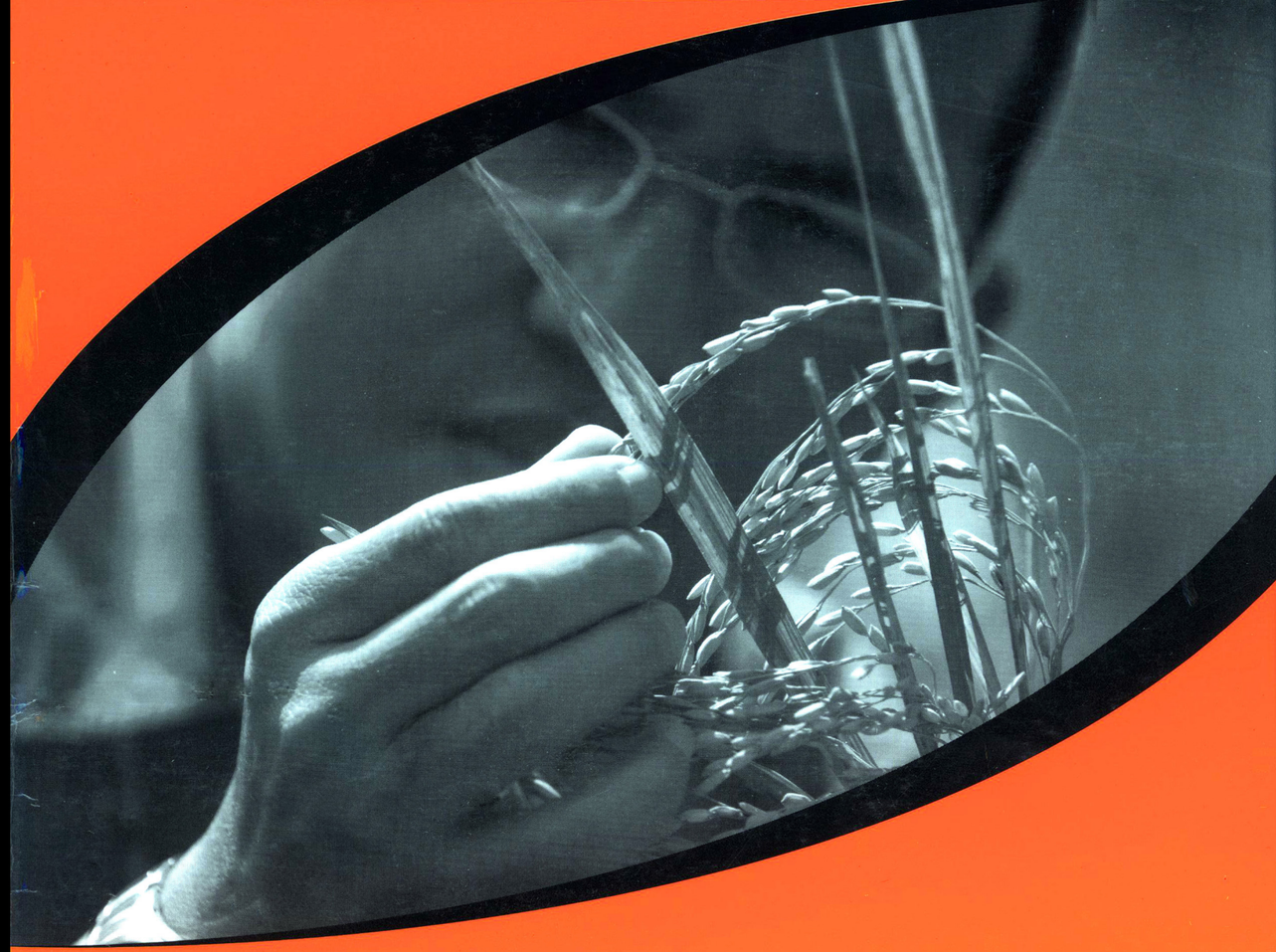
Rice Science for a Better World

Annual Report of the Director General, 2005-06

IRRI



Annual Report of the Director General, 2005-06

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

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

Mailing address: DAPO Box 7777, Metro Manila, Philippines
Phone: +63 (2) 580-5600
Fax: +63 (2) 580-5699
Email: irri@cgiar.org
Home page: www.irri.org.
Rice Knowledge Bank: www.knowledgebank.irri.org
Courier address: Suite 1009, Pacific Bank Building
6776 Ayala Avenue, Makati City, Philippines
Tel. +63 (2) 891-1236, 891-1174, 891-1258, 891-1303

Suggested citation:
IRRI (International Rice Research Institute). 2006. Annual report of the director general, 2005-06. Vol. 16. Los Baños (Philippines): International Rice Research Institute. 160 p.

Production team
Writers: Adam Barclay, Gene Hettel
Editors: Tess Rola, Bill Hardy, Gene Hettel
Design and layout: Mannie Panisales, George Reyes

Annual Report of the Director General, 2005-06

Volume 16, March 2006

An update from Robert Zeigler
DIRECTOR GENERAL

It is hard to believe that one year has already passed since my arrival as IRRI's eighth director general on 21 March 2005. In my remarks concluding the BOT meeting during which my family and I were officially welcomed back into the IRRI community on 1 April 2005, I stated that we had the feeling that we were returning home because we had been here previously during our formative years.

The rich Filipino culture and IRRI's unique set of values from both scientific and humanitarian points of view formed a fertile environment for the growth of my family. And the most important parts of my scientific and professional growth were right here at IRRI as well. This past year has simply reinforced these feelings as I see firsthand that the Institute continues to have major impact and make differences in people's lives like no other institution on the face of the Earth.

It's been a busy year of achievement and progress as we complete the research agenda of our current medium-term plan and chart activities for the next 10 years in our ongoing strategic planning. In this brief update, I will summarize some of the Institute's research discoveries and other significant endeavors. You can find more details elsewhere in this annual report.

RESEARCH PROGRESS IN 2005

The United Nations Millennium Development Goals (www.undp.org/mdg) have achieved much, but considerable work remains. To this end, rice research in general and IRRI in particular are as important as ever. In 2005, IRRI made strong progress in a broad range of research that has, can, and will contribute further to the Millennium Development Goals (MDGs)—especially goal 1, the eradication of extreme poverty and hunger. IRRI's role in these challenges has been further boosted by the Institute stepping up its research into rice grain quality and nutrition and so boosting the fight against the hidden hunger of nutrient deficiency that plagues much of the rice-eating world.

In 2005, IRRI consolidated its research and related activities into 11 projects under four programs—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 continues to be guided by and implemented through two research consortia—the Irrigated Rice Research Consortium and the Consortium for Unfavorable Rice Environments—which bring together IRRI scientists and their colleagues from the national agricultural research and extension systems (NARES) of the institute's partner countries.

The details of our research progress and achievements can be found starting on page 13.

CHARTING IRRI'S FUTURE

When I "fired the starting gun" during a Thursday seminar on 31 May to begin our strategic planning process that would lead, from that point to this writing, to the development of a new strategy, a business plan, and a medium-term plan, I challenged IRRI staff members to think big, but to make sure that we got that planning right. I pointed out that the social, political, economic, and technological environment today is very different from that when IRRI developed its current strategy, IRRI Toward 2020, in 1996. New science and technology, the changing nature of our national partners, and the increasing number of alternate suppliers of rice research, to name but a few items, are both challenges and opportunities for the Institute.

I am pleased with how the strategic planning process has played out, which began with a consultation workshop of 25 external experts on 8-10 August, which was followed immediately by a brainstorming workshop for a cross section of IRRI staff in Tagaytay on 16-17 August (photo). Then, the Annual Program Review, 14-15 November, was primarily devoted to fleshing out the five strategic goals that had evolved in previous meetings and workshops.

These goals center on (1) reducing poverty through improved and diversified rice-based systems; (2) ensuring that rice production is sustainable and stable, has minimal environmental impact, and can cope with climate change; (3) improving the nutrition and health of poor rice consumers and rice farmers; (4) providing equitable access to information and knowledge on rice and helping develop the next generation of rice scientists; and (5) providing rice scientists and producers with the genetic information and material they need to develop improved technologies and enhance rice production.

It is clear, especially with the first three goals listed, that IRRI is strategically linking its activities with the MDGs.

As of this writing, the strategic plan and the business plan for its implementation were nearly ready for sharing with the BOT, which will give final review and sign-off during its 5-7 April 2006 meeting. With BOT approval, IRRI will release in June 2006 a detailed publication that spells out our vision and plans for the next 10 years, which will be reviewed by the CGIAR Science Council in advance of the CGIAR Annual General Meeting later in the year.

A feature of this plan that sets it apart from other plans within the CGIAR community is our firm commitment to very forward looking projects that, if successful, will revolutionize agriculture for future generations of rice farmers and consumers—much like earlier innovations by IRRI have changed the face of rice-growing and -consuming Asia.

We look to adopt a major project on climate change that will surely transform the way rice is grown and bred. Likewise, a project on developing C4 rice will, if successful, create a rice plant that is able to withstand higher temperatures, use nitrogen fertilizer and water more efficiently, and yield 30% more with the same inputs.

IRRI is also progressing in developing rice lines that harbor endogenous N_2-fixing bacteria that will greatly reduce the plant's need for exogenously applied N fertilizer—something that will become increasingly important for the economics of rice growing and the health of the

environment. Finally, we will work to develop drought-tolerant rice for rainfed and water-limited irrigated environments. We believe that within 10 years we will have rice lines in the field that will produce well in the increasingly water-limited environments of Asia and sub-Saharan Africa. IRRI expects to provide seed money for these projects from our strategic reserves with the expectation that interested donors will join us in supporting these visionary activities.

FUNDING

When IRRI management updated the BOT during its September 2005 meeting in Bali, Indonesia, on funding and expenditures for the Institute's 2005 budget, the information showed an expectation of unrestricted revenue at US$18.280 million and a net unrestricted expenditure at $19.200 million, with a planned strategic deficit of $0.920 million, which would be covered by the Institute's accumulated reserves. Since that BOT meeting, two things happened. The US$ underwent a substantial rise in value and our number 1 and 2 leading donors (Japan and the United States) advised us of very significant cuts in their grants to IRRI for 2005. IRRI is adjusting its spending and project development strategies to adjust to these relatively large cuts from these key donors with little reason to expect that they will be restored in 2006.

A summary of financial support begins on page 55. Appendix 3 beginning on page 160 contains the audited financial statements.

BOT MEMBERSHIP CHANGES

IRRI welcomed **Mangala Rai** (left), secretary of the Government of India's Department of Agricultural Research and Education (DARE) and director general of the Indian Council for Agricultural Research (ICAR), to IRRI's Board of Trustees. He is completing the final two years (2006-07) of the unfinished second term of **Kay Beese** of Germany, who resigned effective 8 November 2005. Also welcomed was new Philippine Department of Agriculture Secretary **Domingo Flores Panganiban** (right), who replaced **Arthur C. Yap** as an ex officio member. We also bade farewell to **Shigemi Akita** (Japan, 2000-05) and **E.A. Siddiq** (India, 2000-05).

CRIL: THE IRRI-CIMMYT ALLIANCE'S FIRST TANGIBLE OUTPUT

The long, arduous, and expensive process of developing new crop varieties received a major boost on 24 January 2006 with the joint launch in Mexico and the Philippines of IRRI and CIMMYT's new scientific program that unites key databases and research on the planet's three most important crops: rice, wheat, and maize.

The new Crop Research Informatics Laboratory (CRIL) and its associated research program were officially launched via a video conference link between IRRI and CIMMYT (photo above right). This is the first major output of an Alliance between IRRI and

CIMMYT that was formally established earlier in 2005. The new lab at CIMMYT will link with existing facilities at IRRI, heralding a new era in rice research, especially in such areas as the development of improved crop varieties. Graham McLaren, IRRI senior scientist, biometrics, is heading CRIL and will spend several months each year at CIMMYT in Mexico.

