellent, with no more than 0.1% incidence of poor performance rating.

Man-hour utilization of kabesilya services rendered by two service providers as requested by the various research divisions and support units totaled 624,206 man-hours in 2006. This represents a 17% reduction in utilization from the previous year. Manual bird-scaring services also went down by 4%, from 112,852 man-hours in 2005 to 108,589 man-hours in 2006. Wage rates for the kabesilya workers went up twice in 2006, amounting to a total of 5% pay hike, following two regional wage orders issued by the National Wage Board.

Partnership activities and other support services

In coordination with the Partnerships Office, various external requests for equipment assistance and associated technical support services from the surrounding communities, organizations, and institutions such as the local government units of Bay and Los Baños, nongovernment organizations, PhilRice, the Los Baños Science Community Foundation Incorporated, the University of the Philippines Los Baños (UPLB), and the UP Open University were accommodated by the ES. Equipment and manpower assistance were provided by ES to various UPLB and municipal government units, schools, and communities and during clearing operations after typhoon Milenyo. Communication linkages and close coordination with UPLB were also maintained by the station through regular meetings of the IRRI-UPLB Management Committee and personal communication between UPLB and ES staff. Other support activities provided by ES in 2006 included the conduct of field tours and demonstration for visitors endorsed by the Visitors and Information Services (VIS) as well as the orientation of new staff and scholars endorsed by the Training Center (TC). ES staff also participated as facilitators and trainers in course offerings of the TC and provided planning and logistical support for the conduct of various field demonstration and tours.

Environmental management system implementation

In line with the goals of the IRRI Environmental Agenda, the ES continued implementing its Environmental Management System (EMS) in 2006. The EMS team was constituted with lead staff of each of the ES work units serving as members and the ES senior manager as the team leader and overall EMS coordinator. The review and in-house registration of the first draft of the *EMS manual and system procedures* were completed during the last quarter of the year. Environmental aspects identified by ES staff during the 2005 workshop were reviewed and prioritized by the EMS team and used as basis for establishing five environmental management programs—i.e., management of environmental aspects related to air emissions, solid wastes, energy use, pesticide use, and waste

water effluents. Highlights of this year's EMS-related activities included a seminar workshop and the review of the EMS, which is part of the continual improvement program of the ES. It primarily aims to ensure continuing suitability, adequacy, and effectiveness of various management practices, environmental management programs, and activities to efficiently manage potential environmental impacts of ES operations, products, and services. The workshop was attended by all ES staff and major manpower service contractors for farm labor supply and agrochemical application. The activities of these groups at IRRI can significantly influence the various environmental aspects of farm operations and potentially can cause environmental impacts. The workshop focused on introducing and reviewing various EMS and ISO 14001 concepts, giving updates on the status of EMS implementation, presenting various environmental management programs, and business continuity planning.

LIBRARY AND DOCUMENTATION SERVICE

Enabling information and communication technologies (ICT) transformed traditional library services into better and faster information delivery modes focusing more on electronic rather than print resources. This trend is evident in the IRRI Library and Documentation Service (LDS), as it uses a combination of traditional and modern means of knowledge sharing with clients. Utilizing the latest advances in ICT, the Library continued to strengthen its collection of print and electronic technical literature on rice and related subjects to sustain its ability to put appropriate information sources into the hands of the world's rice researchers.

Enhancement of the electronic contents of the Library's home page (<http://ricelib.irri.org>) was given top priority. The staff regularly provided information service through current awareness, answering of reference questions, computerized literature searches, and electronic document delivery. The Library continued to assume the role of a public library in the community, as evidenced by 11,631 walk-in clients, consisting mostly of students and faculty members from neighboring and remote universities and researchers from various institutions, who availed of LDS facilities and services during the year.

Making information available via IRRI researchers' desktops and other services were accomplished through the Library's knowledgeable and dedicated staff, the robust collection, and state-of-the-art library system, the *Millennium*, which is currently running on *Release 2005*. In addition, collaboration with other libraries, institutions, and

information providers helped to augment the limited resources available.

Information resources

Collection development is hampered by the universal problem of the ever-increasing volume of new relevant books and journals plus the rising costs of access licenses and the limited budget. A summary of collection growth is given in LDS Table 1.

Rice technical literature. The literature output of rice scientists is growing at an unprecedented rate. Alerts, generated by Current Contents Connect for rice articles published in peer-reviewed journals, carry an average of 50 citations per week. Procurement of these articles is a top priority and those published in nonsubscribed journals usually become problematic due to the limited budget. All five librarians teamed up to get free copies from authors and partner institutions. Hence, the number of journal articles purchased via pay-per-view was very minimal at 44. Rice articles, numbering 2,259 (excluding those in print journals), were added to the collection: 10 reprints and 2,249 in pdf. Ninety-eight percent of these were acquired free of charge. Translating this number into savings, assuming that the average cost of pay-per-view is US\$30, the amount saved would be approximately \$66,450.

Partner libraries in the CGIAR system were instrumental in acquiring electronic copies of some rice articles. Rice literature procurement received a major boost through the availment of periodic free trials from publishers of journals and databases.

Digital resources. For instant access to full-text documents, electronic links were created regularly on the Library's databases. Added to the online catalog were 243 electronic journals and 207 electronic monographs (including theses). There were 3,557 links added to the rice database; it now has a total of 5,757 hyperlinks. Through a single mouse click, 8,319 full text documents in pdf are instantly accessible. This is continually increasing as new items are added daily. Regular searching of rice technical literature on the WWW was pursued vigorously by a full-time project employee up to September 2006.

Print monographs. Three thousand and two hundred eighty-five monographic materials (books, theses, and reprints) were added to the print collection. Only 292 monographs, books, and theses were purchased for the Library and 146 for other units. Most of the monographs acquired were donations or exchange materials.

Databases/journal subscriptions. Subscriptions to vital databases such as Current Contents Connect, Web of science,

CABDirect, LC classification Web, and TEEAL (The Essential Electronic Agricultural Library) were sustained. An additional vital full-text resource added is Anthrosource, which makes up for the limited number of current journals in Anthropology available.

The LDS is slowly moving from print journals to online only, which sometimes poses a problem in archival access. Selection of journal titles for subscription is a very complicated process, as the Library already reduced the number of subscriptions to core titles only. While rice technical article content is the main criterion for prioritizing journals for subscription, those titles that are read regularly by local scientists must also be delivered promptly. To make sure that the LDS is in the right track in selection, a survey of journal preferences of IRRI staff was conducted from April to July. The 2006 survey was done via SurveyMonkey, a freeware on the web. Results show that the top 20 titles cited by respondents are already accessible to IRRI staff, which implies that selection is on the right track. The results also indicate a strong preference for electronic journals.

The costs of journals in scientific disciplines relevant to IRRI's research program increased by an average of 38% for the period 2002-06. The LDS subscribed to 174 journal titles, of which 104 are available online. Membership in the CGIAR Libraries and Information Services Consortium (CGIAR-LISC) increased access to e-journals. While only paying for licenses to 34 titles, access is enabled for a total of 131 titles through the payment of cross-access fees. Open access journals available via the WWW were promptly linked to the online catalog and the e-journal links on the web site.

LDS Table 1. Collection development in 2006.

Publication type	Added in 2006	Total collection
Monographs (books and pamphlets)	1,026	76,304
Rice reprints	2,259	27,763
PDF	2,249	8,319
Journals (print and electronic)	6 print	
	17 electronic	1,575 active titles
Rice theses	119	4,589
Video cassettes	10	221
CD ROM	13	173 titles
Online databases	1	47 (includes free sources)
Electronic links created		
OPAC	207	2,562
Rice database	490	5,757
Total	3,282	141,198

Information access

The Library's integrated system: the Millennium. Innovative Interfaces, Inc., the software provider, continually develops the software by issuing annual or semiannual upgrades. *Release 2005* was installed in December, after adding 36.4 GB of disk storage space to the Innopac server. To further improve search and retrieval capabilities, two additional modules were purchased. A URL checker was installed on 20 Jan to monitor activity of hyperlinks on the two databases. The Advanced Searching module was acquired on 15 Jul. These modules enable faster and more sophisticated searches.

The rice database and the online public access catalog (OPAC). The rice database provides instant access to the world's technical rice literature. It grew with 5,467 rice literature citations added this year, making a total of 251,610 bibliographic records, with all documents available upon request. About 5,757 citations have links to the full text. As in the past, the database is available in both print (*Rice literature update*) and electronic formats.

Bibliographic records for 1,146 books, journals, pamphlets, and nonrice reprints, nonprint materials, and remote electronic resources were added to the OPAC. There are 76,304 records in this catalog, with 2,562 electronic links to full-text documents, Web sites, or databases.

The Library's Web site at <http://ricelib.irri.cgiar.org>, which is available to global users with Internet connection, was regularly updated with new information sources: Web sites, databases, and links to electronic journals and monographs. A regular review of information provided and hyperlinks was done for accuracy and seamless connectivity. New information resources were added soon after they are discovered. In 2006, 53,874 users visited the Library's Web site, an average of 4,489 visits per month.

LDS services

The LDS staff worked as a team to fulfill the needs of clients. Normally, requested articles were delivered on the same day the requests were received. Documents were delivered electronically using the latest version of the Ariel software, which is the most cost-effective way of transmitting electronic documents. Only requests without email addresses were filled using the conventional way—i.e., photocopies sent via snail mail. As a research support service, the LDS staff jointly accomplished the following:

- Delivered information to scientists and librarians in 46 countries worldwide with 1,068 documents delivered and 1,308 reference questions answered.

- Did 47 literature searches for IRRI and other scientists.
- Published 2 issues of the *Rice literature update*, the print edition of the rice database.
- Processed 16,167 book loans, renewals, reserves, and holds.
- Lent 40 books to the libraries of UPLB, PhilRice, and the Badham Library, University of Sydney. LDS borrowed 37 books from the UPLB Main Library and 1 from the Badham Library.
- Issued 55 current awareness announcements in the electronic *IRRI Bulletin* and the *IRRI Announcements* Wiki. These included New Books of General Interest, New Reference Sources, Useful Web Sites, Publications by IRRI Staff, Newly Acquired Technical Rice Literature, Rice Theses, Table of Contents Alerts, Free Access to Journal Issues, etc. Some lists carry links to electronic full-text documents.
- Updated the featured lists of new acquisitions, videocassettes in the AVLIC, and rice theses on the library's Web site monthly.
- Conducted orientation and briefings to 161 new staff, scholars, trainees, and visitors.
- Gave instruction to 15 IRRI staff on the installation and use of database and management software such as EndNote, Procite, and WebAGRIS.
- Facilitated the inclusion of IRRI Library's online catalog in the CG Virtual Library. This can be searched, along with other CGIAR library catalogs, at <http://cgvlib.cgiar.org>. Several requests for literature were answered through this portal.
- Added content to the CG Virtual Library by compiling a list of CGIAR databases and feeding the information to the Virtual Library Team.
- Purchased and cataloged 146 books for other units of IRRI.
- Trained a library science student from Germany, Mr. Kai Scheuing, on all aspects of library operation up to February 2006.
- Bound 1,128 volumes of books and journals and fabricated 136 Princeton files and folders.

As in the past, IRRI continued to be a major provider of free documents to CGIAR center libraries (LDS Table 2). In return, IRRI received 58 free documents from CGIAR center libraries.

Countries, availing of LDS services, were reduced from 49 in 2005 to 46 in 2006 (LDS Table 3). One possible explanation is the increasing number of hyperlinks to full-text documents provided via the library's databases.

LDS Table 2. Document delivery/reference questions answered in 2006.

Center name	Articles delivered (no.)	Reference questions answered (no.)
CIAT	2	3
CIFOR	2	14
CIMMYT	47	49
CIP	110	39
ICARDA	6	7
ICRAF	58	48
ICRISAT	85	38
IFPRI	35	20
IITA	37	24
ILRI	13	16
IPGRI	9	9
IRRI	289	231
IWMI	19	25
WARDA	22	3
WorldFish	2	5
Other institutions	332	777
Total	1,068	1,308

LDS Table 3. Document delivery/reference questions answered in 2006.

Country	Reference questions received (no.)	Documents delivered (no.)	Country	Reference questions received (no.)	Documents delivered (no.)
Australia	4	13	Peru	39	110
Bangladesh	1		Philippines	494	362
Benin	3	22	Poland	2	
Brazil	2		Singapore	3	
Cambodia		1	Spain	1	3
Canada		5	Sri Lanka	25	19
Chile	1		Switzerland	2	
China		8	Syria	7	6
Colombia	4	2	Taiwan		1
Costa Rica	1	2	Thailand	1	1
Croatia	1	1	Turkey		3
Egypt		58	UK	1	
Ethiopia	16	13	USA	26	43
France	2		Vietnam	1	
Germany	1		IRRI staff (local & foreign)	231	289
Ghana	1		Total	1,068	1,308
Guyana	1				
India	53	152			
Indonesia	15	2			
Iran	1	5			
Italy	12	9			
Japan	6	6			
Kenya	48	58			
Lao PDR		3			
Malawi		2			
Malaysia	1	11			
Mexico	28	47			
Myanmar	1	1			
Nepal	2	1			
Netherlands		3			
Nigeria	25	37			
Pakistan	5	9			

LDS Table 4. Projects pursued in 2006.

Project title	Entries added in 2006/remarks	Total
International Directory of Rice Workers	415 (revisions and additions)	2,168
Searching of Free Rice Articles/Monographs from the WWW	1,267	2,040 (linked and added to pdf archives)
PDF Archives	6,863	8,319
Rice Thesaurus (jointly with CPS)	841	2,479 terms with subject trees
Database of IRRI Digital Collections (jointly with CPS)	1,976	5,283
Survey of Journal Preferences of IRRI Scientists	Full report may be requested from the LDS	
Digitization of Rice in the News and IRRI in the News Clippings (jointly with VIS)	Digitization of retrospective up to early 2006 was finished on 4 Jul 2006	
IRRI in the News and Rice in the News Database	1,518	15,931
New Publications by IRRI Staff (e-list posted on the Library's Web site)	73	334

Library projects

In addition to basic services, some projects were undertaken to improve library services and to preserve the existing collection for the use of future generations (LDS Table 4). Searching and downloading freely available pdf files of technical rice articles and dissertations from the Web continued until September 2006. This is still being done but no longer on a full-time basis. A total of 1,267 rice articles, books and conference proceedings, and dissertations were downloaded and linked to bibliographic records in the Library's databases.

Partnerships within and outside IRRI

No library, working on its own, can supply all the needs of its clients. At this age of dwindling resources, collaboration with other libraries and institutions enables the LDS to avail of additional services and resources, e.g. interlibrary loans, document delivery, etc.

Within IRRI, the LDS collaborated with Communication and Publications Services (CPS) and Visitors and Information Services (VIS) in undertaking three projects: Phase 2 of the Rice Thesaurus Project and the Database of IRRI Digital Collections (DIDP), and the Digitization of Newspaper Clippings about IRRI and Rice. Phase 3 of the Rice Thesaurus and the DIDP started in December.

The partners outside of IRRI include

- *Exchange partners.* 600+ libraries in the Philippines and overseas received IRRI's free publications.
- *Document delivery partners.* Some local libraries that lent support to IRRI are the Thomas Jefferson Information Center, the libraries of the University of the Philippines Los Baños, the Asian Development Bank, University of the Philippines-Diliman, the Philippine Rice Research Institute, Ateneo de Manila University, and the De La Salle University.

Outside the Philippines, assistance was received from some CGIAR libraries; the IRRI outreach offices in China, India, Korea, and Thailand; the National Agricultural Library in Maryland; the Badham Library, University of Sydney; Developing Libraries Network (India); FAO, and the Hong Kong University of Science and Technology Library. Many foreign authors gave pdf copies of their papers, free of charge. Dr. Takanori Hayashi of the Agriculture, Forestry and Fisheries Research Information Center (AFFRIC) in Japan supplied some of the Japanese rice literature needed by the LDS.

- *CGIAR libraries.* The IRRI LDS supported the creation of the CG Virtual Library (<http://vlibrary.cgiar.org>), which gave wider exposure to the Library's online catalog and to IRRI publications as well. Joint subscriptions with CGIARLISC members continued. Systemwide coordination was done by the IRRI chief librarian. Free-document delivery is another major benefit derived from the consortium.
- *Agriculture Centers Information Network (AGNIC).* A project on digitization of selected pages of IRRI-assisted theses and dissertations started in October in partnership with AGNIC. The digitized collection will be posted in the AGNIC database for wider awareness and accessibility. From the LDS end, links to these resources will be created on the online catalog and the rice database.
- *Food and Agriculture Organization of the United Nations (FAO).* Bibliographic records (257) were contributed to FAO's AGRIS database. The FAO-developed software, WebAGRIS, and Information Management Resource kit CD-ROM were promoted for use by local librarians.
- *International Association of Agricultural Information Specialists (IAALD).* Dr. Enrica Porcari, CGIAR chief

information officer, strengthened the CGIAR's organizational ties with IAALD by contracting for institutional memberships all 15 CGIAR centers and the CG Secretariat libraries.

- Hong Kong Innovative Users' Group. This association of Innopac users invited IRRI librarians to serve as resource persons and to participate in the annual meeting with no charge for registration.
- Local library associations/networks:
 - Agricultural Librarians Association of the Philippines (ALAP). As in the past, three IRRI librarians served as trainers during the Seminar-Workshop on Retooling Librarians and Information Managers on Digital Resources, Database Creation and Management, Benguet State University, 23-24 Feb.
 - PhilAgriNet. IRRI librarians participated in its annual general assembly and assisted in the drafting of a project proposal for submission to FAO. Five members of the network were trained on WebAGRIS installation and database management.
 - Cavite Librarians Association. The IRRI chief librarian was invited to serve as a resource person in two of its major conferences.

The library continued to share extra resources, consisting of superseded editions, duplicate materials, and IRRI publications with local libraries. The following institutions are beneficiaries of these donations: Aklan State University, Mapua University, University of the Philippines Los Baños, Camarines Sur State Agricultural College, Center for Agriculture and Rural Development (CARD-MRI Development Institute (Laguna), University of Southern Mindanao, and V. Mapa High School (Manila).

Professional growth of staff

Most of the Library staff availed of in-house training courses on various Microsoft modules, personnel management, and personal development offered by IRRI.

To be aware of different library facilities and practices, the staff visited the following advanced libraries of the following institutions: the De La Salle University Library, the Philippine Women's University, Brent School, and the Asian Institute of Management.

Through IRRI's professional growth program, all LDS staff participated in the 3-day Millennium Refresher Course conducted by Ms. Krissana Thampalo of Innovative Interfaces, Inc., the provider of the current automation system.

VISITORS AND INFORMATION SERVICES

The Institute welcomed some 46,031 visitors (VIS Table 1). These included distinguished guests such as the president of India, HE A. P. J. Abdul Kalam; the mayor of the California city of Davis, Ruth Asmundson; Senator Ramon Magsaysay, Jr. of the Philippines; five ambassadors; 1,671 government officials; six ministers; various members of the diplomatic community; and representatives of donor and international organizations, including the ADB, the US embassy, and ACIAR. The Institute was also visited by 1,054 farmers.

IRRI via the Visitors Office also hosted the first Rice Camp for young students from Thailand and the Philippines on 24-28 Apr. This was done to mark the start of a major new effort to encourage young Asians to consider a future in rice. During the 5 days, the students—selected because of their interest in or knowledge of rice—learned the very latest scientific techniques in rice research and more specifically were convinced of how rice research can make the future of rice in the region brighter.

Three new sets of activity books for the three school categories (pre-school, elementary, and high school) were introduced to the 38,804 students who visited IRRI last year. The books are intended to educate children on the importance of rice as a staple food and at the same time help them enjoy their tour of the Riceworld Museum and Learning Center.

In providing audio visual support, the Visitors Office also handled 205 Institute seminars, training sessions, and workshops and an overall total of 664 audiovisual requests compared with last year's 535.

Workshops, conferences, and meetings

During the year, IRRI hosted or cohosted 27 regional and international conferences, workshops, and symposia (VIS Table 2). The regional and international workshops attracted 982 delegates from 37 countries.

Riceworld and facilities

Representing IRRI, the Riceworld Museum and Learning Center staff were able to participate in six exhibitions:

- a. Agri-Aqua Fair and Exhibit at the House of Representatives, Quezon City, May 2006
- b. National Science and Technology Week and DOST Annual Science and Technology Fair, Pasay City, Jul 2006
- c. Los Baños Science Community Exhibit, Los Baños, Aug 2006
- d. Bañamos Tuklas-Agham Exhibit, Los Baños, Sep 2006
- e. International Rice Congress, New Delhi, India, Oct 2006

VIS Table 1. IRRI visitors, by group, in 2006.

Visitor group	Philippines	Asia	Africa	Australasia	Europe	Latin America	North America	USA	Total
Students	38,339	375		4	57	11		18	38,804
Conference participants	577		11						588
Nongovernment organizations	284	35			1			1	321
Donors	52	19		3				2	76
Government officials	1,376	286	7					2	1,671
Farmers	585	469							1,054
Faculty members/parents	378	179			8		3	12	580
Scientists, researchers	332	174	1	7	14	3	1	10	542
Private sector	736	325		12	10		2	17	1,102
UN agencies, CGIAR, TAC, etc.		1	2			1		3	7
Diplomatic corps	2	7			12			1	22
Media	57	48			1			1	107
Religious groups	120	59			1			4	184
Tourists	72	170		4	23		4	27	300
Others	548	39	3	11	9	1	6	56	673
Total	43,458	2,186	24	41	136	16	16	154	46,031

Museum improvements were done on the art and culture exhibit section by restoring two *kipping* (rice wafer) chandeliers, two Riceworld panicle signage, and three rice panicle chandeliers. Repairs were also done on the Rice Song section.

The Rice History section was painted over to make way for a future updated version.

Non-IRRI groups requesting to use IRRI facilities but with activities not in line with IRRI's mission and vision were not allowed in the Institute in 2006. IRRI, however, hosted ICRAF, PhilRice/Department of Agriculture/UPLB, UPLB Dev Com, and the Southern Luzon Association of Museums.