IRRI ENVIRONMENTAL COUNCIL GETS ROLLING

On 18 April 2005, when the IRRI Environmental Council (IEC; photo at right next page) held its inaugural meeting, I highlighted the need to give explicit attention to potential environmental impacts of IRRI's activities at the Institute's research station and where IRRI technologies can be adopted. I stressed that the Institute should incorporate environmental considerations into its work in a sincere and fundamental way, not by simply repackaging what IRRI is already doing.

In agreeing that IRRI should pursue an environmentally sustainable Doubly Green Revolution, the IEC created a secretariat and developed a work plan to begin implementing IRRI's Environmental Agenda (IEA). I invited the following IEC members to serve as theme leaders: **Sushil Pandey** (poverty), **Deborah Templeton** (new IEC member replacing **Renee Lafitte**, environmental sustainability and

impact), **Darshan Brar** (biotechnology), **Duncan Macintosh** (public awareness), **Ruaraidh Sackville Hamilton** (biodiversity), **T.P. Tuong** (water use), **Arnold Manza** (environmental management system), and **John Sheehy** (climate change).

Major events in 2005 related to the IEA included World Environment Day, 5 June 2005, on which the Web site (**www.GreenRice.Net**) was launched, and the IEC hosting of a workshop, 4-6 October, to integrate environmental issues into our strategic plan. This event was facilitated by **Professor Jose Furtado**, a former World Bank professional in environmental assessment and currently a visiting professor at the Imperial College, London.

Also, in line with the goals and objectives of the IEA, the first draft of the Environmental Management System (EMS) was developed by the Experiment Station in 2005. A proposed implementation work plan was presented to the IEC during its 12 December meeting. Formal implementation of the EMS work plan began with a seminar-workshop held on 16 December 2005 for Experiment Station staff. The EMS, designed to conform to the international standard ISO14001, is envisioned to serve as a management tool to help us ensure that our activities at the research center are conducted in an environmentally friendly way and in a sustained manner.

BANGLADESH MINISTER OF AGRICULTURE VISITS IRRI

M.K. Anwar, Bangladesh Minister of Agriculture, visited IRRI over a 3-day period in late April 2005. Various IRRI staff members discussed important topics including progress on development of salinity-tolerant and submergence-tolerant varieties, research on Golden Rice, IRRI's strategy for maintaining rice biodiversity, and future directions of IRRI-Bangladesh collaboration. He also visited the Gene Array Molecular Marker Applications Laboratory, the Transgenic Laboratory, the International Rice Genebank, and the IRRI plots to see aerobic rice and the wet and dry irrigation system.

IRRI SEEKS ASEAN SUPPORT FOR MAJOR PROPOSALS

IRRI presented two important proposals during the *5th ASEAN Ministers of Agriculture and Forestry Plus Three (AMAF Plus Three) Meeting* in Tagaytay City on 29 September. This was a historic event in that it was the first time ever that IRRI participated in an ASEAN meeting.

I presented proposals that call for an ASEAN meeting on the future development of the Rice Knowledge Bank (**RKB; www.knowledgebank.irri.org**) to provide farmers with direct access to the latest rice-farming strategies and technologies, and a meeting or workshop focusing on the future training and education of a new generation of rice scientists. IRRI proposes to organize and host the RKB meeting at our headquarters in Los Baños, while the workshop on training and educating new rice scientists could possibly be held in Singapore, to be organized jointly by the Institute and other possible partners in the ASEAN region.

After the AMAF Plus Three Meeting, IRRI hosted four ministers at headquarters on 1 October for further discussions: **H.E. Dr. Anton Apriyantono**, Minister of Agriculture, Indonesia; **H.E. Dr. Siene Saphangthong**, Minister of Agriculture and Forestry, Lao PDR, and former IRRI BOT member; **H.E. Shariff bin Haji Omar**, Deputy Minister of Agriculture and Agro-Based Industry, Malaysia; and **H.E. Major General Htay Oo**, Minister of Agriculture and Irrigation, Myanmar.

On 8-10 August, IRRI staff members **Johnny Goluyugo** and **Paul Hilario** participated in the *9th ASEAN Food Conference* in Jakarta, Indonesia, back to back with the *7th ASEAN Science Technology Week (ASTW)*.

SPEECH BEFORE THE FOREIGN CORRESPONDENTS' CLUB OF JAPAN

In a continuing effort to deliver IRRI's message in various forums, I addressed a professional luncheon of the Foreign Correspondents' Club of Japan (FCCJ) on 3 June. I described the

challenges of feeding Asia, such as growing population and land and water scarcities, and how IRRI is tackling them. I said that "while Asia does seem to be on track to meet MDG#1 (eradicating extreme povety), the recent UNDP task force report on *Halving Hunger: it can be done* points out that there are still more than 521 million food-insecure Asians in deep poverty traps. These traps are ensnaring people who often live on unfavorable lands with poor soils and lack of water and have poor access to markets and information."

ICAR-IRRI AGREEMENT PROVIDES RICE RESEARCH VISION UNTIL 2008

In late June, the Indian Council of Agricultural Research (ICAR) and IRRI announced details of an important new international agreement to support and facilitate India's national rice research efforts over the next 3 years. The new ICAR work-plan agreement (2005-08) with IRRI ensured that India will continue to have access to the very best and latest public rice research and technologies being developed in other countries. Since the first such agreement in 1991, the number of Indian institutes involved has doubled from 26 to 52 and projects developed have gone from 27 to 47. The ICAR-IRRI agreement also ensures that other rice-producing countries around the world will have access to the best Indian rice research. India has the biggest community of rice researchers and scientists in the world and their work is much in demand in other countries.

The signing of this agreement was part of my inaugural trip to India as IRRI's new DG. Afterward, Deputy Director General for Research **Ren Wang**, IRRI Representative in India **J.K. Ladha**, and I spent several days inspecting IRRI projects and meeting with important collaborators. This included the signing in Delhi of a memorandum of agreement with the Mahyco Research Foundation that covers collaboration in functional genomics for brown planthopper resistance, capacity building through human resource development/training for marker-assisted selection, and exchange of germplasm.

ADB PRESIDENT VISITS IRRI HEADQUARTERS

Haruhiko Kuroda (right in photo), the new president of the Asian Development Bank, one of IRRI's most important and committed donors, visited the Institute for the first time on 26 July. I had a thorough discussion with Mr. Kuroda on challenges facing rice growers and consumers in Asia. **Ren Wang**, IRRI deputy director general for research (center in photo), gave an overview on the impact of ADB-funded projects at IRRI.

BOB HAVENER PASSES AWAY IN CALIFORNIA

Robert Dale "Bob" Havener passed away in his sleep on the evening of 3 August at his home in Solvang, California. He had celebrated his 75th birthday with family and friends only 10 days earlier on 24 July. He was interim director general of IRRI for 8 months in 1998 and a great colleague and friend to many staff members. A memorial service in his honor was held on 9 August at IRRI in the auditorium in Chandler Hall. After the service, a tree was planted in Bob's memory on "DG Row" along Pili Drive. On 7 April 2006, at the conclusion of the recent IRRI Board meeting, the auditorium in Chandler Hall was officially named the Robert D. Havener Auditorium in his honor.

A plaque at the entrance reads: "Dedicated with gratitude, to a true visionary, humanitarian, and friend. For more than five decades, his resourceful leadership and communication skills at IRRI and other institutions created fertile environments in which scientific ideas and research programs flourished, ultimately leading to increased food security worldwide. He transcended cultures, religions, and generations. With his actions and wise counsel, Bob touched millions of people. His steady hand, wisdom, sound judgment, patience, humility, and—above all—compassion were critical to guiding IRRI through challenging times."

IAARD HOSTS CORRA, INTERNATIONAL RICE CONGRESS, AND BOT MEETING

In Bali, Indonesia, the Indonesian Agency for Agricultural Research and Development (IAARD) hosted the 9th Annual Meeting of the Council for Partnerships on Rice Research in Asia (CORRA) (9-11 September), an International Rice Congress (12-14 September), and the IRRI BOT meeting (14-15 September). At the CORRA meeting, the world's major rice-producing countries, including the two most populous nations, China and India, emphasized the importance of continuing to develop new rice varieties to guarantee Asia's food security and support the region's economic development.

IRRI-CHINA WORK-PLAN MEETING

The major impact of IRRI germplasm on rice production in China was highlighted during the second IRRI-China Work-Plan Meeting and Rice Science Forum in Hangzhou, China, 11-12 October. The event attracted a large cross-section of IRRI and Chinese researchers. The event was co-organized by the Chinese Academy of Agricultural Sciences (CAAS) and supported by the Chinese Ministry of Agriculture and the National Natural Science Foundation of China (NFSC), and included field tours to the China National Rice Research Institute (CNRRI).

Prior to the Work-Plan Meeting, I visited upland rice farms in Simao Prefecture to observe the performance of high-yielding upland rice varieties that are yielding 3 to 4 tons per hectare in farmers' fields. Upland rice farmers

(like the one I'm pictured with above) and local authorities showed me how high-yielding upland rice varieties have transformed the traditional low-yielding shifting cultivation system of Yunnan into a highly productive permanent upland rice-based system within the short span of 10 years.

After the Work-Plan Meeting, I went to Beijing to visit CAAS, the NSFC, Ministry of Agriculture, and Chinese Academy of Engineering (CAE). At these places, I discussed with officials IRRI's new strategies aimed at poverty alleviation and food security, environmental protection, rice nutrition enhancement, and the establishment of an information platform that includes the Rice Knowledge Bank.

HIGH-LEVEL POLICY DIALOGUE ON BIOTECHNOLOGY

On 7 November in Bangkok, during the High-Level Policy Dialogue on Biotechnology for Food Security and Poverty Alleviation: Opportunities and Challenges, I provided an assessment of the CGIAR's approach to biotechnology and biosafety. Although it is unlikely that CGIAR member countries will reach consensus on every issue related to biotechnology and biosafety, I believe it is crucial that all countries adopt science-based policies. The CGIAR centers, which have developed agreed-upon policies themselves, will work with countries to help them develop their own policies that are based on science and allow them the greatest possible access to, and benefit from, biotechnology.

INTERNATIONAL RICE GENETICS SYMPOSIUM

More than 700 rice scientists and researchers from 20 countries—many world renown and even more young and enthusiastic aiming in that direction—attended the 5th International Rice Genetics Symposium at the EDSA Shangri-La hotel in Mandaluyong City (photo below), 19-23 November 2005. Officially, this was the largest scientific meeting that IRRI has ever hosted in the Philippines.

During the course of the week, I made two major observations: (1) a significant segment of the record-breaking crowd is made up of young scientists attending this quinquennial

event for the first time and (2) the scope of rice research that is being conducted worldwide during the first decade of the 21st century is incredible.

The symposium provided an unprecedented opportunity to hear about the very latest in rice research and its applications to boost rice production and ensure long-term self-sufficiency in the staple crop in the Philippines and many other countries. Moreover, the symposium was an occasion for local rice researchers to get to know more about the products of rice genetics research from around the world.

Following the symposium, a large contingent of scientists visited IRRI on 24 November to see our facilities and learn more about our ongoing research.

IRRI AVIAN FLU TASK FORCE ESTABLISHED

Avian influenza (bird flu) is widespread in Asia, but is transmitted only rarely to people. However, there is a risk that the virus causing the disease will mutate into a form that can be transmitted easily from person to person, causing a global pandemic. So, I appointed an Avian Flu Task Force, chaired by Michael Jackson, which is developing a plan to cope with a flu pandemic, should it occur. In late February 2006, a Web site (**www.irri.org/pandemic**) debuted with the latest information.

INDIAN PRESIDENT'S VISIT TO IRRI FOCUSES ON FARMERS

In a historic, first-ever visit to IRRI by an Indian head of state, Indian President **Dr. A.P.J. Kalam** placed special emphasis on using science and technology to help his country's millions of poor rice farmers.