Distinguished visitors in 2006

Legislators and government officials

Hon. Thomas Mandlate, minister of agriculture, Maputo, Mozambique, 13 Jan

H.E. Dr. Avul Pakir Jainulabdeen Abdul Kalam, president of India, 5 Feb

Hon. Roberto M. Pagdanganan, secretary, Department of Tourism, Philippines, 5 Feb

Mr. Kentaro Kawaguchi, assistant director, Biotechnology Safety Division, Agriculture, Forestry and Fisheries Research Division, MAFF, Tokyo, Japan, 21 Feb

Md. Hamidur Rahman, director general, Department of Agricultural Extension (DAE), Bangladesh, 7 Mar

Md. Abdur Razzaque Buiyam, project coordinating director, Small Holders Agricultural Improvement Project, DAE, Bangladesh, 7 Mar

Md. Rejaul Haider, private secretary to the Secretary, Ministry of Agriculture, Bangladesh, 7 Mar

Md. Fazlul Jaque Mollah, deputy director, administration, DAE, Bangladesh, 7 Mar

Md. Abu Yusuf Mia, additional deputy director, administration, DAE, Bangladesh, 7 Mar

Hon. Qinglin Du, minister of agriculture, People's Republic of China, 26 Mar

Hon. Ruth Uy Asmundson, mayor of Davis City, California, USA, 30 Mar

Atty. Noel Servigon, division director, DFA-UNIO, 13 May

Ms. Azlina Binti Abdullah, Division of Paddy and Rice Industry, Ministry of Agriculture and Agro-based Industry, Malaysia, 29 Jun

H.E. Abdalla Yahia Adam, secretary general, Afro-Asian Rural Development Organization, New Delhi, India, 24 Jul

Hon. Dr. Xu Guanhu, minister, Ministry of Science and Technology, China, 25 Aug

Hon. Ramon Magsaysay, Jr., member of the Philippine Senate, 7 Sep

H.E. Lyonpo Sangay Ngedup, minister of agriculture, Royal Government of Bhutan, 20 Oct

Dr. Kyaw Than, vice president, Myanmar Academy of Agricultural, Forestry, Livestock and Fisheries Sciences, 13 Nov

Chief internal auditors, The Royal Kingdom of Bhutan, 5 Dec

Mr. Ir. Sutarto Alimoeso, director general, Good Crop, Ministry of Agriculture, Indonesia, 14 Dec

Mrs. Atik Wasiati, director, Plant Crop Protection, Indonesia, 14 Dec

Ms. Yang Xinyu, deputy secretary general, China Scholarship Council, Ministry of Education, China, 14-15 Dec

Mr. Xu Haijiang, deputy director, Foreign Economic Cooperation Center (FECC), Ministry of Agriculture (MOA), China, 22 Dec

Ms. Zhang Li, director, Foreign Economic Cooperation Department, FECC, MOA, 22 Dec

Representatives of various organizations

Dr. Sandra Lee Kunimoto, head, Hawaii State Department of Agriculture, 9 Jan

Dr. Andrew Hashimoto, dean, College of Tropical Agriculture and Human Resources, University of Hawaii, Manoa, 9 Jan

Mr. Yasuhiro Onozaki, senior officer, General Affairs Section, Japan International Research Center for Agricultural Sciences (JIRCAS), 5-8 Feb

Mr. Toshiaki Kikuchi, senior officer, Overseas Staff Support Section, Administrative Division, JIRCAS, 5-8 Feb

Dr. Stephen McGurk, regional director, Regional Office for South East and East Asia, International Development Research Centre (IDRC), 20-21 Feb

Dr. Ellie Osir, senior program specialist, Regional Office for South East and East Asia, IDRC, 20-21 Feb

Mr. John Mwangi, associate director, CGIAR IAU, Nairobi, Kenya, 27 Feb

Mr. Thotekat N. Menon, head, Internal Audit, International Crops Research Institute for the Semi-arid Tropics, India, 27 Feb

Professor Sho Shiozawa, Department of Biological and Environmental Engineering, Graduate School of Agricultural and Life Sciences, The University of Tokyo, 20-22 Mar

Air Commodore O. Petinrin, one-star general officer, National War College of Nigeria, 3 May

Dr. Henry Miller, Hoover Institution; founding director, Office of Biotechnology, U.S. Food and Drug Administration, 5 May

Dr. Tuan-Hua David Ho, director, Institute of Plant and Microbial Biology, Academia Sinica, Taiwan, 10 Jul

Mr. Dhak Tshering, deputy chief, Ministry of Works and Human Settlement, Royal Kingdom of Bhutan, 1 Aug

Dr. Muhammad Ehsan Khan, project economist, Southeast Asia Department, Asian Development Bank (ADB), 4 Aug

Dr. Christine Hotz, nutrition coordinator, Harvest Plus Challenge Program, International Food Policy Research Institute (IFPRI), 7-10 Aug

Dr. J. V. Meenakshi, policy and impact coordinator, Harvest Plus Challenge Program, IFPRI, 7-10 Aug

Dr. John Dixon, director, Social Sciences Division, International Maize and Wheat Improvement Center, 9 Aug

Mr. Harry Stine, CEO/owner, Stine Seed Company, Iowa, USA, 22 Aug

Members of the University of the Philippines Board of Regents, 25 Aug

Dr. R.K. Mittal, principal scientist for technical coordination, Indian Council for Agricultural Research, 31 Aug

Dr. Nihal Amerasinghe, international consultant, ADB, 16 Sep

Dr. Urooj S. Malik, director (SEAE), Agriculture, Environment and Natural Resources Division, ADB, 7 Sept

Dr. Achmad Suryana, director general, Indonesian Agency for Agricultural Research and Development, 4-5 Sep

Developing member country (DMC) officials, ADB, 16 Sep

Dr. Kay Porter, director of rice research, Pioneer Hi-Bred International, Inc., 25-27 Sep

Dr. Selvam Ramaraj, vice president, Industrial Malaysian Biotechnology Corporation, 1 Oct

Dr. Richard Jefferson, CEO, CAMBIA, Australia, 5 Oct

Ms. Amelia Goh, communications officer, CGIAR Gender and Diversity Program; molecular genetics researcher, Worldfish Center, 11 Oct

Mr. Erin Zink, scientific program coordinator for social sciences, International Foundation for Science, 11 Oct

Dr. Hu Peisong, head, Department of Program Management and International Cooperation, China National Rice Research Institute, 18 Oct

Dr. Larry Beach, biotechnology advisor, United States Agency for International Development, Washington, D.C., 26 Oct

Prof. Timothy Reeves, Australian Centre for International Agricultural Research, 13 Nov

Dr. Guomin Sui, director general, Liaonin Rice Research Institute, 5 Dec

Prof. Huang Xingqi, president, Yunnan Academy of Agricultural Sciences, 7-8 Dec

Dr. Xu-rong Mei, director general, Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, 11-13 Dec

Ms. Chen Yidan, president, Longping International Company, 22 Dec

Mr. Zhou Chengsu, vice president, Longping International Company, 22 Dec

Mr. Md. Muklesur Rahman, chair, and Mr. Sohrabuddin Khon, joint director, Bangladesh Agriculture Development Corporation.

Members of the diplomatic corps

H.E. Muhammad Abul Quashem, ambassador of the People's Republic of Bangladesh to the Philippines, 31 Mar

H.E. Muhammad Naeem Khan, ambassador of the Islamic Republic of Pakistan to the Philippines, 9 May

H.E. W.M. Senvirathna, ambassador of the Democratic Socialist Republic of Sri Lanka to the Philippines, 6 Jun

Mr. Cleveland Charles, deputy economic counselor, Embassy of the United States of America, Manila, 21 Mar

H.E. Prof. Dr. Irzan Tandjung, ambassador of the Republic of Indonesia to the Philippines, 26 Jul

H.E. Peter Beckingham, ambassador of the United Kingdom of Great Britain and Northern Ireland to the Philippines, 26 Sep

Ms. Debra Benavidez, economic officer, and Ms. Maria Theresa Villa, economic specialist, Embassy of the United States of America, Manila, 14 Nov

H.E. Vu Xuan Truong, ambassador of the Socialist Republic of Vietnam to the Philippines, 4 Oct

VIS Table 2. International and regional conferences, workshops, symposia, and meetings hosted or cosponsored by IRRI in 2005.

Date	Title	Venue	Participants (no.)	Countries represented (no.)
13-14 Feb	The Impact of Rice Production on Environmental Sustainability: Development of Environmental Sustainability Indicators Workshop I—Biological Indicators	IRRI	25	2
14-16 Feb	Project Review and Planning Meeting of ADB-supported Project	Pakistan	39	5
22-24 Feb	Message Design Workshop: Environmental Radio Soap Opera for Rural Vietnam	Vietnam	28	2
6-8 Mar	International Dialogue on Rice and Water: Exploring Options for Food Security and Sustainable Environments	IRRI	52	9
6-9 Mar	Fifth Annual Meeting of the Consortium for Unfavorable Rice Environments (CURE) and Natural Resource Management Workshop	Bangladesh	79	12
20-24 Mar	Climate Change and Rice Planning Workshop	IRRI	55	12
30-31 Mar	2nd Annual Meeting of CPWF Project 10, "Managing Water and Land Resources for Sustainable Livelihoods at the Interface between Fresh and Saline Water Environment in Vietnam and Bangladesh"	IRRI	28	5
3-4 Apr	Aerobic Rice: Progress and Prospects	IRRI	70	12
5-6 Apr	Preliminary Planning Meeting of the ADB-funded RETA project on Development and Dissemination of Water-saving Rice Technologies in South Asia	IRRI	33	7
5-7 Apr	IRRI Board of Trustees Meeting	IRRI	15	10
25-27 Apr	2nd Annual Review and Planning Meeting of CPWF Project 7, "Development of Technologies to Harness the Productivity Potential of Salt-affected Areas of the Indo-Gangetic, Mekong, and Nile River Basins"	India	65	6
2 Jun	World Environment Day 2006: Launching Ceremony	Vietnam		3
17-21 Jul	Supercharging the Rice Engine: C4 Rice Workshop	IRRI	61	8
24 Jul–4 Aug	IRRI Training Workshop: Concepts and Tools for Agricultural Research Evaluation and Impact Assessment	IRRI	25	11
21-23 Aug	The Impact of Rice Production on Environmental Sustainability: Workshop on the Development of Sustainability Indicators	Malaysia	50	6
29-30 Aug	Differential System for Blast Resistance for a Stable Rice Production Environment and Work Plan Meeting for JIRCAS Research Project	IRRI	27	13
13 Sep	IRRI-Philippines Workplan Meeting	Philippines	44	1
25-26 Sep	Inception Meeting of the ADB-supported Project: Development and Dissemination of Water-saving Rice Technologies in South Asia	IRRI	39	6
27 Sep	Workshop on Soil and Root Health Issues in Water-saving Rice Systems	IRRI	39	6
2-6 Oct	Drought Frontier Project Planning Workshop	IRRI	17	10
9-13 Oct	International Rice Congress	India	1,400	46
11-13 Oct	IRRI Board of Trustees Meeting	India	17	10
13-14 Oct	CORRA Meeting	India	32	17
6-8 Nov	LEARN-IT Planning Meeting	Thailand	31	6
7-8 Nov	2nd Annual Meeting of GCP, "Revitalizing Marginal Lands: Discovery of Genes for Tolerance for Saline and Phosphorus-deficient Soils to Enhance and Sustain Productivity	IRRI	36	7
17 Nov	IPMO Annual Meeting	IRRI	24	10
4-8 Dec	Assessing the Potential of Rice-maize Systems in Asia	IRRI	23	9
Total			2,354	

Media

For the Philippine and International media, VIS arranged programs for visits, interviews, and filming in 2006.

Philippine media: AP Television, *The Philippine Star*, ABS-CBN, and *Philippine Daily Inquirer*

International media: TV MBN, Radio CBS (Korea), SciDev Net (London), MMTV Film Production (Germany), Reuters, Bloomberg/Newsroom, Arte F2 and F3, Public Channels, Singing Nomads Productions (Victoria, Team Europe (Russia), China Central Television (China), Cloud South Films Ltd., Info Resources (Switzerland), SciTech (China), *Science Magazine* (Japan), *Nature* (United Kingdom) BBC World Service (United Kingdom), Dow Johnson News-wires (Chicago), *China Daily*, Netscribes PVT. Ltd. (India), United Media (New York), *Seed Magazine* (New York), Hat Trick Production (London), *Catholic Daily* (Italy), Agence France-Presse (AFP) Television, *The Wall Street Journal*, The Development Newswire, BBC Radio, Newsmaker (Washington, Cinema Vision (India)

Press releases. VIS issued 17 press releases during 2006

- Crop development efforts get major boost (24 January)
- Indian President focuses on farmers (7 February)
- The green revolution comes to Laos (15 March)
- Climate change: the rice genome to the rescue (27 March)
- The direct approach: South Asian rice farmers look for more efficient ways to plant rice (6 April)
- The direct approach: South Asian rice farmers look for more efficient ways to plant rice (7 April)
- A rice future for Asia (26 April)
- A cleaner, greener rice industry (5 June)
- Examining a tricky issue and inspiring the future of rice in Asia (29 June)
- International rice industry prepares to gather in India (12 July)
- A more powerful and efficient engine for rice: the C3-C4 challenge (26 July)
- New flood-tolerant rice offers relief for world's poorest farmers (9 August)
- IRRI genebank helps protect Philippine crops (5 October)
- Typhoon blasts rice research institute (2 October)
- Media Alert (5 October)
- A new vision for international rice research attacks the roots of P (9 October)
- Change in IRRI's copyright policy to facilitate the free exchange of vital information (20 October)

In conjunction with CPS, four issues of *Rice Today* were published and distributed to more than 2,425 subscribers in more than 98 countries and 4 on line *IRRI Hotline* issues were released to 2,583 recipients.

INFORMATION TECHNOLOGY SERVICES

The Information Technology Services team improved several aspects of the IRRI IT infrastructure, including a major upgrade of network storage and an increase of Internet connectivity to a total of 8 mbps. The introduction of managed printing and copying services moves IRRI toward a more efficient and environment-friendlier 'fleet printing model' consisting of distributed high-end print/scan/copy/fax devices plus a printing and copy center for high-volume jobs.

Professional development of IRRI's staff and scholars in the information technology area saw a large number of course participants and a record amount of people passing industry-standard certification exams. All staff members are now required to pass the locally developed Computer Security Awareness test, which is accompanied by a training session. The IRRI Cybercafé (actually the ITS training room after working hours, no coffee but plenty of Java) has become popular with staff and scholars. ITS team members participated in several professional training events both in the Philippines and in the region.

The connection to the Asia Pacific Advanced Network (APAN), a network of research institutions that interconnects to similar networks in other parts of the world, continues to enable collaboration with partners in other research organizations. The consortium of Advanced Research Networks (ARNs), also known as Internet 2, has features including the rapid transfer of very large datasets, broadcast-quality multi-party videoconferencing sessions, grid computing, and access to specialized databases. Use of ARNs within the CGIAR system was expanded as a result of the Information and Communication Technology/Knowledge Management (ICT/KM)-funded project, which enabled the connection of CIP and CIMMYT to ARNs in their regions, and laid the foundation for several other centers to follow suit.

IRRI also played a lead role in the CGIAR Enterprise Security and Business Continuity (ESBC) project. A security scan of IRRI's ICT infrastructure was extremely useful, and acted as an eye opener for many. The results of a 'social hacking' exercise were particularly revealing and confirmed the need for professional development of center staff in the use of IT networks. The documentation of the IRRI IT infrastructure was enhanced as a result of the report, with improved policies and procedures where required.

To mobilize the global network of rice researchers that have at any point in their career spent time at IRRI, the alumni project is seeking to collect contact information of all alumni. In addition, the www.irrialumni.org Website was set up using free Web hosting resources, complete with e-mail accounts for all interested alumni. This effort forms part of

activities in IRRI's newly developed MTP to create online communities in rice research by applying existing social networking tools.

Towards the end of 2006, Paul O'Nolan left the position of head of ITS unit after 7 years with IRRI. His contributions are illustrated by IRRI's admission to the "CIO 100 honouree 2006" of *CIO Asia* magazine's annual index of Asia's top-performing enterprise users of IT.

SEED HEALTH UNIT

Phytosanitary certification

The Seed Health Unit issued 355 phytosanitary certificates covering 74,788 seedlots (26,709.60 kg) and sent to 57 countries worldwide in 2006 (SHU Table 1). By region, East Asia received 83 rice seed shipments (8,224 seedlots weighing 25,100.320 kg), Europe received 44 rice seed shipments (2,283 seedlots weighing 25.98 kg); Latin America received 15 rice seed shipments (692 seedlots weighing 7.67 kg); North America received 32 rice seed shipments (6,829 seedlots weighing 142.74 kg); Oceania received 12 rice seed shipments (638 seedlots weighing 9.81 kg); South Asia received 48 rice seed shipments (22,425 seedlots weighing 305.42 kg); Southeast Asia received 101 rice seed shipments (32,532 seedlots weighing 1,072.16 kg); sub-Saharan Africa received 9 rice seed shipments (825 seedlots weighing 26.02 kg); West Africa received 2 rice seed shipments (58 seedlots weighing 1.33 kg); and West Asia and North Africa received 9 rice seed shipments (282 seedlots weighing 18.15 kg).

The exported rice seeds originated from different organizational units: International Network for Genetic Evaluation of Rice (INGER), 23 shipments (1,090 seedlots weighing 58.59 kg); Crop and Environmental Sciences Division (CESD) 13 shipments (417 seedlots weighing 191.04 kg); Genetic Resources Center, 138 shipments (56,817 seedlots weighing 755.12 kg); Grain Quality, Nutrition and Postharvest Center (GQNPC), 30 shipments (480 seedlots weighing 1.11 kg); and Plant Breeding, Genetics and Biotechnology Division (PBGB), 151 shipments (15,984 seedlots weighing 25,703.74 kg) (SHU Table 2).

The different pathogens detected with corresponding detection level and affected seedlots are shown in SHU Table 3. Routine seed health tests conducted on 10,374 nontreated, outgoing seedlots showed that *Curvularia* spp. affected 99.80% of the seedlots, followed by *Phoma* spp., 97.84%, *Sarocladium oryzae*, 75.97%, *Nigrospora* spp., 74.91%, *Fusarium moniliforme*, 55.15%, *Trichoconis padwickii*, 52.07%, *Microdochium oryzae*, 9.42%, *Bipolaris oryzae*, 2.17%, *Tilletia barclayana*, 0.34%, *Aphelenchoides besseyi*, 0.31%, and *Pyricularia oryzae*, 0.24 %. All exported rice

seeds were cleaned for objects of quarantine importance, tested for health, and treated with prescribed ASEAN standard seed treatment for rice—hot water 52–57°C/15 min. This was followed by fungicide slurry treatment with benomyl and mancozeb, both at 0.1% by seed weight, except for countries that do not allow seed treatment. Fumigation with phosphine was also administered to all outgoing seeds.

A total of 71 phytosanitary certificates were also issued to INGER for their nursery rice seed distribution covering 26,662 seedlots (676.49 kg) and sent to 36 countries worldwide (SHU Table 4). By region, East Asia received 17 shipments (4,058 seedlots weighing 104.80 kg); Europe received 8 shipments (1,008 weighing 26.29 kg); Latin America received 6 shipments (3,195 seedlots weighing 73.20 kg); South Asia received 14 shipments (10,743 seedlots weighing 269.30 kg); Southeast Asia received 15 shipments (4,448 seedlots weighing 123.20 kg); sub-Saharan Africa received 6 shipments (886 seedlots weighing 24.80 kg); and West Asia and North Africa received 5 shipments (2,324 seedlots weighing 54.90 kg).

Post-entry clearance

Sixty-one incoming rice seed shipments (covering 7,908 seedlots and weighing 191.224 kg) from 23 countries worldwide were also processed for post-entry clearance (SHU Table 5). The highest total number of rice seed shipments originated from Southeast Asia, with 19 shipments, while the highest total number of seedlots and total weight originated from East Asia with 6,332 seedlots weighing 103.07 kg. The consignees of these seed shipments are shown in SHU Table 6. Plant Breeding, Genetics and Biotechnology received the highest number of incoming rice seed shipments with 31 shipments (6,595 seedlots weighing 137.40 kg); followed by GQNPC, 10 shipments (226 seedlots weighing 7.50 kg); CESD, 7 shipments (497 seedlots weighing 20.24 kg); INGER, 7 shipments (72 seedlots weighing 11.06 kg); GRC, 4 shipments (474 seedlots weighing 14.38 kg); IPMO, 1 shipment (32 seedlots and 0.42 kg); and Intellectual Property Management Unit (IPMU), 1 shipment (12 seedlots weighing 0.22 kg).

SHU Tables 7a and 7b show the result of post-entry examination conducted on incoming 1,838 seedlots. Out of the visually inspected seedlots, 0.00 % were contaminated with weed seeds, 0.11 % had seeds with soil, and 0.29% were damaged by insects mainly by *Sitotroga cerealella*. In terms of general quality, 1, 378 seedlots (74.97%) were under category 3. The seed health tests on 146 incoming nontreated rice seedlots showed that *Trichoconis padwickii* affected 90.41%, followed by *Curvularia* spp. 89.04%, *Bipolaris oryzae* (82.88%), *Sarocladium oryzae* (60.96%), *Phoma* spp.

(57.53%), *Fusarium moniliforme* (48.63%), *Nigrospora* spp. (41.78%), *Microdochium oryzae* (25.34%), *Tilletia barclayana* (22.06%), and *Pyricularia oryzae* (1.37%) (SHU Table 8). The results also show that none of the incoming seedlots were infected with *Aphelenchoides besseyi*. The prescribed ASEAN standard treatments were applied to all incoming seeds.

Crop inspection

Crop health inspections were conducted on post-entry quarantine areas and GRC, PBGB, CESD, and GQNPC multiplication plots during the 2006 dry and wet seasons. Post-entry crop health inspection was conducted on 1,909 entries during the dry season and 4 entries during the wet season. Furthermore, preexport crop health inspection was also conducted on 8,325 entries during the dry season and on 13,658 entries during the wet season. SHU Table 9 shows the different diseases observed with corresponding percentage prevalence. For incoming materials, the most prevalent disease observed during the dry season was rice tungro (11.16%), while the most prevalent disease observed during the wet season was bacterial leaf streak (100%). On the other hand, for materials planted in the multiplication plots, the most prevalent disease observed during the dry season was *Sclerotium* seedling blight (42.10%), while the most prevalent disease observed during the wet season was bacterial leaf streak (20.10%).

Advance testing for GRC seeds

A total of 4,560 GRC seedlots for long-and medium-term storage were processed for seed health status. The different fungi detected with corresponding detection level and affected seedlots are shown in SHU Table 10. Routine seed health testing on 2, 328 untreated seedlots revealed that *Curvularia* spp. affected 99.96% of the seedlots, followed by *Phoma* spp., 93.77%, *Trichoconis padwickii*, 92.27%, *Nigrospora* spp., 68.51%, *Sarocladium oryzae*, 48.28%, *Bipolaris oryzae*, 43.69%, *Fusarium moniliforme*, 33.38%, *Microdochium oryzae*, 5.93%, *Aphelenchoides besseyi*, 2.96%, *Pyricularia oryzae*, 1.63%, and *Tilletia barclayana*, 0.17%

Nonseed biological materials and soil samples

Outgoing (exported). Through the SHU, a total of 71 shipments covering 5,897 samples were processed for phytosanitary certification and sent to 16 countries worldwide (SHU Table 11). By region, East Asia received 11 shipments covering 1,334 samples; Europe received 15 shipments covering 1,477 samples; Latin America received 2 shipments covering 12 samples; North America received 25 shipments covering

2,626 samples; South Asia received 2 shipment covering 14 samples; Southeast Asia received 9 shipments covering 37 samples, and sub-Saharan Africa received 3 shipments covering 254 samples. SHU Table 12 shows the nature of nonseed biological materials with corresponding total number of shipments and total number of samples exported by IRRI during 2006. The highest number of exported non seed biological materials was DNA with 26 shipments covering 2,670 samples, followed by RNA with 13 shipments covering 1,284 samples. The nonseed biological materials came from various organizational units: CESD with 10 shipments covering 1,203 samples of various materials; GQNPC with 2 shipments covering 6 samples of various materials; GRC with 12 shipments covering 1,234 samples of various materials; and PBGB with 47 shipments covering 5,897 samples of various materials (SHU Table 13).

Incoming (imported). Twenty-seven shipments (1,150 samples) coming from four regions were also processed for post-entry clearance (SHU Table 14). The highest number of shipments originated from Europe (14 shipments), while the highest number of samples originated from Southeast Asia (718 samples). SHU Table 15 shows the nature of incoming materials with corresponding total number of shipments and total number of samples. The highest number of incoming materials were ground soil, charcoal, fertilizer, and water with 450 samples, followed by rice ground leaf powder with 276 samples. The recipients of these incoming materials were CESD with 21 shipments covering 959 samples, which consisted of various materials; IPMO with 4 shipments covering 160 samples, which consisted of various materials; and PBGB with 2 shipments covering 31 samples, which consisted of various materials.

Workshops, training courses, and visitors

SHU also participated in various trainings/workshops coordinated by the Training Center, Rice Production Course with 15 participants from 6 countries; Upland Rice Variety Selection Techniques (for African countries) Training Course with 11 participants, and Rice Camp 2006 with 10 Thais and 9 Filipino high school students as participants.