President Kalam (left in photo below with SSD Head Mahabub Hossain and DDG-OSS William Padolina) spent more than two hours

hearing about the latest rice research and advising the Institute's scientists on a Sunday morning, 5 February 2006. We were honored and delighted by the Indian presidential visit. I noted that what was especially impressive about his short time here was how productive it was—we managed to discuss a number of very important issues in depth and to agree to move ahead in several key areas.

UPDATE ON IRRI STAFFING

Changes in responsibility. On 1 February 2006, IRRI's new administrative organization took effect, which was necessitated by the recent budget cuts. IRRI management made some difficult decisions to streamline our administration. With the elimination of the position of director for administration and human resources, **Ian Wallace** departed on 31 January 2006. The remaining management team now includes the deputy director general for research (**Ren Wang**), deputy director general for operations and support services (**William Padolina**), director for program planning and communications (**Michael Jackson**), and director for management services (**Kwame Akuffo-Akoto**). **Joseph Rickman** is currently serving as interim head of operations under the DDG-OSS. We project that these changes will result in significant savings for the Institute. We will closely monitor the effectiveness of these changes in terms of efficiencies and cost savings.

In April 2005, **Gary Jahn** was named project manager for the SDC-funded Lao-IRRI Rice Research and Training Project (LIRRTP), as well as the IRRI representative and coordinator for the Greater Mekong Subregion (Laos, Thailand, Cambodia, Vietnam, Yunnan Province of China, and Myanmar).

In May, **Vethaiya Balasubramanian**, IRRI senior scientist, agronomy, IPMO, accepted the responsibility of being IRRI's Africa Coordinator.

Effective 6 August 2005, **Patria Gonzales** was designated as acting head of the Seed Health Unit. **Grant Singleton** was named Project 6 team leader effective 1 September 2005. He replaces **Roland Buresh**, who remains leader for Program 2, *Enhancing productivity and sustainability of favorable environments.*

In January 2006, **Glenn Gregorio** moved to the WARDA substation at IITA in Ibadan, Nigeria, to begin his duties as IRRI's rice breeder for Africa. Also in January, **David Shires**, international research fellow, was named interim head of the Training

Center and **Elisa S. Panes**, senior manager, was named interim head of human resources services.

Departures and arrivals since the last DG report. After 26 years as a rice breeder at IRRI, Principal Scientist **Sant Singh Virmani** (photo) retired in July, spending

much of that time developing and promoting hybrid rice varieties. Dr. Virmani spent much of his career in the development and successful implementation of hybrid rice technology. He served IRRI as postdoctoral fellow, visiting scientist, plant breeder, and principal plant breeder, working under all of IRRI's directors general to date. He developed superior germplasm using the cytoplasmic male sterility system for the production of F_1 hybrid rice cultivars adapted to tropical growing conditions. In 2005, farmers in nine countries outside of China (Bangladesh, India, Indonesia, Myanmar, Philippines, Sri Lanka, Thailand, USA, and Vietnam) planted around 2.05 million hectares of hybrid rice. He predicted in his farewell seminar that, by 2010, around 6.1 million hectares of hybrid rice will be planted annually in these countries.

Also departing were **M. Zainul Abedin**, SSD international research fellow (2003-05); Mark Bell, head, Experiment Station (1994-99) and Agricultural Engineering Division (1997-99), and head, International Programs Management Office (1999-2005) and Training Center (2002-05); **Humnath Bhandari**, postdoctoral fellow in SSD (2002-05); **Devendra Devendra**, postdoctoral fellow in PBGB (2002-05); **Renee Lafitte**, senior scientist in CSWS (1997-2005); and **Matthias Wissuwa**, international research fellow in CSWS (2001-05). And, departing after the 2004-05 school year were ISLB teachers **Florence Bradford** and **Bruce North**. All of these colleagues moved on to positions they sought to enhance their careers, and we wish them well.

Arrivals in 2005-06 included CPS international research fellow **Adam Barclay**; PBGB postdoctoral fellow **Bertrand Collard**; CSWS project scientist **Yuichiro Furukawa**; SSD international research fellow **Hari Gurung**; PBGB molecular biologist Philippe Herve; **Robert Hijmans**, GIS specialist/head of the GIS-IP laboratory, SSD; EPPD international research fellow **Zahirul Islam**; PBGB postdoctoral fellow **Xuemei Ji**; CSWS international research fellow **Christine Kreye**; GRC international research fellow **Isaiah Mukema**; SSD postdoctoral fellow **Florencia Palis**; EPPD postdoctoral fellow **Chitra Raghavan**; PBGB international research fellow **Rakish Kumar Singh**; **Rachid Serraj**, senior scientist, crop physiology, CSWS; **Grant Singleton**, coordinator of the Irrigated Rice Research Consortium (IRRC); Golden Rice Network shuttle scientist **Inez Slamet-Loedin**; and **Fangming Xie**, senior scientist and hybrid rice breeder, PBGB.

A complete listing of staff arrivals and departures in 2005, which includes international research and postdoctoral fellows, begins on page 101.

AWARDS AND HONORS

Environmental Radio Soap Opera for Rural Vietnam won a World Bank Development Marketplace Award for 2005 in Washington, D.C., on 25 May. This project was developed by **K.L. Heong**, senior scientist, entomology, EPPD, and **M.M. Escalada**, international research fellow, IPMO (pictured receiving the award from World Bank President **James D. Wolfensohn**), in collaboration with

Nguyen Huu Huan of the Ministry of Agriculture and Rural Development and **Vu Huu Ky Ba** of the Voice of Ho Chi Minh. Using entertainment-education principles, the project will focus on promoting "best practices" to enhance environmental sustainability in rice ecosystems. The new soap opera will build on the success of the current Rockefeller Foundation–funded "Farm

IPM Radio." Launched in July 2004, the soap opera *Chuyen Que Minh* ("My Homeland") has gained popularity among rice farmers in the Mekong Delta.

During the Annual General Meeting (AGM) of the CGIAR in Marrakech, Morocco, in December 2005, a team of IRRI scientists and collaborators won the 2005 CGIAR Science Award for Outstanding Scientific Article. The paper, *Rice yields decline with higher night temperature from global warming,* was published in the 6 July 2004 issue of the *Proceedings of the National Academy of Sciences of the United States of America*. IRRI co-authors were **Shaobing Peng, John Sheehy, Rebecca C. Laza, Romeo M. Visperas, Grace S. Centeno**, and **Gurdev Khush** (now at the University of California, Davis). Co-authors from other institutions were **Jianliang Huang**, Huazhong Agricultural University (China); **Xuhua Zhong**, the Guangdong Academy of Agricultural Sciences (China); and **Ken Cassman**, University of Nebraska.

Also during the AGM, IRRI won the Center of the Year Award from the CGIAR's Gender and Diversity Program for Policy Goal Achievements in 2005 for an outstanding series of family-friendly policies that included adoption, maternity leave, paternity leave, nursing with on-campus facilities, increased support for solo parents, and expanded compassionate leave. The award also recognized our "diversity-positive" progress in prevention of harassment and discrimination, diversity-positive recruitment and hiring, and our annual gender and diversity report to the BOT.

Gene Hettel, editor and head, CPS, was presented the 2005 Service Award for more than 33 years of outstanding volunteer efforts and service, Association for Communication Excellence in Agriculture, Natural Resources, and Life and Human Sciences, Texas, USA, in June.

Hei Leung, senior scientist, plant pathology, EPPD, was elected a Fellow of the American Association for the Advancement of Science (AAAS) in September for his contributions to science.

William G. Padolina, IRRI deputy director general for partnerships, was selected as one of the joint winners of the 2005 ASEAN (Association of South East Asian Nations) Science and Technology Meritorious Award (AMSA) for his "qualifications and significant contributions to the development and application of science and technology in the ASEAN regions."

Shaobing Peng, senior scientist, crop physiology, CSWS, received the honor of Fellow of the Crop Science Society of America for 2005. The prestigious award was presented at the CSSA Annual Meeting held in conjunction with the American Society of Agronomy (ASA) and Soil Science Society of America (SSSA) on 6-10 November in Salt Lake City, Utah. Dr. Peng (at left in photo below receiving award from CSSA President James

Coors) focuses mainly on rice physiology with emphasis on improving resource-use efficiency of high-yielding varieties and identifying the morphological traits and the physiological and biochemical processes that limit the advance of rice yield potential in the irrigated ecosystem.

As in every year, numerous other IRS and NRS received various awards and honors. See the complete listing beginning on page 72.

OTHER NOTABLE ACTIVITIES AND EVENTS SINCE THE LAST DG REPORT (APRIL 2005)

Dutch parliamentarians visit IRRI. Four members of the House of Commons from the Netherlands and two staff members from the Royal Netherlands Embassy visited the Institute on 7 April. They came to IRRI to have a general idea of the Institute's research agenda and be briefed on IRRI-Netherlands collaboration and research.

IRRI-JIRCAS workshop and project meeting. IRRI and the Japan International Research Center for Agricultural Sciences (JIRCAS) held a workshop and meeting on the *"Development of an Integrated Rice Cultivation System under Water-saving Conditions"* at IRRI, 11-12 April. **Osamu Ito**, JIRCAS director for the Crop Production and Environment Division and former head of the Agronomy, Plant Physiology, and Agroecology Division at IRRI, gave an overview of the IRRI-Japan Project and **Takashi Kumashiro** discussed the role of the Biological Resources Division of JIRCAS in the project.

Inception and planning meeting on managing rice landscapes ongoing. Participants at this meeting, 18-20 April, on the IFAD-supported project on *Managing Rice Landscapes in Marginal Uplands for Household Food Security and Environmental Sustainability* formulated a 3-year plan to address food insecurity and poverty issues in the uplands.

Letter of Agreement (LOA) between the Rural Development Administration (RDA) of Korea and IRRI. Signed on 20 April, the LOA formally extends up to 2009 the existing collaboration between RDA and IRRI in implementing the training workshop on Rice Technology Transfer Systems (RTTS) in Asia—the first of its kind in Asia. The 5-year extension was made by virtue of the workshop's success since 2002 based on a review of its impact by NARES alumni.

Charles Sturt University and IRRI sign MOU. **Ian Goulter,** vice chancellor of Charles Sturt University (CSU), Australia, visited the Institute on 25 April to co-sign an IRRI-CSU memorandum of understanding (MOU). CSU is an innovative leader in providing an accessible, adaptable, and challenging learning environment to develop graduates and research that meet the needs of its regional, national, and international communities. Through the MOU, CSU has made IRRI an affiliate institute, which will provide the basis for future collaboration in rice research and training.

IRRI Bangladesh Office holds field day on HYV rice. To demonstrate that high-yielding rice varieties have great potential to increase production, the IRRI Bangladesh Office held a field day and crop-cutting ceremony on 7 May at Homna, Comilla, Bangladesh (photo below). Supported by the IFAD project and led by IRRI SSD Head **Mahabub Hossain**, the event was attended by the Honorable Minister for Agriculture **Mr. M.K. Anwar** MP, and guest speakers **Noel P. Magor**, IRRI representative for Bangladesh; **M. Mahiul Haque**, director general of BRRI; **Mukhlesur Rahman**, chairman, BADC; **Nazira Quraishi Kamal**, BRRI director for research; **Mallik Sayed Mahbub**, Upazila Nirbahi officer; and selected farmers.

International workshop on genetic diversity. About 70 participants from China, Vietnam, Nepal, Indonesia, and the Philippines, plus scientists from IRRI, attended a workshop on *Research Prioritization on Genetic Diversification to Sustain Rice Productivity*, 9-11 May at IRRI headquarters, to discuss theoretical principles on the use of genetic diversity for sustainable pest management and improved productivity, share information and experiences gained from research activities on genetic diversification, identify and prioritize research issues, and establish and foster collaborative research among scientists.

Marginal lands workshop. The first planning workshop for a project on *Revitalizing Marginal Lands: Discovery of Genes for Tolerance of Saline and Phosphorus-Deficient Soils to Enhance and Sustain Productivity* was held 17-18 May at IRRI. Thirty-five participants from Australia, Bangladesh, Indonesia, Iran, the US, the Philippines, and IRRI prepared a 2-year work plan, formulated research strategies, and defined team roles.

Generation Challenge Program informatics workshop. The Generation Challenge Program (GCP) Platform Development Workshop was held at IRRI, 10-20 May, focusing on Subprogram 4—Informatics: 2005 Domain Modeling and Data Quality Tasks. Hosted by the Biometrics and Bioinformatics Unit (BBU), it brought together 40 software developers to discuss, design, and begin implementation of a common crop information system for the project.

STAR—System of Temperate and Tropical Aerobic Rice. IRRI organized a mini-workshop and planning meeting on 3-4 November, which was a collaborative research activity of the Irrigated Rice Research Consortium (IRRC) Water-saving work group and the Challenge Program on Water and Food (CPWF). Workshop participants reviewed the results achieved in aerobic rice research, identified the main bottlenecks and priority areas for research, revisited target domain characterization of aerobic rice systems, and planned 2006 activities for CPWF-STAR and the IRRC.

CIAT-IRRI-WARDA joint meeting. Around 25 scientists from CIAT, IRRI, WARDA, and CIRAD/IRD met after the Rice Genetics Symposium on 25 November at IRRI to discuss possible global collaboration in the following areas: genetic resources/plant breeding, disease management, natural resource management, and capacity building. The meeting was proposed by **Lee Calvert** of CIAT and organized by **Edwin Javier** and **Ren Wang**. The group will continue to communicate and develop joint concept notes and work plans to further the collaboration.

Inception workshop of CPWF project held in Thailand. An inception and planning workshop of the project *Rice Landscape Management for Raising Water Productivity, Conserving Resources, and Improving Livelihoods in Upper Catchments of the Mekong and Red River Basins* was held in Chiang Mai, Thailand, 5-7 December. The project was one of the four IRRI-led projects approved by the Challenge Program for Water and Food on a competitive basis in 2003 but received funding support only recently. The project aims to develop and validate improved options for managing rice landscapes in the uplands.

MOU with Mozambique. On Friday, 13 January 2006, an MOU between IRRI and the Government of the Republic of Mozambique was signed by the **Honorable Tomas F. Mandlate**, Minister of Agriculture, Maputo, Mozambique, and me. The MOU reflects scientific and technical collaboration in rice research, training, and technology development and delivery between IRRI and Mozambique.

IR8 cited among top 50 inventions of last half century

I'm going to close on the following note. During the past year, we have pretty much been forward looking as we do strategic planning for the next 10 years. However, every so often it should be allowed to look backward to relive a past glory or two. And it is so much more gratifying when someone else reminds us of that past.

At the close of 2005, the U.S.-based magazine *Popular Mechanics* cited IRRI's IR8 (released in 1966) to be among the top 50 inventions that have "rocked the world" during the past half-century. Published in its December 2005 issue, *Popular Mechanics*' top 50 inventions include scientific and technological advances that have transformed the world in the past five decades.

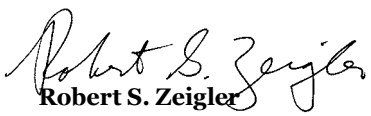
The selection of the top 50 inventions was made by a panel of 25 experts who identified the innovations that have made the biggest impact on

humanity and Earth, from the hospital to outer space to the kitchen.

The *Popular Mechanics* article stated that, in 1966: "The International Rice Research Institute in the Philippines released a semi-dwarf, high-yielding indica variety that, in conjunction with high-yielding wheat, ushered in the Green Revolution. Indica rice thrived in tropical regions of Asia and South America, raising worldwide production more than 20 percent by 1970."

Other inventions cited in the article were the smoke detector, digital music, the computer mouse, the cell phone, the automated teller machine, the Sony walkman, in vitro fertilization, and DNA fingerprinting. Pretty good company!

This provides us with powerful motivation to create a vision of a future world in which rice technology again transforms people's lives—and the confidence that we can do it.



Robert S. Zeigler
Director General

Program 1

Genetic resources conservation, evaluation, and gene discovery

This program includes IRRI's work on collection, conservation, documentation, and exchange of germplasm (plant seeds and tissues), which encompasses conserving and sustaining biodiversity. Further, through Program 1, IRRI aims to make public and freely available—to the international research community, national research and extension agencies, and any other interested party whose goal is improving rice productivity and production—the knowledge gleaned from these genetic resources. This knowledge includes an understanding of the biological functions encoded in the rice genes.

The publication in August 2005 of the finalized sequence of the rice genome has presented scientists with the opportunity to delve further than ever before into the rice plant's genetic secrets.

Through these activities, IRRI continues to foster public access to rice genetic information. As well as possessing an excellent capacity to produce genetic resources, the Institute has the expertise necessary for identifying important traits and an extensive collaborative research network for evaluating the behavior of newly found traits in diverse environments and under a range of biotic stresses (such as disease) and abiotic stresses (such as drought or problem soils). In this light, IRRI is in a unique position to undertake this important task on behalf of publicly funded rice researchers, and of the poor rice farmers and consumers they serve.

There are 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 been at the forefront of 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. 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

Ensuring the long-term preservation of the collections in the IRG is an ongoing commitment. In 2005, IRRI continued the safety duplication of the IRG collection, sending samples of almost 6,000 accessions to the National Center for Genetic Resources Preservation (NCGRP) in Fort Collins, Colorado, USA. These samples are not accessed or distributed from NCGRP but are held as a black-box safety duplication in case

of a catastrophe at IRRI. Some 2,500 new accessions were added to the IRG in 2005. Three thousand cultivated and 550 wild accessions underwent seed replenishment. IRRI tested the viability of more than 19,000 accessions in the active collection and more than 17,000 accessions in the base collection. The total number of accessions at the end of 2005 was 108,706, of which the core collection, a subset of samples representing the range of rice varieties and ecosystems, was about 10%. Location information was updated, corrected, and validated for 63,386 accessions from 69 countries. Location names were validated and geographic coordinates assigned. Rejuvenation, characterization, and viability monitoring continue as core activities.

A set of Generation Challenge Program partners—IRRI, Centro Internacional de Agricultura Tropical (CIAT), Africa Rice Center (WARDA), Cornell University, Chinese Academy of Agricultural Sciences, Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), and Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA)—is now collaborating to determine patterns of alleles (versions of a gene) or genetic fingerprints, using DNA markers (a marker is a segment of DNA linked to an allele that controls an important trait and can easily be detected in the lab) distributed across the genome for previously identified accessions showing diverse reactions to drought stress. This will be one of the largest sets of rice accessions characterized to this level for determining population structure. In 2005, we obtained fingerprinting data on more than 1,500 rice accessions. Genotyping on the remaining accessions continues.

By studying molecular variation at the sites of genes identified as being involved in drought response and other important traits, we will go on to identify sources of new alleles for plant breeding. This work employs EcoTILLING, an application of TILLING (Targeting Induced Local Lesions IN Genomes) designed to detect small variations in gene sequences in natural populations. In 2005, we characterized more than 400 cultivated accessions and nearly 100 wild accessions. Rare allele types were detected at several candidate gene loci. We identified several promising DNA markers that may allow marker-assisted breeding (which involves linking a desired gene with a marker) for salinity tolerance. Accessions showing good tolerance will be used in breeding programs to produce new varieties that will have an important benefit for farmers in saline areas.

In line with IRRI's growing focus on nutritionally enriched rice, we have begun work to identify micronutrient-dense rice varieties, and are currently examining some 1,400 accessions whose micronutrient (iron and zinc) content will be measured.

Work has continued on pinning down the identity of 4,450 wild rice accessions using both molecular and morphological techniques. Nearly 1,500 of the accessions were found to have been misidentified. In 2005, 96 accessions were completely authenticated and 141 accessions were partially authenticated.

Output 2: Rice germplasm exchanged and evaluated internationally

Exchange and dissemination of improved rice germplasm through the International Network for Genetic Evaluation of Rice (INGER) are some of the most enduring features of IRRI's collaboration with national agricultural research and extension systems (NARES) and other international centers. Once improved germplasm is received through INGER, NARES are then able to use it in ways that best fit local needs. In 2005, we assembled and distributed 300 "nursery" sets to 30 countries (22 in Asia, three in Africa, and five in South America). In addition, INGER facilitated the seed requests of 39 countries for some 6,343 seedlots and a special rice blast nursery was sent to five sites in India for field screening. We also supplied salt-tolerant lines to eight NARES in Asia and Africa under an initiative to establish a network of salinity breeding in Asia and Africa.

As part of an ongoing review of the system of germplasm exchange through INGER, an intellectual property rights (IPR) training-workshop and technical advisory committee meeting were conducted. Issues on germplasm and information exchange were discussed in the context of recent developments on international agreements and national laws and policy on IPR and plant variety protection. The workshop was in line with the Council for Partnerships on Rice Research in Asia's goal of building the institutional capacity of NARES in germplasm management, which includes NARES variety contributions to INGER in a changing IPR environment. The meeting also provided a chance to analyze the ways in which NARES use INGER materials—information that will serve as a good database for further studies and breeding programs.

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

A major strategy of the International Rice Information System (IRIS)—the rice implementation of the International Crop Information System (ICIS), which is a database system that provides integrated management of global informa-

tion on genetic resources and crop cultivars—is to consolidate existing IRRI germplasm-related databases, including those for genetic resources, breeding, and INGER, into a single system that can be easily searched via the Internet.

In 2005, we developed and deployed prototypes of software facilities for interoperability between IRIS and other major international biological databases based on Web-service architecture. Consequently, basic interoperability between Web-service applications and databases is now available, although entire ICIS functionality is not yet fully available for all adopted Web-service/Internet protocols.

IRRI and other crop research centers are starting to generate enormous sets of molecular data. These will need a proper database and analysis framework for optimal scientific usage and relevance. In this light, we enhanced IRIS's analysis and visualization tools for molecular characterization of data and populated IRIS with allele-mining data integrated with associated evaluation data from a core collection.

To properly interpret germplasm characteristics, it is crucial to have a sound understanding of the local environment. This is facilitated through geographic information system (GIS)–driven analyses. In 2005, we integrated GIS capability with IRIS to enable analysis of the eco-geographical distribution of genetic diversity.

We also saw in 2005 the beta release of Java-based stand-alone and Web applications for ICIS/IRIS, which are now available for download from the ICIS Web site (www.icis.cgiar.org). The next generation of ICIS, written in Java, will be independent of computer operating systems and will have wider bioinformatics tool integration.

Project leader

Graham McLaren, senior scientist, biometrics, and head, Crop Research Informatics Laboratory, g.mclaren@cgiar.org

PROJECT 2

Functional genomics

Genomics, the science of deciphering DNA sequence structure, variation, and function, is increasingly driving the discovery of plant traits that can improve crop production and, in due course, 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 knowledge will lead to new strategies for genetic improvement that will allow farmers to 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. This progress, building on the draft sequence published in 2002, has presented scientists with the opportunity to delve further than ever before into the rice plant's genetic secrets. This recent leap forward in 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—has laid the foundation for great advances in functional genomics—the whole-

genome approach to 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 make a connection between genotype and phenotype. As more information comes to light, IRRI cements its ability to use genomic databases and to promote public access to these resources by the rice-growing world.

Output 1: Genetic resources—mutants, near-isogenic lines, and mapping populations—developed and characterized for genome-wide assignment of biological functions to DNA sequences

IRRI scientists are developing genetic resources at both the plant and molecular level. In 2005, the IR64 (a popular IRRI-developed rice variety) mutant bank was completed. Almost 50,000 lines have been catalogued and, since the bank was established, we have shipped over 24,000 lines to research groups around the world. We are now in the process of storing small samples of individual lines in IRRI's International Rice Genebank as a permanent public resource for the future.