Other visitors included two plant quarantine officers and one administrative officer from Korea (Seed Multiplication Project); 15 Seed Pathology students and 2 professors from Central Luzon State University, Muñoz, Nueva Ecija; 10 Biology students from the Adventist University of the Philippines; 32 Agronomy 170 (Seed Technology) students from UPLB; scientists from INIA, Spain; head of Information Network, RDA Genebank, National Institute of Agricultural Biotech; two visitors from Chile – director of Department of

Plant Science, School of Agriculture & Forestry, Catholic University of Chile and assistant manager for Arroceros, Tucapel; one USDA technical consultant together with 2 Philippine Plant Quarantine Service Officers; 18 women farmers from Central Luzon who are Members of the *Pambansang Koalisyon Ng Kababaihan sa Kanayunan*;

25 health workers who are members of the Alegheny County Medical Alliance, Young Filipino American of Pittsburg (YPAP), and *Pagmamahal sa Kapwa* Foundation, Inc; four JICA delegates ; two representatives of Pioneer, Inc., and one plant quarantine officer from USDA-APHIS, Beltsville, Maryland, USA.

SHU Table 1. Distribution, by region and country, of rice seeds exported by IRRI, 2006.

Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)	Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)
East Asia (6)				South Asia (5)			
Hongkong	1	1	.060	Bangladesh	7	293	12.039
Japan	23	1,048	9.982	India	36	21,858	289.908
Korea N	2	89	1.460	Nepal	2	193	1.800
Korea S	8	4,564	25,064.446	Pakistan	2	59	1.370
China, PR	43	2,396	23.347	Sri Lanka	1	22	.300
Taiwan	6	126	1.025	Subtotal	48	22,425	305.417
Subtotal	83	8,224	25,100.320	Southeast Asia (8)			
Europe (14)				Indonesia	5	129	.688
Austria	3	33	.666	Laos	5	25,694	297.600
Belgium	2	6	.080	Malaysia	3	37	.324
Czechoslovakia	1	1	.015	Myanmar	6	103	15.910
Denmark	1	3	.225	Philippines	58	6,086	746.708
France	4	1,036	5.745	Singapore	4	22	.581
Germany	7	45	2.539	Thailand	7	172	7.136
Italy	1	7	.190	Vietnam	13	289	3.211
Netherlands	2	4	.038	Subtotal	101	32,532	1,072.158
Portugal	1	36	.190	Sub-Saharan Africa (7)			
Russia	2	28	2.198	Ethiopia	1	9	.419
Spain	4	97	1.215	Ghana	2	24	.390
Sweden	2	42	.963	Nigeria	1	599	16.900
United Kingdom	13	594	3.418	Rwanda	1	102	3.900
Uzbekistan	1	351	8.500	Somalia	2	75	3.060
Subtotal	44	2,283	25.982	South Africa	1	15	.148
Latin America (8)				Togo	1	1	1.200
Brazil	2	53	.234	Subtotal	9	825	26.017
Chile	2	35	2.257	West Africa (1)			
Colombia	5	331	1.677	Benin	2	58	1.333
Cuba	1	17	.024	Sub-total	2	58	1.333
Ecuador	1	90	1.300	West Asia & North Africa (4)			
Surinam	1	103	1.300	Egypt	3	197	16.200
Uruguay	1	17	.024	Iran	4	76	1.838
Venezuela	2	46	.854	Israel	1	1	.010
Subtotal	15	692	7.670	Turkey	1	8	.100
North America (2)				Subtotal	9	282	18.148
Canada	4	92	1.095	Grand total			
USA	28	6,737	141.644	355	74,788	26,709.595	
Subtotal	32	6,829	142.739				
Oceania (2)							
Australia	10	513	5.521				
Papua New Guinea	2	125	4.290				
Subtotal	12	638	9.811				

SHU Table 2. Sources of exported rice seeds exported by IRRI, 2006.

Pathogen	Affected seedlots ^a (%)	Detection level (%)	Mean (%)
International Network for Genetic Evaluation of Rice (INGER)	23	1,090	58.590
Crop and Environmental Sciences Division (CESD)	13	417	191.043
Genetic Resources Center (GRC)	138	56,817	755.117
Grain Quality, Nutrition, and Postharvest Center (GQNPC)	30	480	1.105
Plant Breeding, Genetics & Biotechnology (PBGB)	151	15,984	25,703.740
Grand total	355	74,788	26,709.595

^aBased on 200 seeds/seedlot drawn for testing (n=784).

SHU Table 3. Seedborne pathogens detected on untreated outgoing seeds received by SHU for phytosanitary certification, 2006.

Pathogen	Affected seedlots ^a (%)	Detection level (%)	Mean (%)
<i>Trichoconis padwickii</i>	52.07	1–62	2.52
<i>Curvularia</i> spp.	99.80	1–95	12.56
<i>Sarocladium oryzae</i>	75.97	1–60	3.28
<i>Microdochium oryzae</i>	9.42	1–6	1.08
<i>Fusarium moniliforme</i>	55.15	1–16	1.47
<i>Bipolaris oryzae</i>	2.17	1–3	1.04
<i>Phoma</i> spp.	97.84	1–94	11.80
<i>Pyricularia oryzae</i>	0.24	1–24	2.72
<i>Nigrospora</i> spp.	74.91	1–92	8.53
<i>Tilletia barclayana</i>	0.34	1–90	9.51
<i>Aphelenchoides besseyi</i> ^b	0.31	1–3	1.41

^aBased on 200 seeds/seedlot for testing (n=10,374) ^bActual nematode count using sedimentation test.

SHU Table 4. Distribution, by region and country, of rice seeds exported by IRRI through INGER, 2006.

Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)	Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)
East Asia (3)				Southeast Asia (7)			
Korea N	2	1,099	28.400	Indonesia	1	106	3.500
Korea S	1	636	17.400	Laos	2	443	10.700
China PR	14	2,323	59.000	Malaysia	1	544	12.100
Subtotal	17	4,058	104.800	Myanmar	2	641	27.400
Europe (5)				Philippines	3	595	16.000
France	1	92	1.500	Thailand	2	854	20.400
Italy	2	206	5.100	Vietnam	4	1,265	33.100
Russia	2	183	5.300	Subtotal	15	4,448	123.200
Spain	1	29	0.290	Sub-Saharan Africa (5)			
Uzbekistan	2	498	14.100	Ethiopia	1	66	2.300
Subtotal	8	1,008	26.290	Gambia	1	106	3.500
Latin America (6)				Mozambique	2	208	6.700
Brazil	1	1,236	20.700	Senegal	1	66	2.300
Ecuador	1	196	6.000	Sierra Leone	1	440	10.000
Nicaragua	1	642	17.600	Subtotal	6	886	24.800
Peru	1	462	11.700	West Asia & North Africa (4)			
Surinam	1	274	6.500	Afghanistan	2	1,045	21.000
Venezuela	1	385	10.700	Egypt	1	876	21.600
Subtotal	6	3,195	73.200	Iran	1	292	8.500
South Asia (6)				Turkey	1	111	3.800
Bangladesh	6	1,528	42.200	Subtotal	5	2,324	54.900
Bhutan	1	546	13.600	Grand total	71	26,662	676.490
India	3	6,267	153.600				
Nepal	2	1,108	25.600				
Pakistan	1	974	27.300				
Sri Lanka	1	320	7.000				
Subtotal	14	10,743	269.300				

SHU Table 5. Origin and corresponding total number of shipments, total number of seedlots, and total weight of rice seeds imported by IRRI, 2006.

Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)	Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)
East Asia (4)				South Asia (3)			
Japan	5	3,556	35,532	Bangladesh	4	182	9,660
Korea S	4	1,919	51,500	India	3	9	2,210
China, PR	7	856	15,963	Sri Lanka	1	3	.036
Taiwan	1	1	.075	Subtotal	8	194	11,906
Subtotal	17	6,332	103,070	Southeast Asia (8)			
Europe (3)				Cambodia	1	32	.423
Netherlands	1	100	2,200	Indonesia	1	67	.870
Spain	4	4	3,950	Laos	5	94	6,719
United Kingdom	1	40	.216	Malaysia	1	9	.204
Subtotal	6	144	6,366	Myanmar	1	27	1,400
Latin America (2)				Philippines	6	413	33,751
Colombia	1	20	8,500	Thailand	1	42	.570
Surinam	1	4	.624	Vietnam	3	365	13,725
Subtotal	2	24	9,124	Subtotal	19	1,049	57,662
North America (1)				West Asia & North Africa (1)			
USA	5	123	.789	Turkey	1	20	2,000
Subtotal	5	123	.789	Subtotal	1	20	2,000
Oceania (1)				Grand total	61	7,908	191,224
Australia	3	22	.307				
Subtotal	3	22	.307				

SHU Table 6. Consignees and corresponding total number of shipments, total number of seedlots, and total weight of imported rice seeds, 2006.

Consignee	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)
Crop and Environmental Sciences Division (CESD)	7	497	20,240
Genetic Resources Center (GRC)	4	474	14,375
Grain Quality, Nutrition, and Postharvest Center (GQNPC)	10	226	7,502
International Network for Genetic Evaluation of Rice (INGER)	7	72	11,062
Intellectual Property Management Unit (IPMU)	1	12	0,223
International Programs Management Office (IPMO)	1	32	0,423
Plant Breeding, Genetics & Biotechnology (PBGB)	31	6,595	137,399
Grand total	61	7,908	191,224

SHU Table 7a. Results of visual inspection conducted on incoming rice seeds received by SHU for post-entry clearance, 2006.

Observation	Infested seedlots (no.)	Percent ^a
Weed-contaminated	0	0.00
Weeds		
<i>Echinochloa</i> spp.	0	0.00
<i>Ischaemum rugosum</i>	0	0.00
Insect-damaged	5	0.29
Insects		
<i>Sitotroga cerealella</i>	5	0.29
Seeds with soil	2	0.11

^aBased on 1,838 seedlots visually inspected.

SHU Table 7b. General quality of imported rice seeds received by SHU for post-entry clearance.

General quality ^a	Seedlots (no.)
Category 1	100
Category 2	215
Category 3	1,378
Category 4	145

^aBased on 1,838 seedlots visually inspected.

SHU Table 8. Seedborne pathogens detected on untreated outgoing seeds received by SHU for phytosanitary certification, 2006.

Pathogen	Affected seedlots (%)	Detection level (%)	Mean (%)
<i>Trichoconis padwickii</i>	90.41	1 – 64	24.62
<i>Curvularia</i> spp.	89.04	1 – 72	11.38
<i>Sarocladium oryzae</i>	60.96	1 – 38	5.83
<i>Microdochium oryzae</i>	25.34	1 – 4	1.35
<i>Fusarium moniliforme</i>	48.63	1 – 11	2.17
<i>Bipolaris oryzae</i>	82.88	1 – 46	4.45
<i>Phoma</i> spp.	57.53	1 – 25	4.30
<i>Pyricularia oryzae</i>	1.37	1 – 1	1.00
<i>Nigrospora</i> spp.	41.78	1 – 12	2.48
<i>Tilletia barclayana</i>	22.60	1 – 99	23.42
<i>Aphelenchoides besseyi</i> ^a	0.00	1 – 1	0.00

^aActual nematode count based on 200 seeds/seedlot (n=146).

SHU Table 9. Diseases^a observed on incoming and outgoing entries planted at post-entry quarantine areas (GRC, PBGB, CESD, and GQNPC seed multiplication plots and post-entry quarantine areas), dry and wet season, 2006.

Observation	Incoming				Outgoing			
	Dry-season entries	%	Wet-season entries	%	Dry-season entries	%	Wet-season entries	%
Bacterial leaf blight	0	0.00	0	0.00	6	0.07	0	0.00
Bacterial leaf streak	9	0.47	4	100.00	405	4.86	2,747	20.10
Bacterial stripe	1	0.05	0	0.00	0	0.00	1	0.01
Bakanae	0	0.00	0	0.00	5	0.06	0	0.00
Blast	8	0.42	0	0.00	7	0.08	10	0.07
False smut	1	0.05	0	0.00	46	0.55	18	0.13
Leaf scald	5	0.26	0	0.00	10	0.12	73	0.53
Narrow brown leaf spot	0	0.00	0	0.00	21	0.25	5	0.04
Rice tungro	213	11.16	2	50.00	1,029	12.36	459	3.36
Sclerotium seedling blight	11	0.58	1	25.00	3,506	42.10	309	2.26
Sheath blight	6	0.31	1	25.00	14	0.17	5	0.04
Sheath rot	49	2.57	0	0.00	36	0.43	36	0.26
Yellow dwarf	0	0.00	.	0.00	10	0.12	0	0.00
Dead entries	6	0.31	0	0.00	54	0.65	31	0.23
Entries without diseases	1,588	83.00	0	0.00	3,635	43.60	10,350	75.70
Total entries	1,909		4		8,325		13,658	

^aDiseases observed on plants originating from incoming seeds were not of an introduced nature.

SHU Table 10. Routine seed health test results of untreated GRC seeds for long-term storage (January to July, 2006).

Pathogen	Affected seedlots ^a (%)	Detection level (%)	Mean (%)
<i>Trichoconis padwickii</i>	92.27	1 – 46	5.73
<i>Curvularia</i> spp.	99.96	1 – 110	16.47
<i>Sarocladium oryzae</i>	48.28	1 – 72	3.10
<i>Microdochium oryzae</i>	5.93	1 – 5	1.17
<i>Fusarium moniliforme</i>	33.38	1 – 7	1.25
<i>Bipolaris oryzae</i>	43.69	1 – 10	1.16
<i>Phoma</i> spp.	93.77	1 – 101	4.12
<i>Pyricularia oryzae</i>	1.63	1 – 4	1.26
<i>Nigrospora</i> spp.	68.51	1 – 55	5.02
<i>Tilletia barclayana</i>	0.17	1 – 1	1.00
<i>Aphelenchoides besseyi</i> ^b	2.96	1 – 25	3.64

^aBased on 200 seeds/seedlot drawn for testing (n=2328).

^bActual nematode count using sedimentation test.

SHU Table 11. Distribution, by region and country, with corresponding total number of shipments, and total number of samples of nonseed biological materials exported by IRRI, 2006.

Region/country	Total shipments (no.)	Total samples (no.)	Region/country	Total shipments (no.)	Total samples (no.)
East Asia (3)			Oceania (1)		
Japan	5	673	Australia	4	143
Korea S	5	653	Subtotal	4	143
China, PR	1	8	South Asia (1)		
Subtotal	11	1,334	India	2	14
Europe (7)			Subtotal	2	14
Austria	1	15	Southeast Asia (1)		
Belgium	1	5	Philippines	5	20
France	6	733	Vietnam	4	17
Germany	2	371	Subtotal	9	37
Italy	2	265	Sub-Saharan Africa (1)		
Netherlands	1	38	Nigeria	3	254
United Kingdom	2	50	Subtotal	3	254
Subtotal	15	1,477	Grand total	71	5,897
Latin America (1)					
Peru	2	12			
Subtotal	2	12			
North America (1)					
USA	25	2,626			
Subtotal	25	2,626			

SHU Table 12. Nature of materials with corresponding total number of shipments and total number of samples of nonseed biological materials exported by IRRI, 2006.

Nature of materials	Total shipments (no.)	Total samples (no.)
5 TAQ polymerase enzyme, 60 commercial DNA markers (SSR), 1 RNase, 5 PCR buffer & 1 magnesium chloride	1	72
Antisera	5	19
Bacterial culture (<i>Pseudomonas fuscovaginae</i> isolates)	1	4
Bacterial culture (<i>Xanthomonas oryzae</i> pv. <i>oryzae</i> isolates)	1	12
Brown spot fungus	1	5
DNA	26	2670
DNA and nucleic acid primers	1	6
DNA and RNA	3	203
DNA of rice plants and Taq polymerase enzyme	1	136
DNA samples-PCR products	2	132
Dried mycelia in paper discs	1	3
Frozen leaf	1	11
Frozen roots	1	71
Giami rice granule-bound protein	1	1
Ground leaf samples	1	261
Ground leaf samples, soil samples and zinc sulfate	1	49
Ground straw samples	1	115
Home-made and commercial Taq polymerase, PCR buffer, DNA ladder and DNA weight stand	1	46
Isolates	1	2
Pollen mother cell of <i>O. brachyantha</i>	1	2
Rice main stems	1	648
RNA	13	1284
Roots, shoots (frozen tissues) and extracts	2	53
<i>Sesbania rostrata</i> seeds	1	1
<i>Sesbania</i> seeds	1	3
Soil dry and wet	1	88
Total	71	5,897

SHU Table 13. Sources of nonseed biological materials exported by IRRI, 2006.

Organizational unit	Total samples (no.)	Unit of measurement	Nature of materials
Crop and Environmental Sciences Division (CESD)	15	Tubes	DNA samples-PCR products
	49	Packets	Ground leaf, soil and zinc sulfate
	115	Envelopes	Ground straw samples
	648	Envelopes	Rice main stems
	372	Tubes	RNA
	1	Plastic bag	<i>Sesbania rostrata</i> seeds
	3	Plastic packets	<i>Sesbania</i> seeds
Subtotal 10	1,203		
Grain Quality, Nutrition, and Postharvest Center (GQNPC)	5	Tubes	Brown spot fungus
	1	Sterile microfuge tube	Giami rice granule-bound protein
Subtotal 2	6		
Genetic Resources Center (GRC)	703	Tubes	DNA
Subtotal 12	1,234		
Plant Breeding, Genetics & Biotechnology (PBGB)	72	Ependorf tubes	5 TAQ polymerase enzyme, 60 commercial DNA markers (SSR), 1 RNase, % PCR buffer and 1 magnesium chloride
	19	Tubes	Bacterial culture
	4	Ampoules	(<i>Pseudomonas fuscovaginae</i> isolates)
			Bacterial culture
	12	Tubes	(<i>Xanthomonas oryzae</i> pv. <i>oryzae</i> isolates)
			DNA
			DNA and nucleic acid primers
			DNA and RNA
			DNA of rice plants and Taq polymerase enzyme
			DNA samples-PCR products
			Dried mycelia in paper discs
			Frozen leaf
			Frozen roots
			Ground leaf samples
			Home-made and commercial Taq polymerase, PCR buffer, DNA ladder and DNA weight stands
			Isolates
			Pollen mother cell of <i>O. brachyantha</i>
		RNA	
		Roots, shoots (frozen tissues) and extracts	
		Soil dry and wet	
Subtotal 47	3,985		
Grand total 71	5,897		

SHU Table 14. Origin, total number of shipments, and total number of samples of imported nonseed biological materials, 2006.

Region/country	Total shipments (no.)	Total samples (no.)
Europe (1)		
Netherlands	14	29
Subtotal	14	29
Latin America (1)		
Mexico	1	20
Subtotal	1	20
South Asia (2)		
Bangladesh	3	372
India	1	11
Subtotal	4	383
Southeast Asia (4)		
Cambodia	4	160
Laos	2	143
Thailand	1	404
Vietnam	1	11
Subtotal	8	718
Grand total	27	1,150

SHU Table 15. Descriptions, total number of shipments, and total number of samples of imported nonseed biological materials, 2006.

Nature of materials	Total shipments (no.)	Total samples (no.)
Beech leaf dried ground plant samples	1	1
Corn ground-dried samples	2	17
Corn seeds	1	20
Fresh rice leaves	1	11
Grass ground dried plants(20 g); wheat ground dried plants(20 g); Melon ground plants(20 g); tulip tuber ground dried plants(20 g)	1	4
Grass ground-dried samples	1	1
Ground soil, charcoal, fertilizer, water	1	404
Melon dried-ground samples	1	1
Mungbean dried-ground plant samples	1	16
Pepper dried-ground plant samples	1	1
Potato ground plants (20 g); barley ground plants(20 g); <i>Lucerna</i> ground plants(20 g); Grass ground plants(20 g)	1	4
Reed ground-dried samples	1	1
Rice ground leaf powder	1	276
Rice plant ground samples	2	57
Rice straw dried samples	1	77
Soil ground dried samples	3	9
Soil samples	4	108
Soil, wheat grain, wheat straw and rice straw	1	11
Straw ground samples	1	130
Tulip ground	1	1
Total	27	1,150

SHU Table 16. Consignees of imported nonseed biological materials, 2006.

Organizational unit	Total samples (no.)	Unit of measurement	Nature of materials	Organizational unit	Total samples (no.)	Unit of measurement	Nature of materials
Crop and Environmental Sciences Division (CESD)	1	Packet	Beech leaf dried plants	Subtotal	21	959	Straw ground samples
	1	Packet	Corn ground-dried samples				Tulip ground
	4	Packets	Grass ground-dried plants, wheat ground-dried plants; melon ground-dried plants; tulip tuber ground-dried plants				
International Programs Management Office (IPMO)	1	Packet	Grass ground -dried samples	International Programs Management Office (IPMO)	16	Packets	Corn ground-dried samples
	404	Plastic bags	Ground soil, charcoal, fertilizer and water	16	Packets	Mungbean ground-dried plants	
	1	Packet	Melon ground-dried samples	56	Packets	Rice plant ground samples	
	1	Packet	Pepper ground-dried plants	72	Bags	Soil samples	
	4	Packets	Potato ground plants, barley ground plants; <i>Lucerna</i> ground plants; grass ground plants	Subtotal	4	160	
	1	Packet	Reed ground-dried samples	Plant Breeding, Genetics & Biotechnology (PBGB)	20	Packets	Corn seeds
	276	Vials	Rice ground leaf powder	11	Glassine bags	Fresh leaves	
	1	Packet	Rice plant ground samples	Subtotal	2	31	
	77	Packets	Rice straw dried samples	Grand total	27	1,150	
	9	Bottles	Soil ground dried samples				
	36	Bags	Soil samples				
11	Plastic bags	Soil, wheatgrain, wheat straw and rice straw					

GRAIN QUALITY, NUTRITION, AND POSTHARVEST CENTER

Grain quality evaluation services

GQNPC continued to provide rice quality evaluation services to the breeders using new and established methods. A total of 74,750 analyses were performed in 2006, slightly less than the total 78,000 analyses done in 2005. The decrease is likely due to more careful selection of breeders' lines for quality evaluation.

Of the total analyses, 75% was done on breeders' lines collected from the pedigree nurseries (PN), 20% from replicated yield trials (RYT), and hybridization blocks (HB). About 5% of grains evaluated were from the other programs (Korean and INGER).

Visual screening to evaluate the milling potential comprised 40% of work done on breeders' lines, while physical and cooking quality evaluation comprised 33% and 27%, respectively.

New and improved methods for quality evaluation

Physical quality evaluation. In collaboration with FOSS Tecator AB, the maker of the Cervitec™ 1625 Grain Inspector, work was done to improve the applicability of this instrument for physical quality evaluation of a wider range of rice varieties. This automated high-speed grain image inspection system evaluates physical qualities such as chalkiness and grain dimensions (length, width, area) as well as head rice and damaged kernels. The grains are separated by a rotating disk or wheel that has cavities of specific dimensions to capture each grain. Images of each grain in the cavities are then evaluated using a factory precalibrated system based on artificial neural network technique.

Initial trials showed that the two wheels provided with the instrument (for medium and long grains) were not giving accurate measurements for other rice types. When measuring the short type, two grains were sometimes captured in a cavity, which was recognized by the software as one grain or one small grain was misinterpreted as broken. Hence, GQNPC worked with FOSS to develop two new wheels with the right size and shape of cavities (for short fat and for short skinny rice) and the appropriate calibrations. The program for exporting data from the Cervitec to an MS Excel database was also updated.

In 2006, about 1,800 samples from breeders were evaluated for physical quality (chalkiness, broken, grain length and width) or about 5,400 analyses were completed using the improved Cervitec.