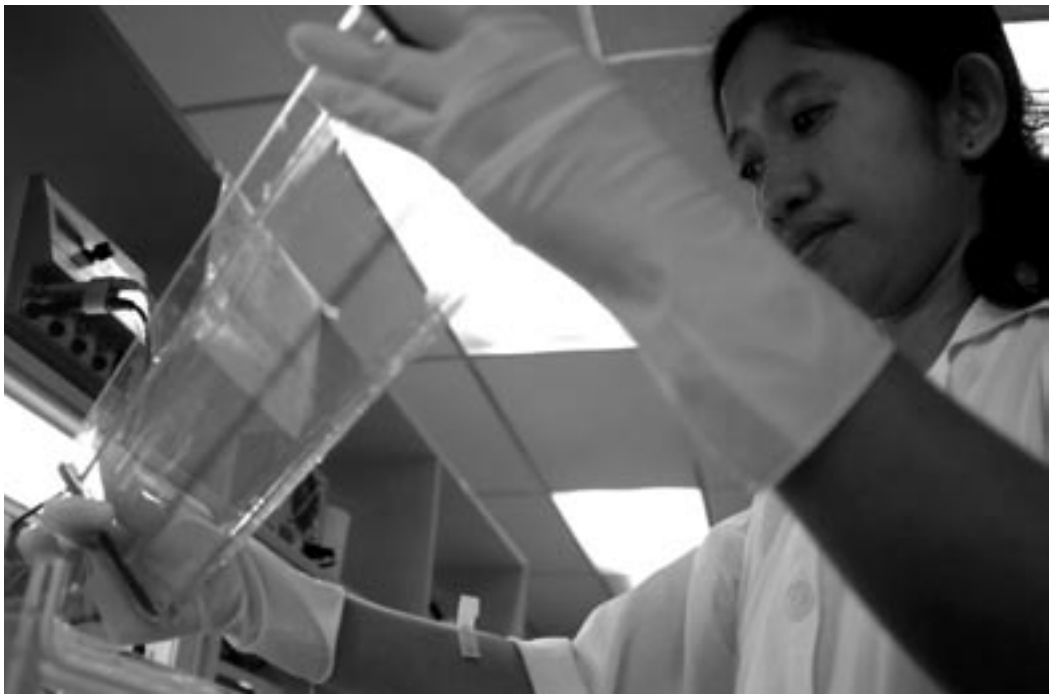
Research in 2005 confirmed the utility of association genetics in analyzing the large pool of germplasm residing in IRRI's International Rice Genebank. We screened more than 900 germplasm samples for single nucleotide polymorphisms (SNPs, a form of genetic variation) at candidate genes for drought tolerance. Initial data suggest significant associations between some SNPs and traits of interest in several indica rice varieties. These traits include lower yield decline, lower biomass decline, higher relative water content, and shorter flowering delay, and these may be crucial in the way the rice plant's growth is regulated in drought conditions.

Near-isogenic lines (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. In 2005, we made use of such NILs to identify five chromosomal segments with a significant contribution to disease resistance, and we combined these segments into advanced lines to produce good parents for breeding for blast resistance. One such line has been used to develop a commercial hybrid variety in China, through collaboration with the Guangdong Academy of Agricultural Sciences.

Wild rice species often exhibit useful traits that can sometimes be transferred to modern varieties. Wild *Oryza rufipogon* introgression lines and deletion mutants were phenotyped to characterize sheath blight resistance. Of 16 wild rice accessions, three *O. rufipogon* accessions showed promising resistance. One mutant line also showed an increased level of sheath blight resistance.

In 2005, the IRRI-coordinated International Rice Functional Genomics Consortium initiated a rice SNP project to provide the rice research community with improved access to information on genetic variation present within and between diverse rice cultivars as well as the genetic resources to exploit such information. Such information is now at our fingertips following publication of the finalized sequence of the rice genome. By identifying sequence variation between major rice varieties, the study will help uncover the genetic basis underlying important agricultural traits. The project sees IRRI and

other members of the international rice research community teaming up with Perlegen Sciences to identify a large fraction of the SNPs present in cultivated rice. U.S.-based Perlegen Sciences' primary focus is on improving the safety and efficacy of medicines through studies of genetic variation among patients, but the company is able to assist IRRI through its world-leading, high-throughput technologies for the detection of genetic variation (in the form of SNPs) and its relationship to specific traits. The project team will make whole-genome comparisons of about 20 rice genomes of both traditional and improved varieties. The SNP data will be publicly available (www.oryzasnp.org).



Output 2: High-throughput gene array facilities established for genotyping and expression analysis of desirable agronomic traits

In 2005, IRRI used a gene chip—a small slide on which the DNA of thousands of genes (22,000 in this case) is arranged in a grid—to examine the expression profile of tungro-resistant rice lines. From these experiments, performed in collaboration with the National Institute for Agrobiological Sciences (NIAS) in Tsukuba, Japan, we identified a small region of the rice genome that may harbor candidate tungro resistance genes. Similarly, candidate genes for resistance against rice stripe virus were identified through the integrative approach of locus mapping and gene expression analysis. In parallel, another gene chip project was undertaken with the Beijing Genomics Institute of the Chinese Academy of Sciences to study drought tolerance. Using a chip containing 60,000 predicted genes, we examined the pattern of gene expression for drought tolerance in two varieties, Apo (which is drought tolerant) and IR64 (which is drought susceptible). This study demonstrates the feasibility of using a gene chip to identify a relatively small set of genes involved in drought response, and the function of the genes can now be validated individually. Together, these studies exemplify the utility of using a genome-wide approach to find genes of interest. This is proving to be a fruitful research direction. We envision that such an integrative approach will be widely used to identify candidate genes for other important traits.

In addition to expression analysis, progress was also made in adopting high-throughput methods to search for useful genetic variation in the gene pool. EcoTILLING is an application of TILLING (Targeting Induced Local Lesions IN Genomes) that is designed to detect small variations in gene sequences in natural populations. To make this technology accessible to national agricultural research and extension systems (NARES), we have converted the EcoTILLING technique to an agarose-based approach—making it possible to perform the technique much more easily and cheaply than before. We anticipate that most NARES labs will now have the capacity to use EcoTILLING to detect genomic variation in the form of SNPs.

Output 3: Candidate genes, favorable alleles, and metabolic pathways for tolerance of abiotic and biotic stresses and for nutritional enhancement identified

Following completion of the finalized sequence of the rice genome, we can now use the sequence information to extract genes that may play a role in the expression of traits of interest. We currently have more than 500 candidate genes associated with the rice plant's response to biotic and abiotic stresses. The next step will be to perform functional tests and gene expression studies to validate the functions of these candidate genes.

Through funding from the U.S. Agency for International Development (USAID) Linkage Program, IRRI is collaborating with the Samuel Roberts Noble Foundation to develop virus-induced gene silencing (VIGS) in rice.

VIGS is a technique used to suppress a gene of interest through a virus vector. If researchers can suppress a certain gene, they can then examine the resulting phenotype and verify the gene's function or estimate its effect. The research team has successfully used VIGS to examine rice genes for disease resistance and will continue to use VIGS to study other rice genes of interest.

Pup1 is a rice gene found on chromosome 12 that improves the plant's uptake of the essential nutrient phosphorus (P). In 2005, in collaboration with NIAS, we identified and sequenced the region containing *Pup1* in the donor variety Kasalath, which is tolerant of P-deficient soils. We compared this with variety Nipponbare, which is susceptible to P deficiency. The results showed that the *Pup1* regions in the two varieties' genomes were quite different, with the Kasalath *Pup1* region about twice as large. This information will allow the identification of versions of *Pup1* that confer P-deficiency tolerance to rice and, ultimately, will allow researchers to produce varieties that perform well in the phosphorus-deficient conditions that affect most upland rice areas.

A research collaboration with USAID Linkage Program partners the University of California at Davis and the University of California at Riverside has identified three tightly linked genes at the locus called *Sub1* that confer tolerance of submergence. Rice varieties possessing a particular version of *Sub 1* can survive completely underwater for up to two weeks. Two of these genes, coding for a transcription factor (which is involved in regulating gene expression), are expressed in response to submergence and overexpression of one of them confers tolerance to otherwise sensitive plants. This information will allow researchers to develop, for a range of cultivars, molecular markers (easily detectable stretches of DNA) for submergence tolerance. Eventually, we will be able to develop submergence-tolerant rice varieties that could stabilize production in areas affected by flooding—a total of about 15 million hectares, mostly in poor regions.

Another USAID Linkage Program–funded collaboration with the University of California at Riverside identified the salt tolerance gene, *Saltol*, on rice chromosome 1. Using the whole-genome "microarray" approach, the research team initially identified 17 genes in the Saltol chromosomal region in three rice varieties. One gene was highly expressed in one of the varieties, FL478, when plants were subjected to saline conditions, making it a strong candidate for conferring salt tolerance. The gene was independently identified and recently cloned. As with *Sub1*, this discovery will allow scientists to create molecular markers and, ultimately, to develop salt-tolerant rice varieties.

Output 4: Databases and bioinformatics support for functional genomics developed

With support from the Generation Challenge Program, we have accelerated and expanded the development of infrastructure used to accommodate data generated from functional genomics. These advances parallel the rapidly growing role of bioinformatics in agricultural research.

In 2005, IRRI's Crop Research Informatics Laboratory (CRIL, formerly Biometrics and Bioinformatics Unit) released a prototype of the next-generation International Rice Information System (IRIS, www.iris.irri.org) platform for local and Web-based access to functional genomics data integrated with germplasm—effectively creating "one-stop shopping" for rice functional genomics data. With our advanced research institute partners, we have achieved initial integration of crop modeling with genomics.

A Wiki is a freely available software tool that allows groups of people to easily access and edit documents or data. CRIL has introduced Wiki technology to teams undertaking trait- or gene-specific research, thereby improving the way in which researchers interested in a particular trait or gene can access information.

A bioinformatics approach was also applied to additional candidate gene positional cloning projects for priority stress tolerance traits. In 2005, this was applied to IRRI's submergence tolerance (*Sub1*) and phosphorus deficiency tolerance (*Pup1*) projects. As more traits are added, researchers will increasingly apply bioinformatics tools to achieve gene discovery and validation.

Output 5: An International Rice Functional Genomics Consortium established to provide a public resource platform and broaden access to genetic resources and genomic technologies

The International Rice Functional Genomics Consortium (IRFGC)—supported by the USAID Linkage Program, the Generation Challenge Program, and a network of projects from national and international programs—is coordinated by IRRI with an open partnership with NARES, and other national and international research institutes. The IRFGC's largest and most visible achievement in 2005 was the organization and hosting in Manila, Philippines, of the Third International Rice Functional Genomics Symposium, organized in conjunction with the Fifth International Rice Genetics Symposium, in November. Boasting more than 700 participants from more than 40 countries, the symposium was the largest gathering of rice genetics and functional genomics researchers since the completion of the rice genome sequence and provided an excellent platform on which to share information and develop new collaboration.

In 2005, we established a functional genomics research agenda with Indian NARES, encompassing four projects under India's national Rice Functional Genomics Network. Specifically, these involve research on drought tolerance and brown planthopper resistance (Tamil Nadu Agricultural University), bacterial blight resistance (Punjab Agricultural University), disease resistance and mutant analysis (University of New Delhi–South Campus), and yield analysis (Indian Agricultural Research Centre).

Three new projects, in collaboration with U.S. universities and supported by the U.S. Department of Agriculture's Competitive Grant Program, were added to the IRFGC agenda in 2005. The projects include small RNA analysis (University of Delaware), chip-based quantitative trait loci mapping (University of Arizona), and whole-genome resequencing and SNP discovery (Colorado State University). These three projects will add new genomic resources to the public resource platform.

Output 6: Resources and information disseminated to NARES through the Asian Rice Biotechnology Network (ARBN) and training workshops

The products of IRRI's functional genomics research continue to be integrated into breeding programs and shared with NARES. Several candidate genes are now available for abiotic stress tolerance of phosphorus deficiency, salinity, and submergence. We also made available to NARES allele-indexed breeding lines for blast resistance. These breeding lines are supported by a set of marker tools to enable direct use of candidate gene polymorphism in the selection of the desired gene combinations.

We held an ARBN marker-assisted selection training workshop (Advances in Marker-Assisted Selection) in February 2005, with support from a German Federal Ministry for Economic Cooperation and Development (BMZ) grant. The workshop focused on practical applications of molecular markers in applied breeding programs and gave NARES access to new high-throughput genotyping tools and technology. The workshop was attended by 62 participants from China, Bangladesh, Egypt, Gambia, Korea, India, Indonesia, Iran, Philippines, Vietnam, and the U.S.

In February and March 2005, we held an EcoTILLING workshop with support from the Generation Challenge Program. Nineteen participants (from Bangladesh, China, France, India, Indonesia, Korea, Philippines, Taiwan, Thailand, Vietnam, Germany, India, and Australia) attended this training course, which gave trainees hands-on EcoTILLING experience.

Project leader

Hei Leung, senior scientist, plant pathology, h.leung@cgiar.org

Program 2

Enhancing productivity and sustainability of favorable environments

The adoption of improved rice varieties and production technologies in the favorable irrigated environment—which accounts for 55% of rice harvested area and contributes to about 75% of total rice production—is a major factor in poverty alleviation across Asia. The resultant increased 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, as prices drop, the food security of the poor improves.

The favorable irrigated environment will remain the major source of rice supply to the rural landless and an expanding urban population. As populations increase, this demand will grow. We need to sustain the high yields already achieved in this ecosystem and, with modern science, explore possibilities of a further increase in yield potential. The challenge, however, is greater than simply feeding more mouths. As populations grow, the irrigated rice production system intensifies, placing increasing pressure on limited natural resources that are, in many cases, already overexploited. A looming water crisis—fueled by increased competition from the domestic and industrial sectors as well as the constant scourge of drought—means that, in many countries, 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 accelerating demand for high-quality rice. Not only do we need varieties with higher yield potential, multiple resistance to diseases and insects, and tolerance of problem soils, but we also need rice with superior grain quality and higher micronutrient content. Micronutrient deficiencies, especially of iron, zinc, and vitamin A, afflict millions of poor Asians—people who receive most of their nutrition from rice and who stand to benefit from consuming more nutritious rice.

3

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. Taken together, these developments mean that farmers will need to produce more rice using less land, water, labor, and chemical support. As well as increasing rice production, there is 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 the rice-consuming world.

This project uses conventional breeding and biotechnological approaches to develop new plant type cultivars and rice hybrids with 15–20% higher yield than existing high-yielding varieties. IRRI researchers are also exploring opportunities for developing even higher yielding rice cultivars and hybrids. We use conventional breeding and techniques, such as wide hybridization (crossing modern rice varieties with their wild relatives, for example) and marker-assisted selection, as well as genetic engineering to improve rice varieties' pest resistance. Conventional breeding and genetic engineering are also used to enhance the palatability and nutrition of rice varieties, including higher content of micronutrients such as iron, zinc, and provitamin A (needed by the body to synthesize vitamin A).

As well as developing high-yielding rice varieties and hybrids that combine desirable features, we develop suitable agronomic management practices for new plant types and hybrids to optimize their performance in farmers' fields.

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

In 2005, we identified many genetic donors suitable for direct seeding and for growing under alternate wetting-and-drying irrigation conditions. These were used in breeding programs to develop elite lines suitable for these crop management strategies.

Following testing of transplanting, spacing, rate, and timing of nitrogen (N) application, and irrigation depth for a new plant type line in the 2005 dry season, agronomic management guidelines for new plant type cultivars were developed and will be evaluated in collaboration with national agricultural research and extension systems (NARES). Breeding efforts for yield improvement of new plant type lines are continuing. This will be followed by the development of appropriate management practices to realize the production potential of improved germplasm in farmers' fields.

Lines derived from crosses of cultivated rice (*Oryza sativa*) with wild species (*O. longistaminata*) with increased tolerance of stem borer have been identified. Field evaluation of these lines will be carried out to determine the stability of the resistance. We have identified donor parents with increased resistance to sheath blight. This offers new opportunities to develop improved germplasm and understand the mechanism of sheath blight resistance.

Genes that have the potential to confer resistance to brown planthopper, bacterial blight, and tungro are being tagged for use in marker-assisted selection, a technique that allows researchers to rapidly search for candidate plants that possess a resistance gene.

Elite rice lines possessing the Xa21 gene (which confers resistance to bacterial blight) or the Bt gene (which confers resistance to stem borer)—were developed through genetic transformation. We field-tested variety IR72, which carries *Xa21*, at IRRI during the wet season.

In our work for the HarvestPlus initiative—a multi-institute program to develop nutritionally enhanced crops—we have identified donor lines for high iron and zinc content in polished rice grains, and a breeding program has begun.

In 2005, we analyzed grain quality, consumer preferences, and blast resistance of elite temperate japonica lines adapted to the tropics. We now expect that, through our Philippine research

and extension partners, the area of japonica cultivation in Bohol, Philippines, will be expanded. One indica introgression line carrying genes from *O. australiensis* has been identified as a new source for blast resistance for temperate japonica, and the resistance gene has been mapped on chromosome 6.

We have begun research to characterize genotypes for the rice plant's leaf arrangement and how that arrangement interacts with sunlight and consequently affects grain yield. Another new activity in 2005 was the characterization of brown planthopper (BPH) populations for gene deployment—that is, the cultivation of varieties possessing specific genes for resistance to different BPH populations. We analyzed variation in BPH populations and will study the genetic structure of different populations in an effort to deploy resistant rice varieties.

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

In 2005, IRRI developed several elite hybrid rice lines that possessed good grain quality, and shared these with NARES. Four elite hybrids are being tested in the national cooperative trials—these were the top three entries in trials of about 20 hybrids bred by both private and public institutions conducted during the previous seasons by the Philippine Rice Research Institute (PhilRice). We are analyzing causes of chalkiness with emphasis on starch structure; overcoming chalkiness would lead to better grain quality. Next, the genetics of chalkiness will be studied in collaboration with China and other NARES.

Elite two-line hybrids were developed using the thermosensitive genetic male sterility (TGMS) system and three elite hybrids are under evaluation in the 2005 International Rice Hybrid Observational Nursery by the International Network for Genetic Evaluation of Rice (INGER).

We developed several cytoplasmic male sterile (CMS) lines possessing higher outcrossing (meaning that it is easier to produce more hybrid seed from these lines). Consequently, a large number of hybrids that were derived from the CMS lines and that possessed improved grain quality were subjected to preliminary replicated yield trials. Transgenic CMS lines possessing the Xa21 gene or the Bt gene have also been developed.

We identified several elite hybrids suitable for growing in a water-saving alternate wetting-and-drying irrigation system. This activity has now been transferred to Project 7.

Through our efforts to improve crop and nursery management, we developed crop establishment guidelines for direct seeding and transplanting hybrid rice varieties. We also evaluated broadcasting seeds at a low seed rate (25 kg per hectare) and developed crop management strategies for high hybrid seed yield. We evaluated hybrid rice under different N management conditions and studied their influence on disease development. High total N rate and excessive late application of N considerably increased the incidence and severity of sheath blight due to increased relative humidity inside the rice canopy.

Direct seeding of rice helps farmers save water and labor. In 2005, IRRI identified physiological attributes of elite hybrid rice that make it suitable for direct seeding. This involved adaptation of the plant's spatial leaf arrangement in response to competition to capture more light. We analyzed the simultaneous impact of spatial leaf arrangement on total leaf area and shoot dry weight and next we will measure the impact on grain yield as well as assess a wider range of genotypes.

Hybrids possessing cold tolerance at the seedling stage and salinity tolerance were identified for cultivation in the dry season. We are evaluating commercial rice hybrids for increased iron content in the polished grains.

Project leader

Darshan Brar, senior scientist, plant breeding, d.brar@cgiar.org

PROJECT 4

Managing resources under intensive rice-based systems

The highly productive favorable irrigated environment produces nearly three-quarters of the world's rice. The doubling of rice production in Asia over the past 30 years has arisen largely from increased production in the two major intensive rice production systems—double cropping of rice and the rice-wheat rotation—brought about by improved rice varieties, expanded irrigation, and higher rates of fertilizer use.

Yield growth, however, has stagnated in recent years. If this trend continues, it will be difficult to grow enough rice to satisfy a growing population of urban poor and rural landless, especially when combined with postharvest losses. Further, as laborers move in increasing numbers away from farms to find jobs in the cities, farmers need solutions to the problems of worsening labor shortages and a consequent increase in labor costs. At the same time, shortages of irrigation water and farmers' misuse of agro-chemicals are causing environmental concern.

Current irrigated yields in the rice-rice and rice-wheat systems, averaging 5 tons per hectare, are well below the estimated potential yield of 8 tons per hectare of existing rice cultivars. Farmers need new knowledge, techniques, and practices to bridge this gap. Without appropriate knowledge, it will be difficult for farmers to increase yields and achieve both increased profitability and minimal environmental impact.

New knowledge-based technologies and machinery that are environmentally sound, socially acceptable, and profitable to farmers can enhance and sustain the productivity of favorable environments. Such technologies must integrate management of soil, water, weeds, pests, and diseases and at the same time 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, as well as a thorough understanding 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 2005, we developed an initial framework for integrated management of nutrients, the crop, and water aimed at increasing input-use efficiency in intensive rice systems. Within this framework, we undertook a series of projects, both at IRRI headquarters and with our national partners throughout Asia.

We conducted field experiments at four sites in China with two cultivars and six nitrogen (N) treatments to develop parameters for quantifying a healthy rice canopy. Work continued

on site-specific nutrient management (SSNM)—the practice of tailoring fertilizer use for individual fields and seasons—which is now well developed for rice. IRRI now has an SSNM Web site (www.irri.org/irrc/ssnm). We are developing locally adapted SSNM recommendations for major rice-growing areas and we completed an assessment of SSNM and its effect on profit and nitrous oxide emissions in Vietnam, the Philippines, and southern India. We are also developing the concept of canopy management and evaluating this for integrated nutrient and disease management, and we examined the interactions of water and residue management on greenhouse gases and nutrient supply. In 2005, we also established a collaborative project in Vietnam, which began in January 2006. This involves two activities: national extension of SSNM through training programs for extension workers in northern and southern Vietnam that are supported by the Vietnam National Agricultural Extension Centre, and a collaborative research initiative in northern, southern, and central Vietnam with support from the Ministry of Agriculture and Rural Development for developing improved practices for integrated management of nutrients, the crop, and water to close the yield gap in irrigated rice.

Our research on N uptake indicates that the practical limit to the recovery of fertilizer N (the fraction of applied fertilizer N taken up by the plant or crop) was just less than 60%. At least 40% of the N is lost even when using an "ideal fertilizer" delivered so as to provide the plant with its exact needs at any time. This loss occurs because the biophysical processes in the soil (such as microbial activity) have as equal an access as roots to nitrogen in the available soil pool. This understanding will guide the establishment of the practical limits to N recovery.

In 2005, IRRI developed a young robust seedling technique for enhancing fast revival of seedlings soon after transplanting and vigorous early growth and canopy development. This has been well tested and the general principles established: transplanting of seedlings at the four-leaf stage and no tillers in the nursery result in an additional yield of 1–2 tons per hectare. In addition, a modified mat nursery to produce robust young seedlings in 15 days has been introduced and is being evaluated in Timor-Leste and a modified mat nursery for boro (dry-season) rice is being tested in West Bengal, India. The private sector in India has also shown support, with seed companies such as Bioseeds-Hyderabad and Annapoorna-West Bengal adopting the young robust seedling technique to increase the seed yield of their seed producers.

Burning crop residue can have harmful environmental effects and it destroys vegetative matter that could benefit the soil and the succeeding crop. In 2005, we evaluated alternative residue management practices and their effects on soil fertility and crop production. This included examining the effects of hastening residue decomposition on organic acids, nutrients, and greenhouse gases and the effects of residue management with various crop, soil, and water management options on soil properties and soil-supplying capacity of nutrients. Initial results from research on the integration of SSNM with residue management indicate that more N is needed early on, at the time residues are incorporated into the soil. In partnership with NARES, we also evaluated practices of reduced tillage and management in rice-rice and rice-wheat systems.