Micronutrient screening. A new instrument, a benchtop analytical Minipal4 energy dispersive X-ray fluorescence spectrometer (XRF), was acquired and set up by GQNPC as a high-throughput tool for screening varieties of rice naturally rich in minerals, specifically Fe, Cu, and Zn. The method is fast, easy to use, nondestructive, usually requiring minimum sample preparation and giving accurate multielement analysis in concentrations down to ppm levels. Analysis by XRF is both qualitative and quantitative. By measuring the energies emitted by the sample, it is possible to determine which elements are present; by measuring the intensities of the emitted energies, it is possible to determine the concentration of each element in the sample. Hence, when calibrated with appropriate standards, the XRF is also a versatile tool for studying other mineral elements and contaminants present in rice.

About 350 Lao colored rice varieties were screened for high Fe content using the Minipal4 XRF. The effect of parboiling on the micronutrient content of rice was also evaluated using this method.

Sample preparation. Delayed and unreliable evaluation results are usually traced to poor sample preparation. Rice milling (or polishing) and grinding are two of the time-consuming and labor-intensive steps in preparing samples for rice quality evaluation. Moreover, undermilling and improper grinding could lead to inaccurate results. To meet the need for a high-throughput, efficient and contamination-free sample preparation system, the use of paint shaker was explored for use in efficient polishing and grinding a large batch of samples.

For a long time, a test tube mill fabricated by Agricultural Engineering has been in use at the Quality Evaluation Lab to polish the limited number of grains from the breeders' pedigree nursery. About 3 g of unpolished rice is mixed with 2 g of an abrasive aluminum oxide in a test tube and 70 tubes are shaken vigorously for 1 h. Although the test tube mill is acceptable for polishing most rice samples, the crude design of the machine is unsuitable for laboratory use. Initial tests revealed that the paint shaker could perform the same task with the use of proper vial size and shaking time. Moreover, the device is more suitable for laboratory use because of its quiet and safe operation. It also has the added capability to pulverize grains with the use of appropriate sample capsules and grinding balls. Testing was done on several containers and balls of various sizes and materials. For micronutrient screening, it was found that polycarbonate tubes and tungsten carbide balls were suitable for contamination-free grinding of the rice samples. Since layers of sample tubes can be stacked

at one time, the paint shaker shows potential as a high-throughput sample preparation system for quality evaluation.

Cooking quality

Amylose content estimation by CT repeat and G/T polymorphisms. Apparent amylose is also determined using a DNA marker on exon 1 of granule bound *starch synthase*—the gene responsible for amylose synthesis. There are at least eight polymorphisms, so the marker is useful in a breeding program aiming to capture quality because progeny with the allele of the high-quality parent can be identified and progressed. The marker was used on 1,100 samples from pedigree nurseries and for the varieties in the hybridization block.

Fragrance detection by allele-specific amplification of FGR gene related to betaine aldehyde dehydrogenase. Our collaborators gave us the primers to detect a deletion in the gene that leads to the accumulation of fragrant compounds. We used the marker to screen for fragrance in many trials and in fragrant rices from the genebank. We also associated the presence of the fragrance gene with the amount of fragrant compounds in the rice, which are analyzed by gas chromatography.

SS11a snps for GT. Starch synthase 11a is the gene that contributes the most to the trait of gelatinization temperature. In one of our collaborative research projects, we discovered four single nucleotide polymorphisms (SNP) in the gene and we have developed markers to detect each functional SNP. This has not yet been introduced to the quality evaluation program.

DEGREE AND POSTDEGREE TRAINING IN 2006

Group training courses conducted in 2006.

Course title	Duration	Participants (no.)
International/special courses		
Two-week Rice Production Training Course	27 Mar - 7 Apr	16
Interpretation of Research from Multiyear and Multilocation Experiments on Crop Residue Management	Jan 9-20	15
Increasing the Impact of Rice Breeding Programs	17-28 Apr	19
Quality Assurance	22 May - 2 Jun	202
Improving and Assuring Data Quality in Crop Research	24-28 Jul	25
Participatory Research and Extension	7-18 Aug	27
Upland Rice Variety Selection Techniques (for African countries)	16-20 Oct	10
Production Technology for Better Quality Rice Quality (for Sri Lankans)	30 May- 4 Jun	36
Subtotal		350
Skills development courses		
English for Conversation Course for Rice Scientists	21 Feb - 16 Mar	23
Trainers Training on Computer Use and Application (Village ICT Project)	3-4 May	17
Scientific Writing Workshop	15-18 May	16
Analysis of Experimental Data using the SAS System	10-14 Jul	21
Basic Experimental Designs and Data Analysis using IRRISTAT	17-21 Jul	21
English for Rice Scientists 1 Course	1-24 Aug	16
English for Rice Scientists 2 Course	7-30 Nov	20
Leadership Course for Asian Women in Agriculture R&D and Extension	27 Nov - 8 Dec	22
Subtotal		156
In-country		
Introduction to SPSS and Analysis of Categorical Data, RNR-RC, The Kingdom of Bhutan	27-31 Mar	20
Laser Levelling Course, Myanmar	19-21 Apr	12
Healthy Rice Seed Management, BAU, India	21 Apr	28
Healthy Rice Seed Management, AAU, India	24 Apr	22
Post Harvest Training, Myanmar	24-26 Apr	23
Healthy Rice Seed Management, India	26 Apr	30
Briefing and Course on International Laws & Regulations Relating to Plant Genetic Resources and IP Management, Myanmar	2-6 May	36
Post Harvest Training, Laos	10-12 May	22
International Crop Information System Training Course, Mexico	8-12 May	28
RKB Fact sheet Writeshop and Presentation Skills Workshop, Sri Lanka	5-7 Jun	36
Scientific Writing and Presentation Skills Course, Myanmar	26 June - 1 Jul	25
Improving Technology Promotion through the use of RKB, Laos	18-19 May	16
Rice Technology Transfer Systems in Asia, South Korea	20 Aug - 3 Sep	16
Training on Biology, Epidimiology, and Management of Rice Ragged and Grassy Stunt Virus Disease, Vietnam	10-12 Oct	16
Basic Experimental Designs and Data Analysis, Indonesia	13-17 Nov	41
Subtotal		371

Continued on next page.

Group training courses conducted in 2006 (continued).

Course title	Duration	Participants (no.)
Scientist visits/tours		
Trainers Training on Computer Use and application	3-4 May	17
Village ICT Project Stakeholders Workshop	5-May	28
Phi-ICT Planning Workshop	14-Jul	28
ANGOC-ICDAI Scientific Visit	8-Sep	14
Subtotal		87
Team-building activities		
Entomology and Plant Pathology Division, Sta Cruz, Laguna	26-Jan	84
Seed Health Unit, Caliraya, Laguna	27-Jan	12
Tissue Culture Unit, IRRI	15-May	17
Association of IRRI Secretaries, IRRI	20-Jul	30
Plant Breeding, Genetics, and Biotechnology Division, Bay, Laguna	18-Aug	204
Crop and Environmental Sciences Division, NAC, Laguna	14-15 Sep	206
Subtotal		553

Scholars on board in 2006, by country and type.

Country	By type	
Africa		
Sierra Leone	1	
Asia		Summary
Bangladesh	6	Type I - PhD & MS scholars, thesis research at IRRI
Cambodia	1	PhD 21
China	9	MS 9
India	7	
Indonesia	2	Type II - PhD & MS scholars, coursework and thesis research at IRRI
Iran	1	
Japan	4	
Korea	3	PhD 4
Lao-PDR	1	MS 3
Nepal	1	
Philippines	22	Type III - OJT/nondegree, Interns
Vietnam	9	OJT/nondegree & interns 44
Europe		
Belgium	1	
France	3	Total 81
Germany	2	
Netherlands	2	
North America		
Canada	1	
United States	2	
Oceania		
Australia	3	
Total	81	

Scholars, by country and type, who completed their training in 2006.

Country	By type	
Africa		
Ghana	1	
Ethiopia	1	Summary
Asia		Type I - PhD & MS scholars, thesis research at IRRI
Bangladesh	11	PhD 41
China	12	MS 18
India	3	
Indonesia	2	Type II - PhD & MS scholars, coursework and thesis research at IRRI
Iran	3	
Japan	3	
Korea	6	PhD 16
Lao PDR	2	MS 6
Myanmar	8	
Philippines	58	Type III - OJT/nondegree
Singapore	1	OJT/nondegree & interns 40
Sri Lanka	1	
Thailand	2	
Vietnam	3	Total 121
Europe		
United Kingdom	1	
North America		
United States	1	
Canada	1	
Oceania		
Australia	1	
Total	121	

WEATHER SUMMARY

Annual rainfall for year 2006 was 2,185 mm for the IRRI dryland (upland) site and 2,122 mm for the wetland (lowland) site (Fig. 1). These values were 126 mm higher than the long-term average rainfall for the dryland site and 132 mm higher for the wetland site. In terms of monthly rainfall, Los Baños experienced exceptionally high rainfall (more than twice of the long-term average) in January and September and exceptionally low rainfall (less than half of the average) in April and October of 2006. The wettest day at IRRI occurred 28 Sep with more than 300 mm rainfall per day due to the passing of typhoon Milenyo; the cumulated rainfall of the days of the three major typhoons in 2006 accounted for 38% of the total rainfall in 2006. The longest recorded continuous wet spell was 11 d at the dryland site (4–14 Aug) and 7 d at the wetland site (8–14 Aug and 23–29 Sep). The longest continuous dry spell was 18 d (1–18 Apr) at the dryland and wetland sites.

Mean monthly solar radiation reached a peak in April (more than 20 MJ m⁻² d⁻¹) and lowest record of 11.0 MJ m⁻² d⁻¹ in December (Fig. 2). The months of July and December had exceptionally low records of solar radiation. The annual average duration of bright sunshine was about 6.2 h d⁻¹ (Table 1). The highest monthly mean value was 10.1 h d⁻¹ in April and declined to low values of 3.8 h d⁻¹ in July. The longest record of sunshine at Los Baños was on 8 May with 12.0 h of bright sunshine.

Maximum temperature reached its highest monthly mean value (Fig. 3) in April (32.8 °C), then declined to its lowest monthly mean value in December (29.2 °C). The hottest day in Los Baños was on 29 Apr with 36.0 °C of

recorded maximum temperature at the dryland site and 35.0 °C at the wetland site. The seasonal pattern of minimum temperatures was more stable than the pattern of the maximum temperatures. The coldest days for 2006 were on 10 and 21 Jan with 20.3 °C in the dryland site and on 11 Jan with 21.0 °C at the wetland site.

Midday vapor pressure deficit was consistently higher in the dryland site than in the wetland site (Fig. 4). Mean early morning relative humidity ranged from 79 to 90% in the dryland site and from 81 to 89% in the wetland site (Table 1).

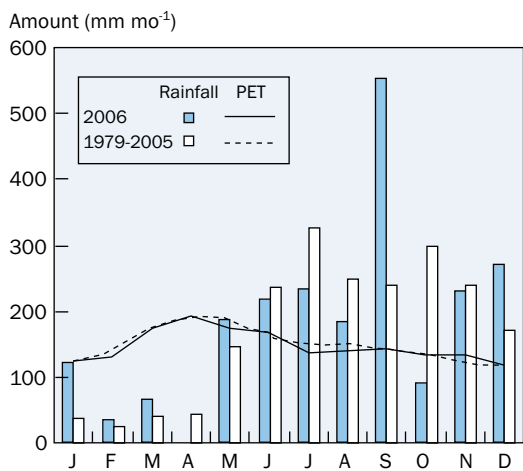
Daily mean windspeed, measured at 2-m height was 1.6 m s⁻¹ for the dryland site and 1.4 m s⁻¹ for the wetland site (Table 1). Windspeed was generally low (<1.9 m s⁻¹), except during typhoons. The highest windspeed was recorded during typhoon Caloy (5.5 m s⁻¹ at the dryland site and 6.5 m s⁻¹ at the wetland site on 13 May), which exceeded the windspeeds of Milenyo (5.3 m s⁻¹; 28 Sep) and Senyang (3.6 m s⁻¹; 10 Dec).

Because of a slightly higher air temperature, higher amount of rainfall, and higher vapor pressure deficit at midday, free water evaporation at the dryland site was slightly higher than at the wetland site (Table 1). Open-pan evaporation totals were 1,742 mm at the dryland site and 1,615 mm at the wetland site. These values were 91 mm lower than the long-term evaporation total at the dryland site and 59 mm lower at the wetland sites (Table 1).

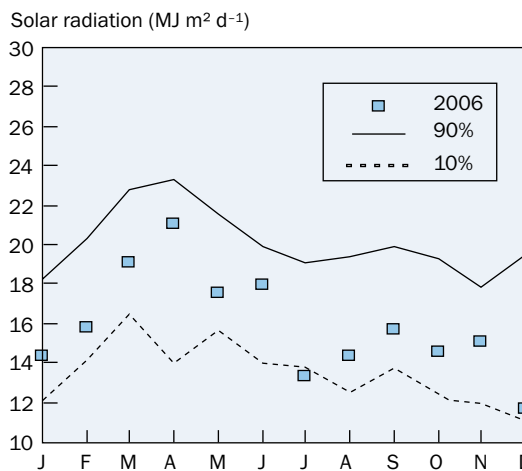
Twenty tropical cyclones (including 10 typhoons) passed through the Philippines' area of responsibility. Three of these typhoons had major impacts in Los Baños: Caloy (9–15 May), Milenyo (25–29 Sep), and Senyang (7–14 Dec).

WS Table 1. Monthly weather data for IIRRI stations, 2006.

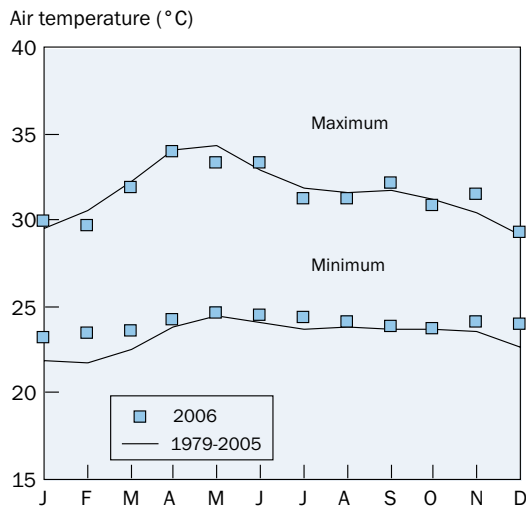
Site		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total or daily average
Rainfall (mm mo⁻¹)														
Dryland site		122	35	64	1	185	217	232	183	554	91	230	272	2,185
Wetland site		131	39	60	1	134	229	280	191	540	75	182	261	2,122
Long-term average (1979-2006)		39	26	39	41	138	230	308	229	232	312	233	163	1,990
Solar radiation (MJ m⁻² d⁻¹)														
Dryland site		14.3	15.8	19.1	21.0	17.5	17.9	13.3	14.3	15.7	14.5	15.1	11.6	15.8
Wetland site		13.7	15.4	18.7	20.6	17.1	17.4	12.9	13.9	15.3	14.2	14.7	11.0	15.4
Long-term average (1979-2006)		14.1	17.5	20.2	22.0	20.1	17.8	16.7	16.0	16.0	15.1	13.5	12.3	16.8
Relative humidity (%)														
Dryland site		89	84	82	79	81	85	86	87	90	87	85	85	85
Wetland site		89	86	83	81	81	85	86	88	88	86	85	86	85
Long-term average		84	83	81	79	79	82	84	85	86	85	85	85	83
Temperature (°C)														
Dryland site	Max	29.9	29.7	31.9	33.9	33.3	33.3	31.2	31.2	32.1	30.8	31.5	29.3	31.5
	Min	23.1	23.4	23.6	24.2	24.6	24.5	24.3	24.1	23.8	23.7	24.1	24.0	24.0
Wetland site	Max	29.2	29.0	30.9	32.8	32.7	33.0	31.1	31.0	31.7	30.7	31.2	29.2	31.0
	Min	23.2	23.3	23.5	24.0	24.8	24.8	24.7	24.5	24.2	24.0	24.2	24.0	24.1
Long-term average	Max	28.3	29.2	30.3	32.3	33.0	32.2	31.3	31.1	31.2	30.6	29.8	28.4	30.6
	Min	21.9	21.8	22.5	23.8	24.5	24.5	24.2	24.2	24.0	23.9	23.5	22.6	23.5
Windspeed (m s⁻¹)														
Dryland site		1.5	1.9	1.6	1.7	1.8	1.3	1.8	1.4	1.3	1.2	1.5	2.1	1.6
Wetland site		1.5	1.8	1.3	1.5	1.8	1.2	1.4	1.0	1.0	1.1	1.4	2.0	1.4
Long-term average		1.8	1.7	1.7	1.5	1.4	1.3	1.3	1.4	1.1	1.2	1.5	1.8	1.5
Evaporation (mm mo⁻¹)														
Dryland site		117	132	178	209	180	168	130	134	133	122	127	114	1,742
Wetland site		108	123	162	197	168	156	121	119	124	113	120	104	1,615
Long-term average		120	132	176	192	182	149	140	135	123	118	106	102	1,674
Sunshine (h)														
Wetland site		5.6	6.7	8.2	10.1	7.2	7.0	3.8	4.5	5.5	5.1	6.9	4.2	6.2
Long-term average		5.5	7.2	8.0	9.0	7.6	6.0	5.1	4.8	4.8	5.1	5.3	4.4	6.1



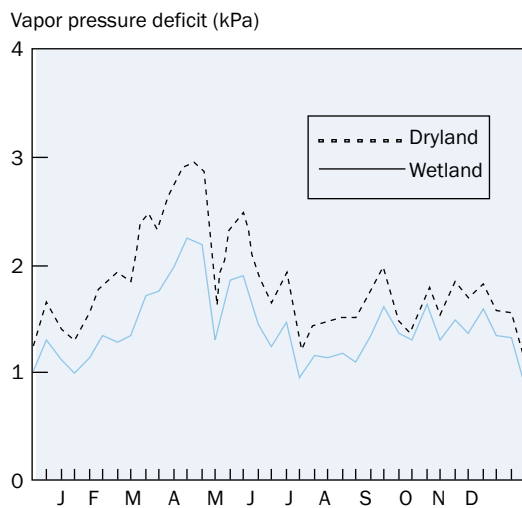
1. Monthly rainfall and potential evapotranspiration in 2006 and long-term average.



2. Mean monthly solar radiation with 10 and 90% probability of occurrence derived from long-term averages. IRRI, 2006.



3. Monthly maximum and minimum air temperature in 2006 and long-term averages. IRRI, 1979-2006.



4. Midday vapor pressure deficit at the dryland and wetland sites. IRRI, 2006.

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 Nguyen Van Doan, *consultant*⁴
 Cao Van Hung, *consultant*⁴
 Vu Cong Khanh, *consultant*⁴
 Ho Thi Tuyet, *consultant*⁴
 Phan Hieu Hien, *PhD, consultant*³
 Geert Claessens, *consultant*³
 Oeun Sophath, *consultant*^{3,4}
 Daniele Marechal, *consultant*¹
 JIng Tan, *consultant*
 Adoracion P. Resurreccion, *PhD, associate scientist*
 Rosario R. Jimenez, *BS, assistant scientist*
 Paterno C. Borlagdan, *MS, assistant scientist*⁶
 Eugenio P. Aquino, *BS, researcher*¹³
 Vito M. Butardo, Jr., *BS, researcher*
 Mariafe P. Navarro, *MS, researcher*
 Elenita C. Suñaz, *BS, officer - administrative coordination*⁶
 Rodolfo A. Angco, *officer-CADD*¹
 Ana Lyn J. Genil, *MBA, secretary II*
 Artemio V. Madrid, Jr., *technician III - research*
 Inofra I. Sandoval, *BS, technician III - research*
 Eduardo L. Secretario, *technician III - research*⁶
 Juan L. Alzona, *technician II - research*
 Romulo N. Aquino, *technician II - research*⁶

Teodoro L. Atienza, *technician II - research*
 Fernando C. Salisi, *technician II - research*^{4,5}
 Lucena C. Samadio, *technician II - research*^{4,5}

Training Center

Noel Magor, *PhD, head*¹⁶
 David Shires, *M Ed, international research fellow*
 Yoke Sau Metz, *consultant*³
 Eugenio C. Castro, Jr., *MS, associate scientist*
 Maria Angeli G. Maghuyop, *MS, specialist - training*
 Gina E. Zarsadias, *MS, assistant manager*
 Maria Socorro S. Arboleda, *BS, officer*
 Ma. Teresa A. Clabita, *BS, officer*
 Sergio R. Magadia, *BS, officer*
 Imee L. Aspiras, *BS, officer - administrative coordination*
 Lauro M. Atienza, *BS, officer - training*
 Melanie M. Quinto, *secretary III*
 Priscilla P. Comia, *BS, secretary II*
 Macario B. Montecillo, *assistant - training logistics*

International Programs Management Office

Headquarters-based

Julian A. Lapitan, *MS, senior manager, acting head*
 Vethaiya Balasubramanian, *PhD, senior scientist, agronomy, and IRRI Africa coordinator*¹
 Ma. Angeles M. Quilloy, *MM, assistant manager II*
 Margaret Ann S. Jingco, *BS, officer - administrative coordination*
 Cecilia V. Lopez, *BS, officer - administrative coordination*¹
 Edna R. Reyes, *secretary III*

Country-based

Mohammed Zainul Abedin, *PhD, IRRI representative for Bangladesh and FoSHoL project leader*⁴
 Noel P. Magor, *PhD, IRRI representative for Bangladesh and FoSHoL project leader*¹
 Gary C. Jahn, *PhD, coordinator for the Greater Mekong Subregion; IRRI representative and Lao-IRRI project manager; and senior scientist, entomology*
 Joseph F. Rickman, *MS, program 3 leader and IRRI representative for the East and Southern Africa Region*^{6,15}
 M.A. Hamid Miah, *PhD, liaison scientist for Bangladesh*
 Mahyuddin Syam, *MPS, liaison scientist for Indonesia/Malaysia/Brunei Darussalam*
 Kai-Jun Zhao, *PhD, IRRI liaison scientist for China*¹
 Ming Zhao, *PhD, part-time IRRI liaison scientist for China*⁴
 Tapash Biswas, *PhD, postdoctoral fellow*¹
 U Ba Hein, *consultant*⁴
 Ngo The Dan, *consultant*¹
 Ahmad Salahuddin, *consultant*⁴
 Karen McAllister, *consultant*³
 Mark Bell, *PhD, consultant*³
 V. Balasubramanian, *PhD, consultant*³

Walter Roeder, *PhD, consultant*³
Hatsadong, *PhD, consultant*³

Bangladesh

Ahmad Salahuddin, *MS, manager, coordination and capacity development*^{1,5}
Mamunul Haque, *assistant manager II, communication*⁵
Tahmina Banu, *MS, officer-administrative coordinator*
Khandakar Enamul Kabir, *administrative coordinator*¹
Mohammad Asaduzzaman, *MS, accountant I*⁴
A. S. M. Zahiruddin, *accountant I*⁵
Md. Abdul Mannan, *researcher (web design & graphic design and data management)*⁵
Shaila Arifa Nabi, *MS, researcher*^{1,5}
Shahjadi Parvin, *MA, secretary II*⁵
Shamima Sultana, *MA, secretary II*⁵
Anthony Sarder, *motor vehicle operator*
Md. Ruhul Amin, *office attendant*⁵
Md. S. M. Suzat, *office attendant*⁵
Nuruzzaman Badal, *driver*⁵
Jopinath Bazi, *driver*⁵
Md. Ahsanullah, *driver*⁵
Md. Alimullah, *guard*⁵
Md. Fazlu Miah, *guard*⁵

Cambodia

Marie Kim Leng, *BS, administrative coordinator*

China

Zhongqiu Wang, *BA, assistant manager II*
Yonghong Sun, *BA, secretary/cashier*

India

Sivaprasad Bandrupalli, *PhD, assistant manager II (lead coordinator)*
Gopal Krishna Agarwal, *BCom, administrative officer (finance and accounts)*
Vanita Gupta, *MCom, administrative associate*⁴
Savita Sharma, *BA, administrative associate*
Ayodhya Lodhi, *driver cum general assistant*
Kuldeep Poonia, *BA, driver cum utility assistant*⁴
Prempal, *assistant (housekeeping)*⁵
Anurudh Singh, *assistant (housekeeping)*⁵

Indonesia

Diah Wurjandari Soegondo, *BS, researcher*
Bambang Soewilanto, *BS, administrative coordinator*
Iwan Adidharmawan, *BS, accounting supervisor*
Juanita Bawolye, *BA, executive secretary*
I Made Agus Mahardhika, *driver*

Korea

Ji-Ung Jeung, *PhD, senior research scientist*^{1,5}
Seung-Hee Han, *BS, administrative coordinator*⁵

Laos

Thiphavong Boupha, *PhD, economist and translator*^{1,5}
Bouachanh Keopha, *administrator*^{1,5}
Thany Keovongvichith, *BA, writer/editor/translator*⁵
Sone Mosky, *BS, administrative officer*⁵
Ounheuang Phouthachit, *administrative assistant*^{4,5}
Sansai Samounry, *accountant*⁵
Vilayvanh Sihabouth, *BA, administrator/accountant*^{1,5}
Chanh Sommaniphone, *guard*^{1,5}
Oudone Srithirath, *guard*^{1,5}
Samien Luanglath, *guard/cleaner*^{5,12}
Kham Souk Mosky, *driver*⁵
Khampay Onesanga, *driver*^{1,5}
Bounmy Sengthong, *driver-general services*^{1,5}
Sommai Yasongkua, *driver*^{4,5}

Myanmar

U Ba Hein, *MS, assistant scientist/assistant manager*^{1,5}
Ohnmar Tun, *BAG, administrative coordinator*
Nanda Soe Myint, *driver/office aide*

Nepal

Bhaba Prasad Tripathi, *PhD, assistant manager/assistant scientist*⁵

Thailand

Apinporn Phuengwattanapanich, *MS, assistant manager II*
Punjama Tasana, *BA, senior accountant*
Amporn Sookyong, *office assistant*
Vitthu Chowanapong, *BS, office clerk*

Vietnam

Nguyen Thanh Huyen, *BS, assistant manager II*
Nguyen Thu Ha, *BS, accountant*¹
Nguyen Van Khang, *driver*

Office of the Director for Program Planning and Communications

Corinta Q. Guerta, *MS, manager*
Alma Redillas-Dolot, *BS, consultant*¹
Ma. Sol V. Ogatis, *BS, assistant manager*
Zenaida M. Federico, *BS, executive secretary*
Ma. Velinda E. Hernandez, *BS, secretary*¹⁹

Communication and Publications Services

Gene P. Hettel, *MA, editor and head*
Bill Hardy, *PhD, science editor/publisher*
Adam Barclay, *Grad Dip Science, international research fellow*
Duncan Graham, *consultant*³
Albert A. Borrero, *BS, manager*

Sylvia Katherine S. Lopez, *MS, assistant manager II - product development*
 Teresita V. Rola, *MPS, specialist - editorial*
 Anna Natasha A. Arsenal, *specialist - marketing*
 Ginalyn H. Santos, *BS, specialist - multimedia/web development*
 Maria Guadalupe Y. Mondoñedo, *BS, specialist - technical writing*
 Antonette Abigail E. Caballero, *MS, officer - administrative coordination*
 Jose M. Ibabao, *officer - video production*
 Christina P. Jimenez, *BS, officer - fulfillment and customer relations coordination¹*
 Ariel D. Javellana, *BS, officer - photography*
 Juan V. Lazaro, *IV, associate - graphics design*
 Emmanuel A. Panisales, *BS, associate - graphics design*
 George R. Reyes, *BS, associate - graphics design*
 Jose Raymond D. Panaligan, *associate - photography/video*
 Diadema I. Martinez, *BS, assistant - editorial*
 Rogelio R. Quintos, *BS, secretary III*
 Cynthia C. Quintos, *BS, secretary II*

Visitors and Information Services

Duncan I. Macintosh, *BA, head*
 Robert Hill, *consultant³*
 Maria Charina Asuncion G. Ocampo, *BA, BL, manager*
 Juanito F. Goloyugo, *MS, specialist - information service*
 Bitra S. Avendaño, *MS, assistant manager I*
 Paul Benjamin R. Hilario, *BS, assistant manager I - rice world*
 Arvin A. Benavente, *BS, officer - audio/visual*
 Zorayda T. Menguito, *BS, associate*
 Joselito A. Platon, *BS, associate - community project*
 Ria Anna B. Dimapilis, *BS, associate - visitors*
 Chrisanto G. Quintana, *assistant - information service*
 Harris L. Tumawis, *assistant - riceworld*

Office of the Director for Management Services

Financial services

Melba M. Aquino, *BS, senior manager*
 Loriza E. Dagdag, *BS, senior manager¹*
 Elisa S. Panes, *BS, senior manager*
 Reymunda C. Labuguen, *BS, assistant manager II - FPR*
 Nestor C. Lapitan, *BS, assistant manager II - FOP*
 Ma. Donnina S. Lopez, *BS, assistant manager II - FOP*
 Edelisa M. Bardenas, *BS, assistant manager I - FOP*
 Mary Grace R. Bautista, *BS, assistant manager I - FOP*
 Julie C. Carreon, *BS, assistant manager I - FOP*
 Eleah R. Lucas, *BS, assistant manager I - FPR*
 Leny M. Medenilla, *BS, assistant manager I - FPR¹*
 Rodelita D. Panergalin, *BS, assistant manager I - FRR*
 Miriam M. Telosa, *BS, assistant manager I - FOP*
 Vilma T. Ramos, *BS, executive secretary*
 Grace P. Abanto, *BS, officer, FOP*
 Eunice Andarin, *BS, officer - FOP⁴*

Lily G. Aquino, *BS, officer - FOP*
 Maria Zenaida V. Borra, *BS, officer - FPR*
 Betty Sarah R. Carreon, *BS, officer - FOP*
 Gemma N. Corcega, *BS, officer - FOP*
 Maria Preciosa C. Dela Cruz, *BS, officer - FOP*
 Michelle V. Ella, *BS, officer - FOP*
 Maricel I. Encanto, *BS, officer - FOP*
 Iris M. Ferrer, *BS, officer - FPR*
 Sheryl C. Herez, *BS, officer - FOP¹*
 Evelyn V. Inocencio, *BS, officer - FPR*
 Grace Javier, *BS, officer - FOP⁴*
 Visitacion Labog, *BS, officer - FOP⁴*
 Annie C. Magcamit, *BS, officer - FPR*
 Mae Christine I. Maghirang, *BS, officer - FPR*
 Paulito J. Oleta, *BS, officer - FOP*
 Mark Allister U. Robis, *officer-FPR³*
 Cindy Shella S. Salazar, *BS, officer - FOP*
 Luisa D. Urriza, *BS, officer - FPR*
 Anabel Valdenaro, *BS, officer - FOP⁴*
 Jane B. Carlos, *assistant - FPR*
 Noel T. Lantican, *BS, assistant - FOP*
 Marilyn I. Villegas, *data encoder - FOP*
 Jelo D. Magat, *BS, secretary II - FOP*

Human Resources Services

Hector V. Hernandez, *LLB, head, human resources⁴*
 Fe V. Aglipay, *BS, manager¹*
 Lilian M. Mendoza, *MS, manager¹*
 Sylvia P. Avance, *MS, specialist*
 Myrna Benilda C. Pablo, *MS, specialist*
 Kathryn Rose C. Victoria, *BS, officer - HRS coordination*
 Selene M. Ocampo, *BS, officer - HRS coordination*
 Nida E. Reyes, *BS, officer - HRS coordination*
 Maria Liza R. Milante, *BS, officer - administrative coordination*
 Alfredo R. Reyes, *BS, officer - HRS coordination*
 Iluminada B. Oleta, *BS, secretary III*
 April Jane D. Muere, *BS, secretary II⁹*
 Larry A. Montermoso, *associate*

Procurement and Materials Management Services

Frisco L. Guce, *BS, senior manager*
 Felicisimo N. Kalaw, *BS, assistant manager I*
 Remedios E. Ballesfin, *BS, assistant manager I - central registry*
 Conception Elybeth A. Alcantara, *MBA, officer, PMMS*
 Angelica P. Valintos, *BS, officer - administrative coordination*
 Anatolio A. Magampon, *BS, officer - property disposal*
 Zenaida M. Belarmino, *BS, officer - purchasing¹³*
 Lourdes A. Belison, *BS, officer - purchasing*
 Anthony C. Daluz, *BS, officer - purchasing*
 Mari Joyce N. Maningas, *BS, officer-purchasing⁴*
 Luzviminda G. Oleta, *BS, officer - purchasing*
 Priscilla T. Cabral, *BS, officer - shipping*
 Louell R. Tanzo, *BS, assistant - central registry*

Wilmer B. Jacob, *assistant - central registry*
Felix C. Estipona, *assistant - Makati Office*
Anicia R. Malabanan, *data encoder*
Maureen C. Pader, *data encoder*
Francisco T. Quillooy, *materials expediter*
Ernesto L. Nirmedez, Jr., *BS, warehouseman*
Fred B. Angeles, *warehouseman*
William M. Estrellado, *warehouseman*
Jose L. Sibal, *warehouseman*
Fortunato L. Parducho, *driver⁴*
Delfin M. Lacandula, Jr., *attendant*
Fortunato P. Presto, *attendant – MMS⁴*

Office of the Deputy Director General for Operations and Support Services

Orlando Santos, *BS, consultant¹²*
Ramon A. Oliveros, *MS, executive assistant I*
Rosalie P. Trinidad, *BS, executive secretary*

Brent School

Joan L. Belsonda, *BS, officer - administrative coordination⁵*

Information Technology Services

Paul O’Nolan, *MS, head¹*
Marco van den Berg, *head⁴*
Tim Overett, *consultant³*
Rogelio P. Alvarez, Jr., *BS, manager*
Loreto R. Puyod, *BS, assistant manager II*
Lino Roy M. Suarez, *BS, assistant manager II*
Eric B. Clutario, *BS, assistant manager II - MIS*
Nestor D. Marcelo, Jr., *BS, assistant manager I - MIS*
Victor L. Alarcon, *BS, systems analyst/programmer*
Faiga A. Amping, *BS, systems analyst/programmer*
Ildefonso B. Cosico, *BS, officer - systems administration*
Reynaldo L. Stevens, *printer*
Jovy P. Gador, *BS, assistant - telecoms*
Arminda B. Laluz, *BS, assistant - telecoms*
Analiza R. Ramos, *BS, secretary III*
Rizza A. Escondo, *BS, secretary II*
Bonifacio C. De Ocampo, *technician III - IT*
Jesus S. Fugen, *technician III - IT*
Nevado M. Ignacio, *BS, technician III - IT*
Bayani N. Perido, *technician III - IT*

Intellectual Property Management Unit

Gerard F. Barry, *PhD, coordinator, Golden Rice Network, and head*
Inez Slamet-Loedin, *PhD, shuttle scientist³*
Raul M. Boncodin, *BS, assistant manager II^{4,5}*
Frances Florifel B. Tesoro, *RN, secretary III*

Legal Services

Walfrido E. Gloria, *MS, senior counsel*
Cherryl C. Brevia, *BS, secretary III*

Library and Documentation Services

Mila M. Ramos, *MS, chief librarian*
Carmelita S. Austria, *MS, assistant chief librarian - library information*
Emerald F. Laxamana, *BS, librarian - catalog*
Iris Marigold P. Operario, *BS, librarian - collections development¹*
Natalia V. Delos Reyes, *BS, librarian - electronic resources and serials*
Reagan R. Austria, *MA, librarian - collections development⁴*
Maria Consuelo S. Parducho, *associate*
Corvett M. Apolinario, *assistant¹*
Marilyn O. Bonador, *BS, assistant*
Isagani P. Garcia, *assistant*
Francisco A. Jaraplasan, *assistant¹²*
Mauro T. Malabrigo, Jr., *assistant*
Emmanuel P. Mendoza, *BS, assistant*
Maria Aisa M. Atienza, *BS, assistant*
Jonnel G. De Jesus, *BS, assistant*

Operations Management

Terry B. Jacobsen, *BA, head⁴*
Joseph F. Rickman, *MS, senior scientist and acting head^{1,6}*
James Denver, *consultant³*
Ricardo M. Hernandez, *BS, assistant manager⁶*

Experiment Station

Arnold R. Manza, *MS, senior manager*
Tomas P. Clemeno, *BS, manager*
Bienvenido B. Manimtim, *BS, assistant manager I*
Roslen S. Anacleto, *MS, programmer*
Roberto P. Escandor, *BS, officer*
Mario A. Mandilag, Sr., *officer*
Erlinda A. Oracion, *MS, officer - administrative coordination*
Rolando R. Pacion, *associate – stock inventory*
Virginia G. Aranda, *BS, secretary III*
Enrico A. Lucero, *secretary III*
Cecilio L. Villamayor, *secretary II*
Francisco G. Calibo, *technician III - equipment*
Jose F. Hernandez, *technician III - equipment*
Rolando G. Guevarra, *technician III - mechanic*
Rogelio R. Pamulaklakin, *technician III - mechanic*
Juanito M. Rosario, *technician III - mechanic*
Efren E. Viquiera, *technician III - mechanic*
Isaias C. Abuyo, *BS, technician III - research*
Benedicto S. Alborida, *technician III – research⁵*
Jesse C. Banasihan, *technician III - research*
Abraham G. Dalid, *BS, technician III - research*
Sulpicio J. Malabanan, *technician III – research*
Jose D. Manuel, *BS, technician III - research*
Nazario B. Timbol, *technician III - research*
Celso L. Varron, *technician III - research*

Romeo T. Llamas, *technician III – research*¹²
 Delfin M. Ilagan, *technician II - equipment*
 Gaudencio S. Indico, *technician II - equipment*¹³
 Nicasio V. Malabanan, *technician II - equipment*
 Pablito M. Pabalate, *technician II - mechanic*
 Pedro C. Aala, *technician II - research*
 Fabian L. Alcachupas, Jr., *technician II - research*
 Carlos P. Alforja, *technician II - research*
 Danilo O. Amoloza, *technician II - research*
 Nestor M. Angeles, *technician II - research*
 Anthony L. Aquino, *technician II - research*⁵
 Melecio J. Arcillas, *technician II - research*
 Efren A. Bagui, *technician II - research*
 Restituto M. Bandyoy, *technician II - research*
 Policarpio S. Barbadillo, *technician II - research*
 Rogelio V. Bargola, *technician II - research*
 Efren P. Bautista, *technician II – research*
 Efren L. Blanco, *technician II - research*
 Pedro G. Cabrera, Sr, *technician II - research*
 Luis M. Calma, *technician II - research*
 Lino M. Carandang, *technician II - research*
 Vicente E. Carandang, *technician II - research*
 Oscar L. Caspillo, *technician II - research*
 Aurelio M. Catangay, *technician II - research*
 Bonifacio B. Chavez, *technician II - research*
 Edgardo T. Diaz, *technician II - research*
 Ariel R. Dimapilis, *technician II - research*
 Rogelio M. Elbo, *technician II - research*
 Cesar Z. Esguerra, *technician II - research*
 William C. Fortuna, *technician II - research*
 Benjamin C. Garcia, *technician II - research*
 Danilo O. Gonzaga, *technician II - research*
 Nestor L. Ilaw, *technician II - research*
 Abraham G. Javier, *technician II - research*
 Eduardo A. Lajarca, *technician II - research*
 Virgilio T. Lalap, *technician II - research*
 Fidel G. Lanorio, *technician II - research*
 Mario M. Malbataan, *technician II - research*
 Leopoldo P. Manito, *technician II - research*
 Mateo F. Manzanilla, *technician II - research*
 Pedro C. Mendoza, *technician II - research*
 Andres M. Mercado, *technician II - research*
 Godofredo M. Mercado, *technician II - research*
 Gelardo R. Morales, *technician II - research*
 Gregorio S. Oca, *technician II - research*
 Ramiro C. Panting, *technician II - research*
 Reynaldo A. Pelegrina, *technician II - research*
 Roberto B. Revilleza, *technician II - research*
 Antonio B. Rivera, *technician II - research*
 Nestor G. Rizaldo, *technician II - research*
 Quirino L. Atienza, *technician I - research*
 Lucas M. Malbataan, *technician I - research*
 Mario F. Villegas, *technician I - research*

Food and Housing Services

Ma. Obdulia B. Jolejole, *BS, senior manager*
 Leody M. Genil, *BS, assistant manager I*
 Melinda M. Cuyno, *BS, officer*¹
 Benita M. Pangan, *BS, officer*
 Pricilla S. Argosino, *MS, officer*⁴
 Gina A. Ypil, *BS, secretary II*^{4,5}
 Fe C. De Ocampo, *BS, associate - food service*
 Jojo P. Cabutin, *BS, assistant - recreation*
 Anselmo R. Reyes, *assistant - recreation*
 Limberto S. Aldipollo, *assistant - stock inventory*
 Edgardo S. Estenor, *BS, attendant - housing*
 Ricardo L. Bejosano, Jr., *attendant - housing*
 Cristina E. Cauntay, *attendant - housing*
 Irene S. Escoses, *attendant - housing*
 Laureano M. Escuadra, *attendant - housing*
 Aurelio C. Garcia, *attendant - housing*
 Francisca O. Oro, *attendant - housing*
 Alfredo G. Regalado, *attendant - housing*

Physical Plant Services

Douglas D. Avila, *BS, senior manager*
 Enrique O. Delos Reyes, *BS, manager*
 Alfredo M. Mazaredo, *MS, manager*
 Jaime A. Fojas, *BS, assistant manager I*
 Fernando B. Madriaga, *BS, assistant manager I*
 Nestor A. Malabuyoc, *BS, assistant manager I*
 Teodoro G. Carreon, *officer*
 Marissa E. Templanza, *BS, officer - administrative coordination*
 Jennifer R. Jarlego, *BS, secretary I*
 Luisito R. Vitan, *lead technician III - civil*
 Rufino R. Gibe, *BS, lead technician III - electrical*
 Danilo F. Banasihan, *lead technician III - instrument and telephone*
 Rodolfo G. Calibo, *lead technician III - physical plant*
 Juan L. Petrasanta, *lead technician III - refrigeration and airconditioning*
 Fidel L. Alvarez, *technician III - carpentry*
 Levi C. Malijan, *technician III - carpentry*
 Virgilio V. Verano, *technician III - carpentry*
 Robert F. Austria, *BS, technician III - drafting*
 Roberto E. Escueta, *BS, technician III - electrical*
 Enrique D. Baterina, *technician III - electrical*
 Mario C. Garcia, *technician III - electrical*
 Felix M. Halili, *technician III - electrical*
 Benjamin C. Libutan, *technician III - electrical*
 Rolando N. Simon, *technician III - electrical*
 Marcelino M. Navasero, Jr., *technician III - electronics and instrument repair*
 Ramon R. Suarez, *technician III - electronics and telephone technician*
 Melencio E. Tapia, *technician III - plumbing*
 Manolo M. De Guia, *technician III - refrigeration and airconditioning*
 Leonardo S. Mangubat, *technician III - refrigeration and airconditioning*

Dionisio A. Ng, *technician III - refrigeration and airconditioning*
Ricardo C. Tabilangon, *technician III - refrigeration and airconditioning*
Domingo M. Ortiz, *technician III - telephone*
Apolinario T. Armia, *technician III - welding*
Anito Q. Mabalhin, *technician III - welding*
Fermin L. Junsay, *BS, assistant - stock inventory*
Almario S. Piñero, *painter*
Roberto N. Tamio, *technician II - masonry*
Regalado Q. Alcachupas, *technician II - plumbing*
Hilarion A. Hibek, *technician II - plumbing*

Safety and Security Services

Glenn A. Enriquez, *BS, senior manager*
Crisanto P. Dawinan, *BS, assistant manager I - occupational safety & health¹*
Maria Cristina B. Andaya, *BS, assistant manager II (pollution control officer)*
Alvin C. Reyes, *BS, assistant manager I⁴*
Bionico R. Malacad, *security investigator*
Salvador T. Zaragoza, Jr., *security investigator*
William G. Amador, *BS, core guard*
Juanito C. Exconde, *BS, core guard*
Macario C. Punzalan, *BS, core guard*
Crisostomo M. Dela Rueda, *core guard*
Rodelo M. Empalmado, *core guard*
Pablo C. Erasga, *core guard*
Roberto M. Espinosa, Jr., *core guard*
Esteban C. Palis, *core guard*
Ernesto S. Regulacion, *core guard*

Transport Services

Manuel F. Vergara, *BS, senior manager*
John Arturo M. Aquino, *BS, assistant manager I - vehicle repair shop*
Carlito C. Cabral, *BS, officer - administrative coordination*
Reynaldo G. Elmido, *associate - MPDS dispatch*
Bonifacio M. Palis, *associate - MPDS dispatch*
Oscar A. Templanza, *associate - MPDS dispatch*
Ariel B. Nuque, *associate - MVRs coordination*
Perlita E. Malabayabas, *BS, secretary III*
Emilio R. Gonzalez, Jr., *technician III - AC mechanic*
Jaime D. Atienza, *technician III - mechanic*
Romeo L. Jarmin, *technician III - mechanic*
Armando E. Malveda, *technician III - mechanic*
Rodrardo S. Quintos, *technician III - mechanic*
Rolando L. Santos, *technician III - mechanic*
Ronilo M. Villanueva, *BS, technician II - mechanic*
Edwin S. Cabarrubias, *technician II - mechanic*

Roger M. Cuevas, *technician II - mechanic*
Mabini M. Linatoc, *technician II - mechanic*
Diosdado D. Mamaril, *BS, driver*
Danilo G. Abrenilla, *driver*
Crisencio L. Balneg, *driver*
Carlos Levy C. Banasihan, *driver⁴*
Rolando A. Cabrera, *driver*
Amador L. De Jesus, *driver*
Rodrigo M. Fule, *driver*
Hernani M. Moreno, *driver*
Eduardo L. Pua, *driver*
Angelito C. Quijano, *driver*
Renato C. Vivas, *driver*

Seed Health Unit

Patria G. Gonzales, *MS, associate scientist and acting head*
Janice Q. Bautista, *BS, assistant scientist*
Carlos C. Huelma, *MS, assistant scientist*
Evangeline G. Gonzales, *BS, secretary III*
Atanacio B. Orence, *technician III - research*
Salome P. Bulaquiña, *data encoder*
Isabel L. Penales, *technician III - research*
Aurelio A. Gamba, *technician II - research*
Florencio I. Lapiz, *technician II - research*
Jay A. Angeles, *technician I - research*
Jose F. Banasihan, *technician I - research*

¹Left during the year

²On leave

³Joined and left during the year

⁴Joined during the year

⁵On project appointment

⁶Transferred from Agricultural Engineering Unit

⁷Transferred from Crop and Environmental Sciences Division

⁸Transferred from Entomology and Plant Pathology Division

⁹Transferred from Financial Operations Unit

¹⁰Transferred from T.T. Chang Genetic Resources Center

¹¹Transferred from Training Center

¹²Died during the year

¹³Resigned

¹⁴Effective 1 February 2006

¹⁵Effective August 2006

¹⁶Effective October 2006

¹⁷Effective December 2006

¹⁸Transferred from Social Sciences Division

¹⁹50% with DPPC, 50% with DDG-R

APPENDIX 1. IRRIS RESEARCH PARTNERS

National agricultural research and extension systems

Bangladesh

Agricultural Advisory Society
Bangladesh Academy for Rural Development
Bangladesh Agricultural Research Council
Bangladesh Agricultural Research Institute
Bangladesh Agricultural University
Bangladesh Fisheries Research Institute
Bangladesh Rice Research Institute
Bangladesh Water Development Board
Department of Agricultural Extension
Department of Agriculture -Karnal
Health Education and Economic Development
Local Government Engineering Department
Rajshahi University
Rural Development Academy
University of Dhaka