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

In recent years, IRRI has had success with an entertainment education (EE) approach to motivating farmers to improve their crop management practices. In 2005, we continued an EE campaign to reduce insecticides in the Mekong Basin. In July 2004, radio soap operas—with storylines designed to educate farmers on the best practices in

reducing pesticides—were launched in Vietnam and Lao PDR. These continued in 2005, with 104 episodes broadcast in each country. In Vietnam, an additional 35 episodes were developed to be broadcast between January and June 2006. Following the launch of the Environmental Soap Opera for Rural Vietnam, farmers in Vietnam's Vinh Long Province used 38% fewer insecticide sprays per season per year and the project won the World Bank Development Marketplace 2005 award.

Research into the relationships between arthropod biodiversity and pest control function indicated that increased predator diversity is associated with increased predation rates in some pest species. We also evaluated farmers' adoption of the trap barrier system for rodent management. The main constraint to adoption is the community participation requirement, which makes the system difficult to scale up without added incentives.

In 2005, we determined the impact of interplanting different rice varieties—four rows of a modern variety interplanted with one row of a traditional variety in a repeating pattern—on diseases, insect pests, and agronomic performance in both indica- and japonica-growing areas. We conducted on-farm experiments in both the wet and dry seasons in which we interplanted Malagkit Songsong (a traditional Philippine variety) with PSBRc82 (a modern indica variety). Lodging and stem borer incidence of Malagkit Songsong were higher when it was planted alone than when it was grown in mixture plots. Lodging and susceptibility to pests discourage farmers from growing Malagkit Songsong on a large scale despite its high market value. Interplanting with a high-yielding modern variety can now be considered an option for improving yield and increasing production.

Characterizing pest ecology in a range of ecosystems will help determine how pest populations are controlled and how plant resistance and natural enemies may interact in controlling pest populations. Patterns of key insect pests and their natural enemies were characterized for cultivated rice, and for wild grass and wild rice habitats. Planthoppers and natural enemies appear more abundant in grass habitats than in rice, indicating that grass habitats may be important in conserving natural enemies of rice pests.

Weeds are a major problem in most rice-based ecosystems. In 2005, we assessed how well different cultivars naturally suppressed weeds, identifying differences in early vigor and competitiveness in a range of cultivars. Differences in vigor as early as 12 days after seeding may indicate abilities of rice varieties to suppress neighboring weed plants and, consequently, be a guide for breeding highly weed-competitive rice varieties. The weed-suppressive effects of different water regimes—covering duration and depth of flooding—were also assessed for a range of weed species. This detailed knowledge of the effect of submergence on weeds will be used to develop decision tools and to guide the application of crop management options.

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

Postharvest losses, through spoilage or pest infestation, are a serious burden on farmers. Appropriate postharvest management systems can prevent debilitating losses. In 2005, approaches for reduced postharvest loss and improved grain storage were adapted to local conditions in several countries and provided for wide-scale delivery. We field-tested the 50-kg hermetic storage bag, known widely as the "superbag"—made from a laminated plastic that incorporates a gas barrier that restricts oxygen and water vapor movement—in Lao PDR, Cambodia, Vietnam, Myanmar, Indonesia, and the Philippines. The superbag helped achieve improved seed quality in Lao PDR and Myanmar and improved aroma of grain in Cambodia.

A comparison of seven cropping systems allowed us to assess the

economic and environmental impact of different rice cropping systems. Energy balance showed that puddled transplant and broadcast systems were the most efficient. Alternate wetting and drying did not increase water-use efficiency.

IRRI continued its work to identify and evaluate equipment and techniques that enhance crop production and processing. In 2005, we developed dry laser land-leveling equipment in Vietnam, wet-leveling systems in China, and a rice hull furnace, which is now being successfully used by the Philippine Rice Research Institute (PhilRice). We also modified and tested a direct-seed-drill prototype for direct seeding and fertilizer application in puddled and dry-seeded soils. Rice crops were successfully established at the same time as fertilizer incorporation in wet puddled and dry systems in the Philippines.

Rodents can do major damage to rice stores. In 2005, we developed rodent identification and management strategies for grain storage systems. In trials, there was only one reported rodent attack on 50-kg storage bags and one attack on a 5-ton storage system. Trials will be undertaken at the farm level in 2006.

Output 4: Resource-use efficiency in the rice-wheat system increased

IRRI's investigation of ways to improve yields and sustainability of the important rice-wheat cropping system in the Indo-Gangetic Plains of South Asia focused in 2005 on an integrated system incorporating tillage, nutrients, weed management, and water use in the rice crop. To investigate the interactions among these factors, we conducted multilocation trials in India, Nepal, Pakistan, and Bangladesh. Data are now being collected, compiled, analyzed, and interpreted, and two research papers have been submitted to international refereed journals.

One hundred drum seeders were imported from Vietnam to India for evaluation of row seeding in puddled soil in countries that use the rice-wheat system. Findings so far are that, by using the drum seeder, the cost of cultivation can be substantially reduced, with some water saving.

To develop efficient crop establishment methods for rice in the rice-wheat system, we evaluated resource-conserving technologies in farmers' fields. Several on-farm technology trials were carried out at five sites in Bangladesh, Nepal, Pakistan, and India. Key technologies include zero-tillage, laser leveling, dry direct seeding, drum seeding, bed planting, residue management, weed management (including through brown manure), the leaf color chart (used by farmers to check the crop's N needs), and integrated crop management (ICM).

We also evaluated the effects of direct-seeding practices on weed species composition and weed management in more than 100 farmers' field trials in the states of Uttaranchal, Uttar Pradesh, and Bihar in India. The information obtained on weed species shifts and ecology will help guide management options. Overall, results are promising, with the technologies leading to an increase in farmers' income and therefore good potential for widespread adoption.

To help farmers maximize the potential of the rice-wheat system, we refined, standardized, validated, and calibrated an existing simulation model to evaluate various management options to increase water- and nitrogen-use efficiency as well as overall productivity of the system. This model, known as the denitrification and decomposition model, was evaluated for its ability to simulate N dynamics and balances in the rice-wheat cropping system in the Indo-Gangetic Plains, using a range of

management practices. Knowledge of the magnitude of N losses in different transects of the Indo-Gangetic Plains will allow us to develop appropriate N management practices and recommendations.

To assess the influence of soil management on soil nutrient-supplying capacity, we examined soil organic matter and soil physical properties in a range of areas using the rice-wheat system. Soils were analyzed for various soil parameters and soil organic matter levels, and the relationship between these properties and the soil's nutrient-supplying capacity was established. This work will allow accurate assessment of soil health and productivity and allow the development of appropriate on-farm management strategies.

Project leader

David Johnson, senior scientist, weed science, d.johnson@cgiar.org

PROJECT 5

Enhancing water productivity in rice-based production systems

The development of an irrigated rice production system that makes better use of water has emerged as a crucial issue in recent years. Farmers are facing ever-declining water supplies as they battle not only widespread drought but also increasingly fierce competition—from growing industrial, urban, and domestic sectors—for available water. And, as supplies diminish, the price of water is rising, either via direct costs or through the power outlay for pumping groundwater. The seriousness of the situation becomes clear in the light of Asia's dependence on irrigated rice for food security. In Asia, irrigated agriculture uses 90% of total diverted fresh water, and about half of that irrigates rice. Irrigated rice varieties, grown in continuously flooded paddies, require substantially more water to produce a given amount of grain than does any other major crop.

Not only is water-efficient rice production necessary due to dwindling resources, but it will also help farmers find relief from the rising cost of irrigation. The ability to grow rice with less water is also crucial if farmers are to mitigate the effects of drought, which in 2005 devastated many farms throughout Asia.

We have already seen good progress toward the development of water-saving irrigation techniques, such as reducing losses to percolation and seepage. But, as a water crisis looms ahead of us, we need to explore a range of new crop management strategies, such as cultivating rice in saturated soil on raised beds, along with the development of 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

Research continued on a number of water-saving technologies, including aerobic rice, which can grow in conditions too dry for commonly grown modern varieties and which is useful when rice fields cannot be flooded at all.

Alternate wetting and drying is useful under moderate water scarcity and shallow groundwater depths. Up to 20% of the water can be saved without affecting yield and the same fertilizer recommendations as for flooded rice can be followed. The water savings are mainly realized through a reduction in seepage and percolation losses, whereas evapotranspiration losses are hardly affected. In 2005, we looked at the interaction between nitrogen (N) and water,

and its effect on leaf color chart (LCC) and SPAD (chlorophyll level) readings of rice under alternate wetting and drying. The linear relationship between leaf-N concentration and SPAD readings (or LCC) holds for well-watered as well as alternate wetting-and-drying treatments. We also developed a field-level monitoring system for simultaneous and continuous measurement of nitrous oxide, methane, and carbon dioxide fluxes, and evaluated general conditions of soil, soil solution, and standing water under alternate wetting-and-drying treatments during a dry season. We concluded that SPAD readings or the LCC can be used for real-time N management in rice subjected to alternate wetting-and-drying irrigation.

We assessed the potential of existing cultivars in larger-scale furrow-irrigated or supplemented irrigated systems. We tested alternate wetting and drying for five contrasting genotypes, finding no impact on grain yield. In large fields at the IRRI farm, puddled systems use about 4,000 liters of water per kg of grain yield, and nonpuddled systems use 6,000 liters per kg of grain yield. Alternate wetting and drying in puddled systems appears to be the most efficient water use. We also identified candidate traits for high performance under alternate wetting and drying on flat land. Overall, there was no significant impact on crop performance and water productivity and no significant physiological adaptation for safe alternate wetting and drying. We plan to conduct the same type of experiment under more stringent water-saving conditions.

In 2005, we evaluated water, nutrient, and crop management options for aerobic rice. In the tropics, stable wet-season aerobic rice yields of around 4 tons per hectare are feasible in field experiments and in farmers' fields with supplemental irrigation of 1–2 ap-

plications. In the dry season, yields of up to 6–7 tons per hectare have been recorded in field experiments and up to 5–6 tons per hectare in farmers' fields, but complete yield failures have also been recorded at several locations. The dry-season problems may be due to soil-borne diseases such as nematodes, fungi, and root aphids, and we have also documented micronutrient imbalances. Optimum nitrogen application rates are 70–90 kg per hectare in the wet season and 90–120 kg per hectare in the dry season, in three splits some 10–14 days after emergence, at tillering, and at panicle initiation. The optimum seeding rate is 60–80 kg per hectare. Row spacing can vary from 20 to 35 cm without a significant effect on yield or susceptibility to lodging. In the wet season, 1–2 supplementary irrigations are usually sufficient when dry spells occur; in the dry season, no optimum water application rates have been established because of problems with soil-borne diseases.

In IRRI's long-term aerobic rice experiment, a gradual and consistent yield decline has been confirmed under continuous aerobic rice cropping. Preliminary analysis suggested that the N supply of soil or N-uptake ability of aerobic rice decreased as the number of seasons progressed. However, two-season fallow and three-season flooding of fields reversed the yield decline and can offer practical management options.

In 2005, we synthesized the results of a three-year monitoring project in northern China—where aerobic rice was being tested by farmers on around 80,000 hectares in water-scarce irrigated environments—which incorporated biophysical and socioeconomic factors of early adopters of aerobic rice. Yields were 3–5 tons per hectare with 2 to 4 supplementary irrigations (200–400 mm compared with 1,100–1,300 mm in flooded rice). Economic returns were lower than for cotton and maize but, in flood-prone areas, upland crops are severely damaged when flooded and aerobic rice has higher profitability. Farmers indicated that yields need to increase to 6 tons per hectare in "normal years" to be competitive with other upland crops in water-scarce irrigated environments, but that "any yield" was good in case of flooding. Field experiments indicated that aerobic rice yields of 4–6 tons per hectare can be obtained with supplemental irrigations of 300–600 mm, depending upon rainfall. In many fields, the soil N supply is abundant, probably because of years of overfertilization, and little response to fertilizer N has been found. In the Philippines, national agricultural research and extension systems (NARES) partners incorporated aerobic rice in their own research programs. Farmers are testing aerobic rice at several pilot sites.