Brazil

Empresa Brasileira de Pesquisa Agropecuária

Cambodia

Battambang Provincial Department of Agriculture
Cambodian Agricultural Research and Development Institute
Department of Agricultural Extension
Ministry of Agriculture, Forestry and Fisheries
Prek Leap National School of Agriculture
Prey Veng Provincial Department of Agriculture
Royal University of Agriculture

China

China Agricultural University
China National Rice Research Institute
Chinese Academy of Agricultural Sciences
Chinese Academy of Sciences
Fudan University

Guangdong Academy of Agricultural Sciences
Guangxi Academy of Agricultural Sciences
Huazhong Agricultural University
Hunan Agricultural University
Ministry of Agriculture of the People's Republic of China
Nanjing Agricultural University
Northeast Agricultural University
Peking University
Wuhan University
Yangzhou University
Yunnan Academy of Agricultural Sciences
Yunnan Agricultural University
Zhejiang Academy of Agricultural Sciences
Zongnan University of Economics and Agriculture

Egypt

Ministry of Agriculture and Land Reclamation
Rice Research and Training Center

Guatemala

Instituto de Ciencia y Tecnología Agrícolas

India

Acharya N.G. Ranga Agricultural University
Anand Agricultural University
Assam Agricultural University
Banaras Hindu University
Birsra Agricultural University
CCS Haryana Agricultural University, Rice Research Station,
Kaul (Kaithal)
Central Rainfed Upland Rice Research Station (Hazaribagh)
Central Rice Research Institute
Chandra Shekhar Azad University of Agriculture and
Technology, Kanpur
Directorate of Rice Research
Goa University
Govind Ballabh Pant University of Agriculture and Technology

Indian Agricultural Research Institute
Indian Council of Agricultural Research
Indira Gandhi Agricultural University
Jawaharlal Nehru Krishi Vishwa Vidyalaya
Kuvempu University
Maharana Pratap University of Agriculture and Technology
Ministry of Agriculture
Narendra Deva University of Agriculture and Technology
Orissa University of Agricultural Technology
Punjab Agricultural University
Rajendra Agricultural University
Sardar Vallabh Bhai Patel University of Agriculture and
Technology
Tamil Nadu Agricultural University
Tata Energy Research Institute
University of Agricultural Sciences
University of Calcutta
University of Delhi
University of Hyderabad

Indonesia

Indonesia Agricultural Post Harvest Research Institute
Indonesian Agency for Agricultural Research and
Development
Indonesian Agricultural Biotechnology and Genetic Resources
Research Institute
Indonesian Center for Agricultural Biotechnology and Genetic
Resources and Research Development
Indonesian Center for Agricultural Post Harvest Research and
Development
Indonesian Center for Food Crops Research and Development
Rice Research Institute

Iran

Agricultural Biotechnology Research Institute of Iran
Agricultural Research and Education Organization
Rice Research Institute of Iran
University of Mazandaran

Kenya

Kenya Agricultural Research Institute

Lao PDR

Department of Agricultural Extension
Huay Khot Research Station
Luang Namtha Research Station
Ministry of Agriculture and Forestry
National Agricultural Research Center
National Agriculture and Forestry Research Institute
Phone Ngam Research Station
World Vision Laos, Savanaketh Project

Malaysia

Malaysian Agricultural Research and Development Institute
Universiti Kebangsaan Malaysia

Mozambique

National Agricultural Institute of Mozambique

Myanmar

Department of Agricultural Research
Myanma Agriculture Service
Yezin Agriculture University

Nepal

Nepal Agricultural Research Council
Regional Agricultural Research Station
Tribhuvan University- Institute of Agriculture and Animal
Science

Pakistan

National Agricultural Research Center
On-Farm Water Management
Pakistan Agricultural Research Council

Philippines

Advanced Science and Technology Institute
Agricultural Productivity Center for Bohol and the Visayas
Bulacan Agricultural State College
Bureau of Plant Industry
Central Luzon State University
Central Mindanao University
Dapitan sa Kaumhan
Department of Environment and Natural Resources
Leyte State University
National Food Authority
National Irrigation Administration
Pampanga Agricultural College
Philippine Rice Production Consortium
Philippine Rice Research Institute
University of Southern Mindanao
University of the Philippines Los Baños
University of the Philippines Diliman
Western Visayas State University

Sri Lanka

Center for Agricultural Research and Programming
Department of Agriculture
Field Crops Research and Development Institute
Rice Research and Development Institute
University of Peradeniya

South Africa

African Centre for Gene Technologies

Thailand

Chamnien Saranaga Foundation
Chiang Mai University
Department of Rice
Kasetsart University
Khon Kaen Plant Material and Technical Service Center
Khon Kaen University
Rice Research Institute
Ubon Ratchani Rice Research Center

Vietnam

Agricultural Genetics Institute
An Giang University
Bac Lieu People's Committee
Can Tho University
Cuu Long Delta Rice Research Institute
Department of Agriculture and Rural Development-Bac Lieu
Hanoi Agricultural University
Hue University of Agriculture and Forestry
Integrated Resources Mapping Centre
Ministry of Agriculture
National Agricultural Extension Center
National Institute of Soils and Fertilizers
Nong Lam University
Plant Protection Department
Research Institute for Aquaculture No. 2
Southern Plant Protection Center
Sub-Institute of Water Resource Planning
Thai Nguyen University
Vietnam Agricultural Science Institute
Vietnam Institute Agricultural Engineering and Post-Harvest
World Vision-Vietnam

Advanced research institutes

Australia

Charles Sturt University
Commonwealth Scientific and Industrial Research Organisation
Curtin University of Technology
New South Wales Department of Primary Industries - Agriculture
University of Queensland
University of Sydney

Belgium

Universite Catholique de Louvain-Unite de Physiologie
Vegetale

Canada

Agriculture and Agri-Food Canada
McGill University
University of Alberta

Denmark

Riso National Laboratory

France

Agropolis
Centre de coopération internationale en recherche
agronomique pour le developpement
Institut de recherche pour le développement
Institut national de la recherche agronomique
Unite de recherche en genomique vegetale

Germany

Center for Environmental Research
Christian Albrecht University-Kiel
Forschungszentrum Karlsruhe GMBH
Martin Luther University Halle-Wittenberg
Max-Planck Institut fur Zungtungsforschung
MIPS Bioinformatics Center
Technische Universitat Darmstadt
University of Bayreuth
University of Freiburg
University of Hamburg
University of Hannover
University of Hohenheim
University of Leipzig

Japan

Foundation for Advanced Studies in International Discipline
Japan International Cooperation Agency
Japan International Research Center for Agricultural Sciences
Ministry of Agriculture, Forestry and Fisheries
National Agriculture Research Center
National Institute for Crop Sciences
National Institute of Agrobiological Sciences
Overseas Agricultural Development Association
Tsukuba University

Korea

Pohang University of Science and Technology
Rural Development Administration

Netherlands

Plant Research International
Wageningen University and Research Centre

Singapore

National University of Singapore

Switzerland

Swiss Federal Institute of Technology

United Kingdom

Imperial College of Science, Technology and Medicine
Horticulture Research International

University of Greenwich
University of Liverpool

United States of America

Clemson University
Colorado State University
Cornell University
Fred Hutchinson Cancer Research Center
Institute for Genomic Research
Kansas State University
National Agricultural Library
National Center for Genome Resources
Ohio State University
Pennsylvania State University
Purdue University
University of Arkansas
University of California-Davis
University of California-Riverside
University of Florida-Gainesville
University of Hawaii
University of Illinois
University of Maine
University of Minnesota
University of Washington
Virginia Polytechnic Institute and State University
Yale University

Venezuela

Instituto Nacional de Investigacion Agropecuaria

International centers/organizations

Africa Rice Center
Food and Agriculture Organization
Gramene: A Comparative Mapping Resource for Grains
International Atomic Energy Association
International Center for Agricultural Research in the Dry Areas
International Center for Biosaline Agriculture
International Center for Research in the Semi-arid Tropics
International Institute for Rural Reconstruction
International Center for Tropical Agriculture
International Center of Insect Physiology and Ecology
International Institute of Tropical Agriculture
International Livestock Research Institute
International Maize and Wheat Improvement Center
International Network for the Improvement of Banana
and Plantain
International Plant Genetic Resources Institute
International Potato Center
International Water Management Institute
SEAMEO Regional Center for Graduate Study and Research
in Agriculture

World Agroforestry Center
WorldFish Center

Nongovernment organizations

Bangladesh

Wave Foundation

Cambodia

Srer Khmer

India

Barwale Foundation
M.S. Swaminathan Research Foundation
SAMRUDHI

Myanmar

Myanmar Rice and Paddy Traders Association

Philippines

Infanta Integrated Community Development Assistance, Inc.
Ayala Foundation Inc.

Thailand

Plan International

United States of America

Public Intellectual Property Resource for Agriculture
The Samuel Roberts Noble Foundation, Inc.

Private organizations

Australia

BCM Software Tools PTY LTD

Bangladesh

Socioconsult Ltd.

Cambodia

Crenn and Associates

China

Fujian Science and Technology Publishing House

Denmark

FOSS

Switzerland

CIBA-Geigy Limited Seeds Division

United States of America

Li-Cor Inc.
Nabisco Research and Development
Perlegen Sciences, Inc.

Vietnam

Voice of Ho Chi Minh Radio Broadcasting

APPENDIX 2. SELECTED ACRONYMS USED THROUGHOUT THIS PUBLICATION

AEU	Agricultural Engineering Unit
ARBN	Asian Rice Biotechnology Network
ASEAN	Association of Southeast Asian Nations
ASL	Analytical Service Laboratories
BB	bacterial blight
BBU	Biometrics and Bioinformatics Unit
BOT	Board of Trustees
BPH	brown planthopper
BRRI	Bangladesh Rice Research Institute
CA	Comprehensive Assessment of Water Management in Agriculture
CARDI	Cambodian Agricultural Research and Development Institute
CESD	Crop and Environmental Sciences Division
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
CIP	International Potato Center (Peru)
CIMMYT	International Maize and Wheat Improvement Center (Mexico)
CIRAD	Centre de coopération en recherche agronomique pour le développement (France)
CNRM	crop and natural resource management
CORRA	Council for Partnerships on Rice Research in Asia
CPS	Communication and Publications Services
CPWF	Challenge Program on Water and Food
CRIL	IRRI-CIMMYT Crop Research Informatics Laboratory
CSB	community seed bank
CSSP	Crop Science Society of the Philippines
CSWS	Crop, Soil, and Water Sciences Division
CURE	Consortium for Unfavorable Rice Environments
DA	Department of Agriculture (Philippines)
DDG-OSS	Deputy Director General for Operations and Support Services
DFID	Department for International Development (UK)
DPPC	Director for Program Planning and Communications
EE	entertainment-education (approach)
EIRLSBN	Eastern Indian Rainfed Lowland Shuttle Breeding Network
EMS	environmental management system
EPPD	Entomology and Plant Pathology Division
ES	Experiment Station
EVIS	Events, Visitors, and Information Services (formerly VIS, Visitors and Information Services)
FAO	Food and Agriculture Organization
FARMSTEAD	Fish and Rice Management System to Enable Agricultural Diversification

FOP	Financial Operations (Unit)	NARES	national agricultural research and extension systems
FoSHoL	Food Security for Sustainable Household Livelihoods	NIAS	National Institute for Agrobiological Sciences (Japan)
FPR	Financial Planning and Reporting (Unit)	NICS	National Institute of Crop Science (Korea)
GAMMA	Gene Array and Molecular Marker Application	NIL	near-isogenic line
GCP	Generation Challenge Program	NRM	natural resource management
GMS	Greater Mekong Subregion	NRS	nationally recruited staff
GQNPC	Grain Quality, Nutrition, and Postharvest Center	PBGB	Plant Breeding, Genetics, and Biotechnology (formerly Biochemistry) Division
GRC	Genetic Resources Center	PhilRice	Philippine Rice Research Institute
GRIMS	Genetic Resources Information Management System	PNRI	Philippine Nuclear Research Institute
ICAR	Indian Council of Agricultural Research	PROVIDE	Poverty Reduction Options Validated in Drought Environments
ICIS	International Crop Information System	PVS	participatory varietal selection
ICOP	in-country outreach program	QTLs	quantitative trait loci
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)	RCCC	Rice Climate Change Consortium
ICRAF	World Agroforestry Center	RDA	Rural Development Administration (Korea)
IFAD	International Fund for Agricultural Development	RILs	recombinant inbred line
ILRI	International Livestock Research Institute	RKB	Rice Knowledge Bank
INGER	International Network for Genetic Evaluation of Rice	SDC	Swiss Agency for Development and Cooperation
IPM	integrated pest management	SHU	Seed Health Unit
IPMO	International Programs Management Office	SNP	single nucleotide polymorphism
IPR	intellectual property rights	SPAD	soil plant analysis diagnostic
IRC	International Rice Congress	SSD	Social Sciences Division
IRG	International Rice Genebank	SSNM	site-specific nutrient management
IRIS	International Rice Information System	SSR	simple sequence repeat (marker)
IRRC	Irrigated Rice Research Consortium	SMTA	standard material transfer agreement
IRRN	International Rice Research Notes	TC	Training Center
ITS	Information Technology Services	TEEAL	The Essential Electronic Agricultural Library
IWMI	International Water Management Institute (Sri Lanka)	TILLING	Targeting Induced Local Lesions IN Genomes
LCC	leaf color chart	TNAU	Tamil Nadu Agricultural University
LEARN-IT	Linking Extension and Research Needs through Information Technology	UPLB	University of the Philippines Los Baños
LIMS	Laboratory Information Management System	USAID	United States Agency for International Development
LITE	Livelihood Improvement Through Ecology	USDA	United States Department of Agriculture
MARD	Ministry of Agriculture and Rural Development (Vietnam)	UPRIIS	Upper Pampanga River Integrated Irrigation System
MAS	marker-assisted selection	WARDA	Africa Rice Center (West Africa Rice Development Association; Benin)
MDGs	Millennium Development Goals		

APPENDIX 3. AUDITED FINANCIAL STATEMENTS

**INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)**

**FINANCIAL STATEMENTS
AND SUPPLEMENTARY SCHEDULES
AS OF AND FOR THE YEARS ENDED
DECEMBER 31, 2006 AND 2005**



Corporate information

Board of Trustees

Members-at-large

Mr. Fazle Hasan Abed
Dr. Achmad Mudzakkir Fagi
Dr. Eun-Jong Lee
Dr. Keijiro Otsuka
Prof. Baowen Zhang
Prof. Ruth K. Oniang'o
Dr. Ronald L. Phillips
Dr. Elizabeth J. Woods
Dr. Ralph Anthony Fischer
Dr. Mangala Rai (joined January 2006)

Ex officio members

Dr. Emerlinda R. Roman
President, University of the Philippines

Mr. Domingo F. Panganiban (left 17 October 2006)
Mr. Arthur C. Yap (joined 18 October 2006)
Secretary, Philippine Department of Agriculture

Dr. Robert S. Zeigler
Director General

Officers

Dr. William G. Padolina
Secretary to the Board

Mr. Kwame Akuffo-Akoto
Treasurer to the Board

Los Baños Headquarters Location/Address

College, Los Baños
4031 Laguna
Philippines
Tel: (63-2) 580-5600, 845-0563
(63-49) 536-2701 to 2705
+1 (650) 833-6620 (USA direct)
Fax: (63-2) 580-5699; 845-0606
(63-49) 536-7995
+1 (650) 833-6621 (USA direct)

Email: irri@cgiar.org
Web: www.irri.org

IRRI Makati Office Location/Address

10th Floor, Suite 1009
Security Bank Center
6776 Ayala Avenue, Makati City 1226
Philippines
Tel: (63-2) 891-1236, 891-1303
Fax: (63-2) 891-1174

External Auditors

Isla Lipana & Co.
A member firm of PricewaterhouseCoopers



Finance and Audit Committee

Membership

The members of the Finance and Audit Committee are appointed by the Board. Its duty is to review and audit, from time to time, the accounts and financial condition as well as the management and internal control systems and procedures of the Institute. It also reviews periodically the Institute's guidelines and procedures pertaining to human resources development, finance and budget, and other administrative matters, and exercises the powers and performs the duties delegated to it by the Board. For the Institute's audit and accounts, the Committee discharges its functions in consultation and coordination with the external auditors, the internal auditors, and appropriate consultants of the Institute.

The Chairperson of the Finance and Audit Committee, who is customarily appointed by the Board at the time when the Board appoints members of the Committee, presides over all meetings of the Committee. In his/her absence or disability, the Vice Chairperson shall act as the Chairperson for that meeting.

The Finance and Audit Committee shall meet at least once a year. Special meetings may be held upon call by its Chairman or upon request of at least one member.

A vacancy in the Finance and Audit Committee is filled from among other members of the Board through election by the Board or election by the remaining members of the Finance and Audit Committee. Any person so elected by the Committee serves only until the next meeting of the Board.

Authority

The Finance and Audit Committee is authorized to investigate any activity of the Institute within its terms of reference and all employees shall be directed to cooperate with any request made by the Committee. The Committee shall be empowered to retain persons having special competence as necessary to assist the Committee in fulfilling its responsibilities.

The Composition in 2006 and Designation of Finance and Audit Committee

Mr. Fazle Hasan Abed	- Chairperson
Vacant	- Vice Chairperson
Dr. Ruth K. Oniang'o	- Member
Dr. Ronald L. Phillips	- Member
Prof. Baowen Zhang	- Member
Dr. Emerlinda R. Roman	- Member
Dr. Ralph A. Fischer	- Member
Dr. Elizabeth Woods	- Member

Dr. Robert S. Zeigler (Director General), member, Finance only, does not participate in Audit Section of the Committee's deliberations.



Statement by the Board Chair

for the year ended 31 December 2006

The year ending 31 December 2006 was a “transformational year” for IRRI. The significant highlights are discussed below.

New Strategic Plan for IRRI

The Board approved the Institute’s new strategic plan that defines IRRI’s goals and objectives for the next 10 years. The Board and management, after reviewing the external and internal environment of IRRI, identified the challenges and opportunities for the Institute upon which the foundation of the strategic plan was based. Five major goals have been identified. Four of these have very strong linkages with the Millennium Development Goals of the United Nations.

IRRI in Africa

The Institute took steps to become more active in Africa in 2006. A second IRRI scientist who is a Post Harvest Expert was posted in Africa, hosted by INIA in Maputo, Mozambique. He is pursuing collaboration with ASARECA to help solve high-priority rice research problems in Eastern and Southern Africa. Capacity building for NARES in the region will also be supported and promoted. This East Africa support complements staff already placed in West Africa.

Financial Status

Revenue for 2006 amounted to \$30.2m against expenditures of \$33.6m, resulting in a deficit of \$3.4m before unrealized foreign exchange translation gain. The deficit has two components. The first is a deficit on the year’s operations of about \$1.9m. Although actual expenditures were within planned levels, a significant and unexpected default by a major donor in unrestricted grants to the tune of \$1.5m late in the year (after the 17 October Board meeting) resulted in the

elevated deficit. This non-receipt was partially mitigated by World Bank by providing additional grant in the amount of US\$0.4m. If this default had not occurred, the deficit would have been \$0.7m which is below the approved budgeted level of \$1.3m. These developments in funding present challenges to the Institute in the immediate future that the Board and management are working to address. The second component, \$1.5m of the deficit was due to the implementation of the planned use of reserves for identified new research initiatives. The utilization of the Institute’s reserves is going on according to the plan. The Institute’s net assets at the end of 2006 amounted to \$43.5m, with liquidity and long-term stability indicators well above the CGIAR-recommended minima.

Board of Trustees

The IRRI Board of Trustees met on two occasions in 2006. I would like to express my sincere best wishes to Mr. Fazle Hasan Abed and Mr. Domingo F. Panganiban, who left the Board at the end of the year. The Institute gained from their invaluable contribution to the governance of IRRI. Mr. Arthur Yap and Dr. Mangala Rai joined the Board during the year.

Appreciation

On behalf of the Board of Trustees, I would like to thank the management and staff for their dedication and perseverance in facing the challenges during the year under review. We would like also to put on record our appreciation of our donors and investors and CGIAR partners for their continued support and cooperation.

Dr. Keijiro Otsuka
Chairperson, Board of Trustees



International Rice Research Institute

Financial statements

December 31, 2006 and 2005

Management Statement of Responsibility for Financial Reporting

The accompanying financial statements of the International Rice Research Institute (IRRI), for the year ended December 31, 2006 and 2005 are the responsibility of management. IRRI management also claims responsibility for the substance and objectivity of the information contained therein.

Our financial reporting practices follows the “Accounting Policies and Reporting Practices Manual - Financial Guidelines Series No. 2” of the CGIAR. IRRI maintains a system of internal control designed to provide reasonable assurance that assets are safeguarded and transactions are properly recorded and executed in accordance with management’s authorization.

A system of reporting within the Institute present the management with an accurate view of the operations, enabling us to discern risks to our assets or fluctuations in the economic environment of the Institute at an early stage and at the same time providing a reliable basis for the financial statements and management reports.

The Board of Trustees exercises its responsibility for these financial statements through its Finance and Audit Committee. The Committee meets regularly with management and representatives of the external auditors to review matters relating to financial reporting, internal controls, and auditing.

A handwritten signature in black ink, appearing to read "Robert S. Zeigler".

Dr. Robert S. Zeigler
Director General

A handwritten signature in black ink, appearing to read "Kwame Akuffo-Akoto".

Kwame Akuffo-Akoto
Treasurer and Director for
Management Services

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

FINANCIAL STATEMENTS
AND SUPPLEMENTARY SCHEDULES
AS OF AND FOR THE YEARS ENDED
DECEMBER 31, 2006 AND 2005

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

FINANCIAL STATEMENTS AND SUPPLEMENTARY INFORMATION
AS OF AND FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005

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Statements of Activities	4
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Schedule of Temporarily Restricted Agenda and Challenge Programs Fundings	Exhibit 2
Details of Operating Expenses	Exhibit 3
Calculation of Indirect Cost Rate	Exhibit 4

Independent Auditor's Report

To the Board of Trustees of
International Rice Research Institute

We have audited the accompanying financial statements of the International Rice Research Institute (a nonstock, not-for-profit organization), which comprise the statements of financial position as of December 31, 2006 and 2005 and the related statement of activities, changes in net assets and cash flows for the years then ended, and a summary of significant accounting policies and other explanatory notes.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements and the supplementary schedules referred to below on the basis of accounting practices prescribed for international agricultural research centers under the auspices of the Consultative Group on International Agricultural Research (CGIAR). This responsibility includes: designing, implementing and maintaining internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or errors; selecting and applying accounting policies; and making accounting estimates that are reasonable in the circumstances.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits in accordance with International Standards on Auditing. Those standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

Independent Auditor's Report
To the Board of Trustees of
International Rice Research Institute

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of the International Rice Research Institute (a nonstock, not-for-profit organization) as of December 31, 2006 and 2005, and the results of its activities and its cash flows for the years then ended in conformity with the CGIAR guidelines.

Our audits were made for the purpose of forming an opinion on the basic financial statements taken as a whole. The supplementary schedules of grant revenue, temporarily restricted agenda and challenge programs fundings, operating expenses and the calculation of indirect cost rate for the years ended December 31, 2006 and 2005 are presented for purposes of additional analysis and are not a required part of the basic financial statements. The information in such supplementary schedules has been subjected to the auditing procedures applied in the audit of the basic financial statements and, in our opinion, is fairly stated in all material respects in relation to the basic financial statements taken as a whole.

PricewaterhouseCoopers

Makati City, Philippines
April 17, 2007

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF FINANCIAL POSITION
DECEMBER 31, 2006 AND 2005
(All amounts in thousand US Dollars)

	Notes	2006	2005
<u>ASSETS</u>			
Current assets			
Cash and cash equivalents	3	17,037	21,861
Short term investments	4	2,652	39
Accounts receivable - net			
Donors	5	3,788	6,876
Employees		122	153
Other CGIAR Centers		18	335
Others	6	1,554	1,807
Inventories - net	7	555	475
Prepaid expenses		179	253
Total current assets		25,905	31,799
Non-current assets			
Property and equipment - net	8	9,883	8,524
Long term investments	9	23,738	19,665
Refundable deposits		6	6
Total non-current assets		33,627	28,195
Total assets		59,532	59,994
<u>LIABILITIES AND NET ASSETS</u>			
Current liabilities			
Accounts payable			
Donors	10	5,652	6,382
Other CGIAR Centers		356	85
Others	11	2,834	1,078
Accruals and provisions	12	7,227	7,110
Total current liabilities		16,069	14,655
Net assets			
Designated	14	43,463	45,339
Total liabilities and net assets		59,532	59,994

The accompanying notes are an integral part of these financial statements.

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF ACTIVITIES
FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005
(All amounts in thousand US Dollars)

	Note	2006			Challenge Programs	Total	2005
		Unrestricted	Temporarily Restricted*	Sub-total			
Revenues							
Grants (Exhibit 1)		12,836	10,414	23,250	4,660	27,910	28,937
Other revenues	16	2,269	-	2,269	-	2,269	1,858
		15,105	10,414	25,519	4,660	30,179	30,795
Operating expenses							
Program-related (Exhibit 3)		13,541	10,057	23,598	4,660	28,258	27,491
Management and general (Exhibit 3)		6,210	357	6,567	-	6,567	7,660
		19,751	10,414	30,165	4,660	34,825	35,151
Recovery of indirect costs		(1,274)	-	(1,274)	-	(1,274)	(1,266)
		18,477	10,414	28,891	4,660	33,551	33,885
Net deficit from ordinary activities		(3,372)	-	(3,372)	-	(3,372)	(3,090)
Unrealized foreign exchange translation gain (loss)		1,676	-	1,676	-	1,676	(2,295)
Net deficit		(1,696)	-	(1,696)	-	(1,696)	(5,385)
Memo items							
Operating expenses -							
by natural classification:							
Personnel costs		9,660	3,781	13,441	961	14,402	13,300
Supplies, services and others		6,872	3,909	10,781	1,177	11,958	12,755
Collaborators/Partners		344	1,277	1,621	2,196	3,817	4,144
Operational travel		1,111	1,214	2,325	326	2,651	2,906
Depreciation		1,764	233	1,997	-	1,997	2,046
Recovery of indirect costs		(1,274)	-	(1,274)	-	(1,274)	(1,266)
		18,477	10,414	28,891	4,660	33,551	33,885

* of which US\$1.76 million is attributed funding

The accompanying notes are an integral part of these financial statements.

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF CHANGES IN NET ASSETS
FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005
(All amounts in thousands of US Dollars)

	Note	Designated										Total Net Assets
		Undesignated	<i>Vested</i>	<i>Non-Vested</i>						Total non-vested	Total designated net assets	
			Invested in fixed assets	Fixed assets acquisition	Staff separation	Risk management	Unrealized FOREX translation	GRC reserve	Research initiative fund (Note 14)			
Balances, January 1, 2005		2,189	9,127	12,261	6,632	5,160	6,518	-	8,750	39,321	48,448	50,637
Board of Trustees appropriation		(2,189)	-	(3,261)	-	-	-	-	5,450	2,189	2,189	-
Capital reserve replenishment		-	(1,807)	1,807	-	-	-	-	-	1,807	-	-
Acquisition of fixed assets		-	1,337	(1,250)	-	-	-	-	-	(1,250)	87	87
Net deficit for the year		-	(133)	-	-	(1,219)	(2,295)	-	(1,738)	(5,252)	(5,385)	(5,385)
Balances, December 31, 2005		-	8,524	9,557	6,632	3,941	4,223	-	12,462	36,815	45,339	45,339
Board of Trustees re-designation	14	-	-	(3,368)	(6,632)	-	-	10,000	-	-	-	-
Capital reserve replenishment		-	(1,764)	1,764	-	-	-	-	-	1,764	-	-
Acquisition of fixed assets		-	3,220	(3,400)	-	-	-	-	-	(3,400)	(180)	(180)
Net surplus (deficit) for the year		-	(97)	-	-	(1,770)	1,676	-	(1,505)	(1,599)	(1,696)	(1,696)
Balances, December 31, 2006		-	9,883	4,553	-	2,171	5,899	10,000	10,957	33,580	43,463	43,463

The accompanying notes are an integral part of these financial statements.

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF CASH FLOWS
FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005
(All amounts in thousands of US Dollars)

	Notes	2006	2005
Cash flows from operating activities			
Net deficit		(1,696)	(5,385)
Adjustments for:			
Depreciation of assets	8	1,997	2,046
Interest income		(1,690)	(1,130)
Net book value of disposed property and equipment		97	133
Net deficit before working capital changes		(1,292)	(4,336)
(Increase) decrease in:			
Short term investments		(2,613)	2,797
Accounts receivable		3,689	(3,935)
Inventories		(80)	(93)
Prepaid expenses		74	(81)
Increase in:			
Accounts payable		1,296	1,320
Accruals and provisions		117	988
Cash generated from (absorbed by) operations		1,191	(3,340)
Interest received		1,690	1,130
Net cash provided by (used in) operating activities		2,881	(2,210)
Cash flows from investing activities			
Increase in long term investments		(4,073)	(9,475)
Net movement of fixed assets/acquisition reserve		(180)	87
Acquisition of property and equipment	8	(3,452)	(1,576)
Net cash used in investing activities		(7,705)	(10,964)
Net decrease in cash and cash equivalent		(4,824)	(13,174)
Cash and cash equivalent			
At the beginning of the year		21,861	35,035
At the end of the year		17,037	21,861

The accompanying notes are an integral part of these financial statements.

**INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)**

NOTES TO FINANCIAL STATEMENTS
AS OF AND FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005
(All amounts in thousands of US Dollars unless otherwise stated)

Note 1 - General

International Rice Research Institute (the Institute) was established in 1960 to undertake basic research on the rice plant and applied research on all phases of rice production, management, distribution and utilization with the objective of attaining nutritive and economic advantage and benefit for the people of Asia and other major rice-growing areas.

The Institute was conferred the status of an international organization in the Philippines under Presidential Decree (PD) No. 1620.

As a nonstock, not-for-profit organization under Republic Act No. 2707 and an international organization under PD No. 1620, the Institute was granted, among other privileges and prerogatives, the following tax exemptions:

- a. exemption from the payment of gift, franchise, specific, percentage, real property, exchange, import, export, documentary stamp, value-added and all other taxes provided under existing laws or ordinances. This exemption extends to goods imported and owned by the Institute, leased or used by its staff;
- b. exemption from payment of gift tax; all gifts, contributions and donations to the Institute are considered allowable deductions for purposes of determining the income tax of the donor; and
- c. exemption from payment of income tax of non-Filipino citizens serving on the Institute's technical and scientific staff on salaries and stipends in United States (US) dollars received solely from, and by reason of, service rendered to the Institute.

The Institute receives support from various donor agencies and entities primarily through the Consultative Group on International Agricultural Research (CGIAR). CGIAR is a group of donors composed of governments of various nations and international organizations and foundations.

On May 19, 1995, an international agreement that recognizes the status of the Institute as an international organization was signed. The said agreement allows the Institute to have a juridical status to more effectively pursue its international collaborative activities in rice research and training.

The Institutes major facilities are located in Los Baños, Laguna, Philippines. In addition, the Institute owns an administrative office in Makati City, Philippines. As of December 31, 2006, the Institute has 905 employees (2005 - 884).

The accompanying financial statements and supplementary schedules of the Institute were approved and authorized for issue by the Board of Trustees on April 17, 2007.

Note 2 - Significant accounting policies

The principal accounting policies applied in the preparation of these financial statements are set out below. These policies have been consistently applied to all the years presented.

Basis of financial statements

The accompanying financial statements, expressed in US dollars, are prepared on the basis of accounting practices prescribed for international agricultural research centers (Accounting Policies and Reporting Practices Manual - Financial Guidelines No. 2) under the auspices of the CGIAR.

The preparation of financial statements in conformity with CGIAR requires the use of accounting estimates and assumptions concerning the future. The resulting accounting estimates will, by definition, seldom equal to related actual results. It also requires management to exercise its judgment in the process of applying the Institute's accounting policies.

Revenue recognition

Grants are recognized as revenue upon the substantial fulfillment of the conditions attached to them, regardless of the period when it is intended to be used, or when the donor has explicitly waived the conditions. Grants are classified according to the type of restrictions attached to them.

Unrestricted grants are grants received which the Institute may freely use for its mandated activities. Unrestricted grants are recognized in full in the period specified by the donor.

Restricted grants and challenge program are grants received in support of specified projects or activities mutually agreed upon by the Institute and donors, and labeled as permanently or temporarily restricted. Revenue is recognized to the extent of expenses actually incurred. Excess of grants received over expenses, representing grants applicable to succeeding years, are shown as "Accounts payable - donors" account in the statement of financial position.

Grants in kind are recorded at the fair value of the assets received while cash grants are recorded at its US dollar equivalent.

Expense recognition

Expenses are recognized when a decrease in future economic benefit related to a decrease in an asset or an increase in a liability has arisen that can be measured reliably. Expenses are recognized on the basis of a direct association between the costs incurred and the earning of specific items of revenue.

Cash and cash equivalents

Cash includes cash on hand and in banks. Cash equivalents are short-term, highly liquid investments that are both (a) readily convertible to known amounts of cash and (b) so near maturity date that they present insignificant risk of changes in value. These investments, as distinguished from short term investments are those that are acquired with original maturities of three months or less.

Short term investments

These consists of investments that are (a) acquired with original maturities of more than three months but not exceeding one year, and (b) those that are originally long-term in nature but are currently due to mature within one year of the balance sheet date.

Accounts receivable

Accounts receivable are carried at gross amount less an allowance for any uncollectible amounts. Allowance for doubtful accounts is based on past experience and on a continuous review of receivable aging reports and other relevant factors.

When an accounts receivable is deemed doubtful of collection, the Institute provides an allowance for doubtful debt during the year in which it is deemed doubtful.

Any receivable or a portion thereof adjudged to be uncollectible is written-off. The write-off is done after all efforts to collect have been exhausted.

Inventories

Inventories are stated at the lower of cost or net realizable value. Cost, which includes the purchase price plus cost of freight, installation and handling charges, is determined using the moving-average method.

Property and equipment

Property and equipment acquired prior to 1991 are carried at cost or estimated value; acquisitions starting 1991 are stated at cost. Capital expenditures with a minimum cost of US\$500 or its equivalent and with an estimated life beyond one year are capitalized. The cost of an item of property and equipment comprises its purchase price and all other incidental cost in bringing the assets to its working condition for its intended use. Depreciation of all assets which are owned by the Institute is computed using the straight-line method over the estimated useful lives of the related assets, as follows:

Category description	Estimated life in years
Physical facilities	
Building and improvements	60
Infrastructure	
Site improvements	25
Furnishing and equipment	
Farming	
Farm machinery and equipment	7-10
Shop machinery and equipment	7-10
Laboratory	5-10
Office	5-10
Auxiliary units	5-10
Vehicles	4-7
Computers	3-5

Depreciation is charged from the month an asset was placed in operation and is continued until the asset has been fully depreciated or its use is discontinued.

Property and equipment acquired through the use of grants restricted for a specific project are recorded as assets. Such assets are depreciated at a rate of 100% in the year of purchase. The depreciation expense is charged directly to the appropriate restricted project.

Long term investments

Investments are initially recorded at their acquisition cost if they are purchased and at their fair market value if they are received as grants. Investments in equity securities and debt securities are re-measured at their market value as of the reporting date. Investments acquired with the intention of keeping the same for more than a year from the acquisition date and which are not maturing within one year as of the reporting date, are classified as long term investment.

Accruals

Accruals represent liabilities to pay for goods or services that have been received, supplied, invoiced or formally agreed with suppliers.

Provisions

Provisions are recognized when the Institute has: (a) a present legal or constructive obligation as a result of past events, (b) it is more likely than not that an outflow of resources will be required to settle the obligation, and (c) a reliable estimate of the amount can be made. Provisions are measured at the present value of management's best estimate of the expenditure required to settle the present obligation at the statement of financial position date.

When there are a number of similar obligations, the likelihood that an outflow will be required in the settlement is determined by considering the class of obligations taken as a whole. A provision is recognized even if the likelihood of an outflow with respect to any one item included in the same class of obligations may be small.

Leases

Leases of property where a significant portion of the risks and rewards of ownership are retained by the lessor are classified as operating leases. Payments made under operating leases are charged to operations on a straight-line basis over the period of the lease.

Foreign currency transactions and translations

Foreign currency denominated transactions are translated to US dollars for reporting purposes at standard bookkeeping rates which approximate the exchange rates prevailing at the dates of the transactions. Exchange differences arising from (a) the settlement of foreign currency-denominated monetary items at rates which are different from which they were originally booked; and (b) the translation of balances of foreign-currency denominated monetary items are credited or charged to operations during the year.

Nationally Recruited Staff (NRS) Provident Fund

The Institute maintains a noncontributory provident fund for the benefit of its nationally recruited staff. Monthly contribution to the fund is computed at 10.5% of an employee's monthly basic salary which is remitted to trustee-administered funds. The fund provides for lump-sum payment to qualified employees/members, upon their separation from the Institute, under certain conditions.

Recovery of indirect costs

The pooling of direct and indirect costs is based on the principle of attribution and assignability. Expenditures are pooled to different resource user units (cost centers) by direct identification. Expenditures that are common to the different cost centers are allocated on the basis of resource drivers. Non-operating and non-recurring expenditures are excluded in the computation.

Direct and indirect costs exclude capital expenditures but include depreciation in the case of core projects. For restricted projects, the indirect cost rates may include capital expenditures depending on the terms and conditions of the relevant agreements.

The method of calculating the indirect cost recovery rate is prescribed in the CGIAR Financial Guidelines No. 5.

Subsequent events

Post-year-end events that provide additional information about the Institute's situation at the statement of financial position date (adjusting events) are reflected in the financial statements, if any. Post-year-end events that are not adjusting events are disclosed in the notes when material.

Note 3 - Cash and cash equivalents

This account consists of:

	2006	2005
Cash on hand and in banks	5,917	6,456
Cash equivalents	11,120	15,405
	17,037	21,861

Note 4 - Short term investments

This account consists of:

	2006	2005
With original maturities of more than 3 months but less than one year	22	19
Long term investments due to mature within one year	2,630	20
	2,652	39

Note 5 - Accounts receivable - donors

This account consists of outstanding approved unrestricted grants and expenses not yet reimbursed on account of restricted and challenge programs projects.

	2006	2005
Unrestricted	1,283	2,826
Restricted	2,251	3,988
Challenge programs	306	158
	3,840	6,972
Allowance for doubtful accounts	(52)	(96)
	3,788	6,876

Note 6 - Accounts receivable - others

This account consists of:

	2006	2005
Advances to suppliers	1,133	1,563
Others	421	244
	1,554	1,807

Note 7 - Inventories

This account consists of:

	2006	2005
Spare parts	501	551
Supplies and other inventories	302	239
	803	790
Allowance for obsolescence	(248)	(315)
	555	475

Note 8 - Property and equipment

The details of property and equipment at December 31, 2006 and their movements during the year consist of:

	Physical facilities	Infrastructure and leasehold	Furnishing and equipment	Total
At December 31, 2005				
Cost	123	692	34,339	35,154
Accumulated depreciation	(26)	(224)	(26,380)	(26,630)
Net book value	97	468	7,959	8,524
Year ended December 31, 2006				
Opening net book value	97	468	7,959	8,524
Cost				
Additions	-	352	3,100	3,452
Disposal	-	-	(4,015)	(4,015)
Accumulated Depreciation				
Depreciation expense for the year	(2)	(27)	(1,968)	(1,997)
Disposal	-	-	3,919	3,919
Closing net book value	95	793	8,995	9,883
At December 31, 2006				
Cost	123	1,044	33,424	34,591
Accumulated depreciation	(28)	(251)	(24,429)	(24,708)
Net book value	95	793	8,995	9,883

The details of property and equipment at December 31, 2005 and their movements during the year consist of:

	Physical facilities	Infrastructure and leasehold	Furnishing and equipment	Total
At December 31, 2004				
Cost	123	657	34,679	35,459
Accumulated depreciation	(24)	(205)	(26,103)	(26,332)
Net book value	99	452	8,576	9,127
Year ended December 31, 2005				
Opening net book value	99	452	8,576	9,127
Cost				
Additions	-	35	1,541	1,576
Disposal	-	-	(1,881)	(1,881)
Accumulated Depreciation				
Depreciation expense for the year	(2)	(19)	(2,025)	(2,046)
Disposal	-	-	1,748	1,748
Closing net book value	97	468	7,959	8,524
At December 31, 2005				
Cost	123	692	34,339	35,154
Accumulated depreciation	(26)	(224)	(26,380)	(26,630)
Net book value	97	468	7,959	8,524

Assets purchased through the use of restricted grants are reported as part of Institute assets but are depreciated 100% in the year of purchase. The total of said assets amounted to US\$2,545 thousand and US\$4,841 thousand in 2006 and 2005, respectively.

Depreciation expense amounted to US\$1,997 thousand and US\$2,046 thousand in 2006 and 2005, respectively.

Note 9 - Long term investments

As of December 31, 2006 and 2005, long term investments consist of deposit instruments of varying amounts held in custody by four financial institutions.

Note 10 - Accounts payable - donors

This account consists of grants received in advance applicable to succeeding years.

	2006	2005
Unrestricted	836	1,194
Restricted	3,537	4,123
Challenge programs	1,279	1,065
	5,652	6,382

Note 11 - Accounts payable - others

This account consists mainly of accrued project scientists' allowances and benefits, and training charges of research fellows and trainees, such as stipend, board and lodging and other direct expenses to be paid by the Institute. This account also includes funds provided by donors, which are managed by the Institute, with non-CGIAR centers as ultimate beneficiaries.

Note 12 - Accruals and provisions

This account consists of:

	2006	2005
Accruals		
Trade	1,920	1,961
Capital projects	29	69
Others	2,539	2,736
	4,488	4,766
Provisions	2,739	2,344
	7,227	7,110

Provisions consist of accumulated leave credits due to staff as of December 31, 2006 and 2005 based on current personnel policy manual, in addition to repatriation costs of internationally recruited staff.

Note 13 - Nationally Recruited Staff (NRS) Provident Fund

The Institute maintains a noncontributory provident fund for the benefit of its nationally recruited staff. The fund is administered by a Retirement Committee with the Fund managed by two Trustee Banks based on approved investment guidelines as contained in the Trust Agreement. Contributions to the fund amounted to about US\$360 thousand and US\$299 thousand in 2006 and 2005, respectively.

Note 14 - Net assets

The movements in Research Initiative Fund are shown below:

	GRCEGD*	Frontier Projects	Strategic Research Initiative	Africa and Needy Countries	Knowledge Pathways Initiative	Total
Balances, January 1, 2005	7,549	-	-	-	1,201	8,750
Board of Trustees appropriation	(7,549)	10,000	2,043	1,000	(44)	5,450
Net deficit for the year	-	-	(1,215)	(256)	(267)	(1,738)
Balances, December 31, 2005	-	10,000	828	744	890	12,462
Net deficit for the year	-	(310)	(415)	(591)	(189)	(1,505)
Balances, December 31, 2006	-	9,690	413	153	701	10,957

Designated

On October 12, 2006, the Board of Trustees approved the re-designation of US\$6,632 thousand and US\$3,368 thousand from the Staff Separation Reserve and Capital Reserve, respectively, to GRC Operations Reserve.

On September 16, 2005, the Board of Trustees approved the re-designation of US\$3,261 thousand and US\$7,549 thousand and US\$44 thousand from the Fixed Assets Acquisition Reserve, Genetic Resources Conservation, Evaluation and Gene Discovery (GRCEGD) and Knowledge Pathways Initiative Fund respectively, to Frontier Projects and Africa and Needy Countries.

Net assets amounting to US\$43,463 and US\$45,339 as of December 31, 2006 and 2005, respectively, have been designated by the Institute's Board of Trustees as shown in the statements of changes in net assets.

Undesignated

The Institute does not have undesignated net assets as of December 31, 2006 and 2005.

Note 15 - Leases

- a. On September 7, 2001, the Institute renewed its lease agreement for research facilities with the University of the Philippines System (University). The new lease agreement, which took effect on July 1, 2000, is for a period of 25 years up to June 30, 2025, and is renewable upon mutual agreement of the parties. Under the terms of the agreement, the following provisions apply:
- i. The Institute will pay a rental of one peso every year for the parcels of land used as sites for its laboratories, office and service buildings and housing. In addition and continuing the past practice of providing the equivalent in cash of the approximate value of agricultural products that otherwise could be grown on this land, the Institute provided a lump-sum, and non-reimbursable financial assistance to the University in the amount of US\$375,000.
 - ii. For the duration of the lease, the Institute will also contribute to the cost of development and maintenance of the University road network, utilities, other infrastructure, health services, sanitary landfill management, security, etc. outside the leased land, in the amount of US\$12,500 per year. Upon signing of the agreement, the first 10-year payment (US\$125,000) was paid as a lump-sum, and the remainder will be paid in annual installments starting from the 11th year of the lease.
 - iii. Pursuant to the Memorandum of Understanding between the Government of the Republic of the Philippines and the Institute, all the physical plant, equipment and other assets belonging to the Institute shall become the property of the University when and if the Institute ceases its operation.
 - iv. In support of any expansion of the agricultural research program of the Institute and the University, the Philippine Government authorized the University to acquire, by negotiated sale or by expropriation, private agricultural property under PD No. 457.
- b. The Institute signed a lease contract with Hewlett Packard for a seat management agreement involving the lease of computers and other bundled services. The lease is effective for 3 years beginning from October 2004.
- c. The Institute also leases land and other properties from third parties for project experimental sites with periods ranging from one to five years.

The leases mentioned above are accounted for as operating lease.

Note 16 - Other revenues

This account consists of:

	2006	2005
Investment income	1,690	1,130
Realized foreign exchange gain	318	293
Self-sustaining activities	143	306
Miscellaneous	118	129
	<u>2,269</u>	<u>1,858</u>

Note 17 - Indirect cost recovery rate

The indirect cost recovery rate computed as per the CGIAR Financial Guideline No. 5 is 21.01% and 20.99% in 2006 and 2005, respectively. The computation of indirect cost recovery rate is shown on Exhibit 4.

Note 18 - Contingencies

The Institute has certain pending legal lawsuits and disputes. Management, however, believes that the ultimate outcome of these lawsuits and disputes will not materially affect the Institute's financial position and the results of its activities.

INTERNATIONAL RICE RESEARCH INSTITUTE

SCHEDULES OF GRANT REVENUE
FOR THE YEAR ENDED DECEMBER 31, 2006

(All amounts in thousand US Dollars)

With Comparative figures for the year ended December 31, 2005

Donors	2006				Grant 2005
	Total Funds Available	Accounts Receivable	Advance Payment	Grant	
Unrestricted Agenda					
Australia	1,129		(566)	563	616
Canada	953			953	863
China		140		140	140
Denmark	480			480	443
Germany	381			381	158
Japan		882		882	1,831
Korea	150			150	150
Netherlands	410			410	432
Norway	323			323	303
Philippines	75	13		88	97
Sweden	748		(270)	478	509
Switzerland	494			494	497
Thailand	(40)	80		40	40
United Kingdom	2,171			2,171	2,017
United States	3,200			3,200	3,200
Vietnam	15			15	15
World Bank	1,900	168		2,068	1,550
Sub-total	12,389	1,283	(836)	12,836	12,861

Donors	2006			Grant	Grant 2005
	Total Funds Available	Accounts Receivable	Advance Payment		
Permanently Restricted					
Agenda					
Asian Development Bank (ADB)	757	376		1,133	789
Australia	433	57	(47)	443	356
Brazil	20		(20)		
Canada	61		(18)	43	106
European Commission	563		(353)	210	1,930
Food and Agricultural Organization of the United Nations (FAO)	10			10	
France	483			483	472
Germany	1,169		(309)	860	1,004
Global Crop Diversity Trust	230		(12)	218	
Grain Biotech Australia (GBA)	20			20	19
Grand Challenges in Global Health through Albert - Ludwigs University of Friedburg	168		(1)	167	
HTSPE Limited					92
India	450			450	150
International Development Research Centre (IDRC)					16
International Fund for Agricultural Development (IFAD)	496	267	(82)	681	468
International Fertilizer Industry Association (IFA)/ International Plant Nutrition Institute (IPNI)/ International Potash Institute (IPI)	179	19		198	146
Iran	340		(277)	63	78
Japan	884	1,100	(436)	1,548	1,204
Korea	1,107		(414)	693	648
Malaysia	70		(38)	32	
Mexico	10			10	
Monsanto Fund	4	2		6	90
Nunhems BV	41		(8)	33	21
Philippines	80	11	(35)	56	55
Rockefeller Foundation (RF)	833		(356)	477	830
Switzerland	1,402	207	(298)	1,311	1,517
United Kingdom	96			96	187
United States United States Agency for International Development (USAID)	1,264		(785)	479	311
United States Department of Agriculture (USDA)	6	88		94	74
World Bank	456	119	(17)	558	528
Others	68	5	(31)	42	94
Sub-total	11,700	2,251	(3,537)	10,414	11,185
Total Agenda Grants	24,089	3,534	(4,373)	23,250	24,046

EXHIBIT 1

Donors	2006			Grant	2005
	Total Funds Available	Accounts Receivable	Advance Payment		
Challenge Program					
Water and Food	2,831	90	(441)	2,480	2,653
Generation	2,152	124	(690)	1,586	1,745
Harvest Plus	650	92	(148)	594	493
Sub-total	5,633	306	(1,279)	4,660	4,891
Total grants	29,722	3,840	(5,652)	27,910	28,937

INTERNATIONAL RICE RESEARCH INSTITUTE

SCHEDULES OF TEMPORARILY RESTRICTED AGENDA FUNDING AND
CHALLENGE PROGRAMS FUNDINGS
FOR THE YEAR ENDED DECEMBER 31, 2006
(All amounts in thousand US Dollars)

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2006	Total
TEMPORARILY RESTRICTED AGENDA					
<i>Asian Development Bank (ADB)</i>					
Development and Dissemination of Water-Saving Rice Technologies in South Asia	01/01/06 - 31/05/09	1,000		256	256
Improving Poor Farmer's Livelihood Through Post-Harvest Technology	11/07/05 - 31/12/08	750	58	180	238
Improving Poor Farmer's Livelihood Through Rice Information Technology	19/11/04 - 19/11/08	1,000	26	280	306
Enhancing Farmers' Income and Livelihoods Through Integrated Crop and Resource Management in the Rice-Wheat System in South Asia	01/01/05 - 31/12/07	700	191	215	406
Integrating and Mobilizing Rice Knowledge to Improve and Stabilize Crop Productivity to Achieve Household Food Security in Diverse and Less Favorable Rainfed Areas of Asia	01/01/04 - 31/12/07	900	523	202	725
		4,350	798	1,133	1,931
<i>Australia</i>					
Training Workshop on Evaluation Training for Agricultural Research Projects for Papua New Guinea Researchers and Officials	24/04/06 - 01/06/06	11		11	11
Impact of Migration and/or Off-farm Employment on Roles of Women and Appropriate Technologies in Asian and Australian Mixed Farming Systems	01/07/04 - 31/12/07	379	127	131	258
Implementation of Rodent Management in Intensive Irrigated Rice Production Systems in Indonesia and Vietnam	01/04/06 - 30/09/09	90		21	21
Further Development of ICIS by Collaboration with Value Added Wheat CRC, Australia	01/07/06 - 30/06/08	28		2	2
Fertilization-Independent Formation of Embryo, Endosperm and Pericarp for Apomictic Hybrid Rice	01/07/03 - 30/06/08	1,090	518	237	755
Training Workshop on Application of Participatory Approaches to Agricultural Research and Extension	20/07/06 - 18/09/06	6		6	6
Training Needs Assessment of Seeds of Life Program in East Timor	17/09/06 - 23/09/06	20		20	20
Training Workshop on Leadership for Asian Women in Agriculture R & D and Extension	27/11/06 - 08/01/07	4		4	4
Publication of Rice in Laos	11/07/06 - 30/06/07	15		11	11
		1,643	645	443	1,088

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Prior Years	Expenditures 2006	Total
Canada					
Developing Efficient Methods for Detecting Genes Enhancing Rice Drought Tolerance (CCLF)	01/04/04 - 31/03/07	119	58	43	101
European Commission					
Coordinating NGO Interventions for Improving Small and Marginal Farmer's Households, Livelihood and Food Security in Bangladesh	01/07/04 - 31/08/09	1,800	459	210	669
Food and Agriculture Organization of the United Nations (FAO)					
Improved Understanding of How Irrigation System Managers Deal with the Effects of Major Droughts on Water Supplies	17/10/05 - 30/10/06	10		10	10
France					
IRRI/France Collaborative Projects	01/01/06 - 31/12/06	483		483	483
Germany					
Food Security and Commercialization in Uplands of Northern Vietnam	01/10/03 - 28/02/06	23	9	14	23
Nutrient Management in Aerobic Rice Systems	01/07/05 - 30/06/08	194	24	53	77
Applying Genetic Diversity and Genomic Tools to Benefit Rice Farmers at Risk from Drought	01/02/04 - 31/12/07	606	204	230	434
From Genes to Farmers' Fields: Enhancing and Stabilizing Productivity of Rice in Submergence Prone Environments	01/01/04 - 31/12/06	843	512	253	765
Managing Crop Residues for Healthy Soils in Rice Ecosystems	01/04/03 - 30/07/07	1,417	1,105	310	1,415
		3,083	1,854	860	2,714
Grain Biotech Australia					
IRRI Collaborative Project on "Further Development of the International Crop Information System"	01/08/04 - 31/07/06	60	20	20	40
Global Crop Diversity Trust					
Long-term funding of the Situ Collection of Rice Germplasm held by IRRI	01/11/06 - 31/10/07	200		200	200
Development of a Global Strategy for the Ex Situ Conservation of Rice	01/04/06 - 31/03/07	60		18	18
		260		218	218
Grand Challenges in Global Health through Albert-Ludwigs University of Friedburg					
ALUF/GCGH - Engineering Rice for High Beta-Carotene, Vitamin E and Enhanced Iron and Zinc Bioavailability	28/09/05 - 30/06/07	326		167	167
India					
IRRI/India Collaborative Project	01/01/06 - 31/12/06	150		150	150
Transgenic in Rice	01/01/06 - 31/12/06	200		200	200
Biotic and Abiotic Stress					
Bio-fortification					
Functional Genomics	01/01/06 - 31/12/06	100		100	100
		450		450	450

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2006	Total
<i>International Fund for Agricultural Development (IFAD)</i>					
Managing Rice Landscapes in the Marginal Uplands for Household Food Security and Environmental Sustainability	26/07/05 - 30/09/08	1,190	127	222	349
Accelerating Technology Adoption to Improve Rural Livelihood in the Rainfed Eastern Gangetic Plains	22/09/03 - 30/06/07	1,500	809	459	1,268
		2,690	936	681	1,617
<i>International Fertilizer Industry Association (IFA)/International Plant Nutrition Institute (IPNI)/International Potash Institute (IPI)</i>					
Reaching Toward Optimal Productivity in Intensive Rice Systems : The Development, Evaluation and Delivery of Site-Specific Nutrient Management in Myanmar	01/01/06 - 31/12/06	5		5	5
The Irrigated Rice Research Consortium Phase III-Site Specific Nutrient Management	01/01/05 - 31/12/08	432	43	193	236
		437	43	198	241
<i>Iran</i>					
Scientific & Technical Cooperation between IRAN & IRRI	01/01/99 - 31/12/07	1,270	930	63	993
<i>Japan</i>					
Germplasm Conservation, Characterization, Documentation and Exchange: Rice and Biofertilizer Genetic Resources Conserved and Characterized	01/01/06 - 31/12/06	200		200	200
Functional Genomics	01/01/06 - 31/12/06	200		200	200
Genetic Enhancement for Yield, Grain Quality, and Stress Resistance	01/01/06 - 31/12/06	200		200	200
Managing Resources under Intensified Rice-Based Systems	01/01/06 - 31/12/06	200		200	200
Genetic Enhancement for Improving Productivity and Human Health in Fragile Environments: Superior Germplasm Developed for Rainfed Lowlands					
Superior Germplasm Developed for Flood-Prone and Infertile Lowlands					
Superior Germplasm Developed for Infertile Uplands					
Aerobic Rice Germplasm Developed for Water-Scarce Tropical Environment	01/01/06 - 31/12/06	100		100	100
Natural Resource Management for Rainfed and Upland Rice Ecosystems	01/01/06 - 31/12/06	200		200	200
Development of Integrated Rice Cultivation System Under Water Saving Conditions	01/10/04 - 30/09/09	1,424	119	398	517

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures		Total
			Prior Years	2006	
Capacity Building to Enhance IRRI-NARS Future Collaboration	01/11/06 - 31/03/07	10		1	1
Training Course on Upland Rice Variety Selection Techniques - For African Countries	15/09/06 - 30/11/06	10		10	10
Collaborative Research on Socioeconomic Constraints to Adoption of Technology and Farmer's Response	01/04/05 - 31/03/07	56	8	39	47
		2,600	127	1,548	1,675
<i>Korea</i>					
Korea Support to IRRI's Program Wide Hybridization and Gene Introgression for Rice Improvement/Broadening Gene Pool of Rice: Wild Species Introgression and Marker Assisted Selection	01/01/06 - 31/12/06	50		50	50
Rice Functional Genomic Approach Against Rice Blast Disease /Functional Genomics Approach to Identification of Broad-Spectrum Resistance Genes Against Rice Blast Disease in Korean Germplasm	01/07/03 - 31/08/09	240	127	34	161
Cooperative Funding for Korea-IRRI Collaborative Projects	01/01/99 - 31/12/06	410	297	11	308
Korea-IRRI Collaborative Project (Germplasm Utilization and Value- Added)	01/01/01 - 31/12/06	275	143	27	170
IRRI Korea Office	17/11/01 - 31/12/06	1,250	1,008	196	1,204
Large Scale Korean Seed Multiplication Project	01/11/05 - 30/04/06	112	16	96	112
Improvement of Water Management to Control Non-point Pollution from Rice Paddy Field	20/04/04 - 31/12/06	10	4	6	10
Development of Japonica Cultivars with Pyramided Genes for Resistance to Bacterial Blight	01/01/06 - 31/12/07	5		5	5
Elucidation of the Causal Agents for Yellowing Syndrome of Rice	01/01/06 - 31/12/07	5		5	5
Study on Utilization and Evaluation of Hybrid Rice	01/01/06 - 31/12/07	5		5	5
Breeding for Super High-Yielding Rice Variety	01/01/06 - 31/12/07	5		2	2
A Comparative Study of Women's Role and their Status in Societies under Semi-subsistence and Commercialized Agriculture in the Philippines, Vietnam and Korea	01/01/06 - 31/12/07	5		2	2
Major Characteristics Evaluation of Early Maturing Japonica Rice (MEJR)	12/26/06 - 30/11/07	30			
Molecular Characterization and Allele Mining of Korean Rice Germplasm and Extension to the IRRI Core Collection	01/09/04 - 31/08/06	40	19	21	40

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures		Total
			Prior Years	2006	
Development of Water Saving Technology for Increasing Water Productivity in Rice Cultivation	01/04/04 - 31/05/07	48	22	20	42
Breeding for Micronutrient-Enriched Japonica Rice for Improving Human Health	01/04/05 - 31/03/08	100	15	58	73
Identification of Resistance Genes for Biotic Stresses in Rice Through the Location/Expression Candidate Association Approach	01/01/06 - 31/12/08	90		27	27
Korean Seed Multiplication Project	01/07/91 - 31/12/06	355	232	64	296
		3,275	1,969	693	2,662
Malaysia					
The Impact of Rice Production on Environmental Sustainability	01/09/05 - 30/09/08	90		17	17
Genetic Enhancement of High Quality Rice	01/01/06 - 30/12/08	40		15	15
		130		32	32
Mexico					
IRRI/Mexico Collaborative Project for Arroz Hibrido	01/01/06 - 31/12/06	10		10	10
MONSANTO FUND					
Improving the analytical capability of IRRI in support of the nutritional improvement of rice grains and the dissemination of modern nutritional information to under-served Asian populations	23/06/04 - 22/06/07	220	168	6	174
NUNHEMS B.V.					
Further Development of International Crop Information Systems (ICIS) in collaboration with Nunza	01/04/02 - 31/03/06	80	59	21	80
Further Development of ICIS in collaboration with Nunhems - Phase II	01/04/06 - 31/03/10	80		12	12
		160	59	33	92
Philippines					
Assessing the Impact of Potential Trade Liberalization of the Philippine Rice Sector	01/04/02 - 30/06/07	38	30	8	38
Hybrid Nucleus and Breeder Seed Production (PhilRice - UPLB- IRRI)	16/01/04 - 15/01/08	17	11	6	17
Improving Knowledge Exchange and Decision Making Among Rice Stakeholders Through ICT-based Technology Promotion and Delivery Systems	01/01/06 - 31/12/08	67		12	12
Developing New Plant Type for Direct Seeding Rice Production Systems in the Philippines	20/05/04 - 19/05/07	90	46	30	76
		212	87	56	143

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures		Total
			Prior Years	2006	
Rockefeller Foundation (RF)					
Using Entertainment-Education (EE) Approach to Motivate Rice Farmers to Reduce Pesticide Use in the Mekong Basin	01/01/03 - 30/06/06	300	291	9	300
Detecting Alleles Conferring Improved Reproductive-Stage Drought Tolerance in Rainfed Rice	01/04/04 - 31/03/07	276	192	70	262
Developing and Disseminating Resilient and Productive Rice Varieties for Drought-Prone Environments in India	01/03/05 - 28/02/08	610	141	144	285
Introgression of Genes for Drought Tolerance from <i>Oryza glaberrima</i> into <i>indica</i> rice	01/04/05 - 31/03/08	76	21	25	46
International Rice Genetics Symposium Research and Training Cost in Advance Techniques of Biotechnology at ARBN Laboratory of IRRI	01/05/05 - 30/04/06	50	41	9	50
Tilling of Rice (Identification and Characterization of Genes that have the Potential to Enhance Drought Tolerance in Rice)	01/01/05 - 31/12/06	25	5	20	25
Tilling of Rice (Identification and Characterization of Genes that have the Potential to Enhance Drought Tolerance in Rice)	01/09/03 - 28/02/07	125	60	50	110
Pathway Dissection and Candidate Gene Identification for Drought Tolerance in Rice by a Forward Genetics Approach	01/03/05 - 28/02/08	582	156	36	192
Marker Aided Pyramiding of QTLs for Development of Drought Tolerant IR64	01/04/02 - 30/09/06	117	116	1	117
Screening Methods for Improving Grain Yield under Reproductive Drought Stress in Rainfed Rice	01/04/02 - 30/09/06	446	437	9	446
Molecular Dissection and Marker Assisted Breeding of Drought Tolerance in Rice	01/04/05 - 30/09/06	107	44	63	107
Mass Screening of Rice for Drought Tolerance	01/04/05 - 30/09/06	131	91	40	131
Economic Costs of Drought and Rainfed Farmers' Coping Mechanism	01/04/02 - 30/09/06	93	92	1	93
		2,938	1,687	477	2,164
Switzerland					
Lao-IRRI - Rice Research and Training Project Phase V	01/07/03 - 30/09/06	2,215	1,755	460	2,215
Lao PDR - Rice Research and Training Project - Transition Budget	01/10/06 - 30/09/07	418		77	77
The Irrigated Rice Research Consortium – Phase III					
Irrigated Rice Research Consortium Management Team	01/01/05 - 31/12/08	1,446	183	374	557
Productivity Workgroup	01/01/05 - 31/12/08	402	107	89	196
Water Saving Workgroup	01/01/05 - 31/12/08	356	70	51	121
Labor Productivity	01/01/05 - 31/12/08	356	65	87	152
Post Production Workgroup	01/01/05 - 31/12/08	353	91	81	172
Lao PDR Rice Biodiversity Project, Phase 2	01/01/03 - 30/09/06	425	359	66	425
Rice Mutant Bank and Resource Platform for Functional Genomics	01/08/01 - 31/01/06	975	949	26	975
		6,946	3,579	1,311	4,890

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures		Total
			Prior Years	2006	
<i>United Kingdom</i>					
Validation and Promotion of Technologies for Rice Sheath Blight Management	01/02/05 - 31/07/06	45	22	18	40
Promotion of Weed Management Options for Irrigated Rice in India: IRRI Component	01/04/05 - 31/01/06	77	51	26	77
Rice Weed Decision Support : IRRI Component	01/04/05 - 31/01/06	55	22	33	55
Managing Rice Pest in Bangladesh: Improving Extension Service Information Management for Policy Planning	01/02/05 - 31/01/06	31	12	19	31
		208	107	96	203
<i>United States</i>					
<i>United States Agency for International Development (USAID)</i>					
Testing, Comparing, NuMaSS: The Nutrient Management Support System	01/09/03 - 30/09/07	51	25	12	37
Development of Rice Biotechnology Products for Asia: Technical and Pre-regulatory Components	01/01/05 - 31/12/07	1,260	167	274	441
KSU - CCGI Identification and Functional Validation of Genes Conditioning Broad-Spectrum Disease Resistance in Rice and Pearl Millet	01/03/04 - 30/09/06	275	170	105	275
KSU - CCGI An Information System to Link Genotype to Phenotype Comparatively Across Diverse Cereal Crops	01/03/04 - 30/09/06	57	9	48	57
The Development of Adapted Germplasm for India with High Levels of Pro Vitamins Carotenoids	01/01/05 - 31/12/07	385		21	21
Ecological based Participatory IPM for Southeast Asia (Led by Clemson University - IPM-CRSP)	01/10/05 - 30/09/07	34		19	19
		2,062	371	479	850
<i>United States Department of Agriculture (USDA)</i>					
Participatory Assessment of Social and Economic Impacts of Biotechnology	15/09/01 - 31/03/06	120	77	37	114
KSU - Contribution of Three Defense Response Genes in Quantitative Disease Resistance	01/07/03 - 30/06/07	134	108	8	116
Enabling Open Access to IRRI-Assisted Theses and Dissertations Funding Proposal	30/09/06 - 30/09/07			4	4
Tilling and Ecotilling Resources of Japonica and Indica Rice	01/04/04 - 31/03/07	90	7	45	52
		344	192	94	286

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures		Total
			Prior Years	2006	
<i>World Bank</i>					
Upgrading the International Rice Gene Bank Collection at IRRI	01/01/03 - 31/12/06	1,164	908	256	1,164
Advanced Research Networking for the CGIAR	01/08/04 - 31/05/06	112	109	3	112
Environment Radio Soap Opera for Rural Vietnam	01/07/05 - 15/06/07	132		95	95
Project on Security and Business Continuity	01/03/04 - 31/12/06	441	129	204	333
		1,849	1,146	558	1,704
<i>Others</i>					
		155	26	42	68
Total Temporarily Restricted Agenda		38,090	15,261	10,414	25,675
CHALLENGE PROGRAMS					
Water and Food	01/11/02 - 31/10/09	12,837	3,608	2,480	6,088
Generation	01/01/04 - 28/02/08	5,710	2,485	1,586	4,071
Harvest Plus	01/01/03 - 31/12/07	2,237	969	594	1,563
Total Challenge Program Fundings		20,784	7,062	4,660	11,722
GRAND TOTAL		58,874	22,323	15,074	37,397

EXHIBIT 3

INTERNATIONAL RICE RESEARCH INSTITUTE

DETAILS OF OPERATING EXPENSES
FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005
(All amounts in thousand US Dollars)

	Program Related				Management and General			Total	2005
	Research	Research	Operations	Sub-Total	Management	General			
	Programs	Support				Administration	Sub-Total		
UNRESTRICTED									
Personnel Costs	5,031	740	1,691	7,462	2,198		2,198	9,660	8,153
Supplies & Services	1,604	468	1,178	3,250	795	2,827	3,622	6,872	7,864
Collaborators/Partners	344			344				344	243
Operational Travel	909	75	25	1,009	96	6	102	1,111	1,008
Depreciation	687	165	624	1,476	61	227	288	1,764	1,807
Total Operating Expenses	8,575	1,448	3,518	13,541	3,150	3,060	6,210	19,751	19,075
Recovery of Indirect Cost						(1,274)	(1,274)	(1,274)	(1,266)
Sub-Total	8,575	1,448	3,518	13,541	3,150	1,786	4,936	18,477	17,809
RESTRICTED									
Personnel Costs	3,761		20	3,781				3,781	4,296
Supplies & Services	3,418	26	269	3,713	196		196	3,909	3,801
Collaborators/Partners	1,277			1,277				1,277	1,311
Operational Travel	1,008	4	41	1,053	161		161	1,214	1,538
Depreciation	233			233				233	239
Sub-Total	9,697	30	330	10,057	357		357	10,414	11,185
CHALLENGE PROGRAMS									
Personnel Costs	961			961				961	851
Supplies & Services	1,177			1,177				1,177	1,090
Collaborators/Partners	2,196			2,196				2,196	2,590
Operational Travel	326			326				326	360
Sub-Total	4,660			4,660				4,660	4,891
Grand Total	22,932	1,478	3,848	28,258	3,507	1,786	5,293	33,551	33,885
Personnel Costs	9,753	740	1,711	12,204	2,198		2,198	14,402	13,300
Supplies & Services	6,199	494	1,447	8,140	991	2,827	3,818	11,958	12,755
Collaborators/Partners	3,817			3,817				3,817	4,144
Operational Travel	2,243	79	66	2,388	257	6	263	2,651	2,906
Depreciation	920	165	624	1,709	61	227	288	1,997	2,046
Sub-Total	22,932	1,478	3,848	28,258	3,507	3,060	6,567	34,825	35,151
Recovery of Indirect Cost						(1,274)	(1,274)	(1,274)	(1,266)
Grand Total	22,932	1,478	3,848	28,258	3,507	1,786	5,293	33,551	33,885

INTERNATIONAL RICE RESEARCH INSTITUTE
STATEMENTS OF OPERATING EXPENSES
FOR THE YEARS ENDED DECEMBER 31, 2006 AND 2005
 (All amounts in thousand US Dollars)

	2006	2005
Direct Operating Expenses		
Research	24,791	24,482
Research support	2,952	4,163
Operations	1,256	627
Subtotal	28,999	29,272
Less: Overhead recovery	(1,274)	(1,266)
Total	27,725	28,006
Indirect Operating Expenses		
Management	2,877	2,670
Common sustenance services	2,949	3,209
Total	5,826	5,879
Total Operating Expenses	33,551	33,885
Cost Ratios		
Direct/Total	82.64%	82.65%
Indirect/Total	17.36%	17.35%
Indirect/Direct	21.01%	20.99%