In 2005, IRRI hosted a *Comprehensive Assessment Workshop on Water-Saving Technologies in Rice Production*, whose ultimate aim is to influence policy and decision makers in investments in water for agriculture. The workshop outcomes have been incorporated in the *Synthesis Chapter on Water and Rice of the Comprehen-*

sive Assessment. We also developed a synthesis chapter for the *Comprehensive Assessment of Water Management in Agriculture*. The final synthesis of the *Comprehensive Assessment* is scheduled to be published in September 2006.

In 2005, we saw the completion of an Australian Centre for International Agricultural Research–supported project on irrigation and water productivity in China, which had received a 6-month extension following favorable evaluation. Project findings highlighted the need for a multiscale integrated approach to the improvement of water management at the irrigation-system level. Interventions need to combine improvements in irrigation infrastructure, supporting policies, management schemes, and farm-level technologies such as alternate wetting and drying or aerobic rice. The findings were published in a special issue of *Paddy and Water Environment Journal* and presented at the 2005 International Commission on Irrigation and Drainage Congress in Beijing. Next, we will carry out a dialogue with Chinese irrigation managers and policymakers on recommendations based on the project findings.

As part of the 2005 strategy for Theme 1 (Water Productivity) of the Challenge Program on Water and Food, a conceptual framework for the analysis and improvement of crop water productivity, using a systems-analysis approach, has been developed. This will form an umbrella for research on developing technologies to improve water productivity in 11 core projects of the Challenge Program on Water and Food.

Output 2: Interactions among the hierarchical scales of irrigation systems investigated and strategies identified for translating water savings at the farm scale into savings at the scale of irrigation systems

In 2005, a paper on "Operational and resource-use performance in the Cu Chi irrigation system" was published in the ACIAR Proceedings No. 118. This was part of our system-level studies in Vietnam. The findings showed that there was considerable water reuse within an irrigation system but the operational and resource-use performances of the system were low, which was attributed to low income from rice and a lack of incentives for farmers to reduce water inputs.

Project leader

Bas Bouman, senior scientist, water science, b.bouman@cgiar.org

PROJECT 6

Irrigated Rice Research Consortium

An estimated 2.2 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 the enormous importance of rice, however, many farmers who grow it remain poor.

The Irrigated Rice Research Consortium (IRRC) provides a framework for partnership that combines IRRI and national agricultural research and extension systems (NARES) and that facilitates and strengthens NARES research and technology delivery. The IRRC is active in nine Asian countries that grow irrigated rice 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 nongovernmental organizations and the private sector to identify and help implement solutions to farmers' problems.

In 2005, phase III of the IRRC began, and will continue until 2008. The IRRC is organized in workgroups composed of interdisciplinary teams of research and extension workers within each of the sites at which the consortium operates. The workgroups are based on national research priorities and specific activities designed to solve farmers' problems of production in the irrigated and favorable rainfed rice ecosystem. Each activity has high anticipated impact for the collaborating site at which it is undertaken and, most importantly, for the region. The workgroups—Productivity and Sustainability, Water Saving, Postproduction (postharvest), and Labor Productivity—are linked to an overarching Impact Workgroup, 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 2005, the IRRC consolidated its research-extension partnerships and continued work to ensure the relevance of NARES research. Some key achievements in 2005 included the recruitment of an IRRC coordinator of Phase III (2005-08), the establishment of a new Steering Committee for Phase III, and an increase in the resources and efforts for training NARES partners. IRRI

hosted a meeting of the IRRC Steering Committee in September 2005 to review progress in 2005 and plans of workgroup activities for 2006. Substantial research activities under the IRRC workgroups have progressed in nine countries, with new research activities begun in Myanmar. In 2005, the IRRC conducted 24 workshops, presented 40 conference papers, and produced 18 scientific publications.

The new IRRC structure and NARES partnerships are now in place and poised to provide an international platform and effective mechanism, both of which will allow the research-extension partnership to promote the use of sustainable, benefit-enhancing technologies in irrigated rice-based systems.

The IRRC will take several important steps in the near future, including recruitment of a social scientist, exploration of opportunities for strengthening involvement in Lao PDR and Myanmar, and development of a communication plan, including documentation and promotion of success stories that highlight technologies positioned for impact.

The IRRC developed a framework in 2005 for integrating the most appropriate crop and resource management technologies to meet location-specific needs and opportunities among consortium partners in the major rice-growing countries of Asia. These include

- *Myanmar*. An in-country outreach program (ICOP), launched in Octo ber 2005 with the Myanma Agricul ture Service.
- *Vietnam*. Meetings held in October to discuss a Vietnam ICOP. Support is strong for scaling up site-specific nutrient management, crop establishment technologies, water man agement, and extension and training activities on rice grain-drying systems for NARES and private indus try partners.
- *China*. A national IRRC workshop was held in October 2005, with par ticipants showing strong interest in scaling up the delivery of tech nologies developed from collab orative research on nutrient and pest management.
- *Philippines*. Information on water-saving technologies was synthesized and evaluated, and a national work shop on progress and plans for aero bic rice was conducted.
- *India*. The IRRC helped scale up di rect-seeding options for farmers in the states of Uttaranchal, Uttar Pradesh, and Bihar.

We have made strong progress toward placing NARES and industry partners in position to scale up the delivery of technologies in China, Myanmar, the Philippines, and Vietnam.

In several countries in 2005, the Postproduction Workgroup evaluated a cheaply produced moisture meter and simple grain quality kit, and began a study of the effect of hermetically sealed bags (the "superbag" developed at IRRI) and other hermetically sealed systems on grain and seed quality. We continued to compile and analyze data on the monthly market prices of milled grain in different regions of several countries and we evaluated rice mills in Indonesia and Vietnam. In Vietnam, we oversaw the adaptation of a rice hull furnace with improved feeding for use with commercial rice dryers and we trained staff from Nong Lam University and

researchers from Bac Lieu Province on laser leveling.

The Productivity and Sustainability Workgroup further established research and local extension partnerships in several countries, including a crop residue management project in China and a study of potassium needs for high yield in the rice-wheat belt of northern India. Site-specific nutrient management underwent further promotion in China, Myanmar, the Philippines, and Vietnam. We established an active partnership with the Center for Chinese Agricultural Policy for farmer participatory and policy research and with China Agricultural University in other national initiatives. In Indonesia, the IRRC provided about 40,000 new four-panel leaf color charts (used by farmers to easily determine the nitrogen needs of their rice plants) for distribution and, at a June 2005 workshop, built consensus on nutrient management and research, and private sector and extension partnerships. Leaf color charts were also provided for distribution by NARES in Myanmar, the Philippines, and Vietnam. In central Vietnam, we completed two seasons of farmer participatory research in 2005, determining that yields could be increased by 0.5 ton per hectare or more with the addition of zinc to sandy loam soil, and that potassium and phosphorus deficiencies existed across different soil types. In northern Vietnam, the IRRC collaborated with the Danish International Development Agency to establish training of trainers and farmer field schools in integrated nutrient management.

The Water Saving Workgroup synthesized and evaluated information on water-saving technologies, ultimately contributing to the *Comprehensive Assessment of Water Management in Agriculture* (see Project 5). In the 2005 wet and dry seasons, experiments were conducted at four locations in the Philippines on water-saving technologies with emphasis on aerobic rice. Also in the Philippines, we conducted an ongoing assessment of farmers' adoption of alternate wetting and drying (dry season) and aerobic rice (wet season) in Central Luzon, and developed water-saving extension materials (posters, leaflets, brochures, and a flip chart) in both English and Tagalog. These were distributed to NARES partners, extension workers, and farmers. In China, we conducted water-saving experiments with emphasis on aerobic rice.

The Labor Productivity Workgroup tested direct-seeding options and compiled information for decision frameworks for crop establishment and weed management in Bangladesh and India. Sources of information availability for Bangladeshi and Indian rice farmers are being assessed and information gaps identified. In India, Indonesia, and the Philippines, we analyzed shifts in weed species as influenced by different weed management practices. In 2005, research began in Indonesia on yield losses due to weeds and management options in southern Sumatra. In Myanmar, we developed a poster for weed identification. In Malaysia, information was drafted for a publication on "weedy rice" and we began evaluating integrated weed control measures for weedy rice. The distribution of weedy rice infestation in China's Liaoning and Jilin provinces was determined in an initial survey and we evaluated integrated weed control measures in Zhejiang Province. Studies on the distribution of the weed Cyperus rotundus and its adaptation to lowland rice in the Philippines were undertaken with the University of the Philippines Los Baños.

Project leader

Grant Singleton, coordinator, Irrigated Rice Research Consortium, g.singleton@cgiar.org

Program 3

Improving productivity and livelihood for fragile environments

Rice farmers working in environments that are unfavorable for high levels of production—infertile uplands, rainfed lowlands subject to frequent droughts and submergence, and deepwater and coastal areas that suffer from flooding, strong winds, salinity, and other soil-related problems—suffer from low farm income and high incidence of poverty. Further, more than 700 million of Asia's poor depend on rice grown in these environments, receiving 50–80% of their calories from cereal 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, given the environmental perils they face, unwilling to invest adequately in inputs such as fertilizer. The resultant yields they achieve are thus low, averaging less than 2 tons per hectare compared with more than 5.5 tons per hectare in favorable irrigated lowlands. But, if farmers are to adopt them, new, higher-yielding varieties—which must be tolerant of drought, submergence, and problem soils—must also be comparable in quality with traditional varieties if farmers are to adopt them. Such varieties, along with appropriate and efficient crop management practices, will help reduce the risk in rice cultivation that contributes to socioeconomic inequity and will help increase both yield and farm income.

Recent advances in molecular biology for tagging and characterizing genes and their transfer to other

species have increased the chance of successfully developing high-yielding rice varieties suitable for unfavorable ecosystems. The diverse nature and wide geographical spread of these environments make it essential that this research be carried out in partnership with national agricultural research and extension systems (NARES) and 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 are grouped into three projects, on genetic enhancement, natural resource management, and the activities of CURE. Project 8, which focuses on natural resource management, now also incorporates the former Project 11: *Enhancing ecological sustainability and improving livelihoods through ecoregional approaches to integrated natural resource management*, which aims to improve rural livelihoods by enhancing the sustainability of supporting ecosystems.

PROJECT 7

Genetic enhancement for improving productivity and human health in fragile environments

Improving rice production in unfavorable cropping areas that rely on rainfall can lead to important gains in food security, human nutrition, poverty reduction, and environmental protection. Most modern rice varieties developed for irrigated systems in more favorable environments tend to perform poorly under rainfed conditions, resulting in low and unstable yields and poor profitability. For these reasons, it is crucial that we develop rice varieties that are tailored for unfavorable ecosystems. Such varieties should combine high and stable yields and consumer-preferred grain type with traits such as enhanced seedling vigor; greater resistance to drought stress through improved tolerance, avoidance, or escape; heightened tolerance of submergence; improved ability to grow in soils that have toxic levels of salt, iron, or aluminum or are deficient in phosphorus or zinc; and strengthened resistance to pests and diseases, especially the blast fungus. Development of these types of varieties is the goal of Project 7.

Although improved, more reliable yields will offer more calories, there is also potential to improve the

diets of poor consumers beyond simply increasing their food intake. Rice is the dominant staple in the Asian diet, often providing more than half—and up to three-quarters—of consumers' 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.

Thanks to a number of scientific advances in recent years, researchers have already identified promising genetic material and clear breeding strategies for the genetic enhancement of varieties for fragile environments. Prospects are now good for breeding into rice varieties several important traits such as higher nutrient levels and tolerance of drought, submergence, phosphorus deficiency, and saline soils.

Aiding our progress in this field is IRRI's unique ability to bring together the research performed in advanced research institutes and the private sector in industrialized countries with that of the NARES in developing countries. In this way, we can use the best of both worlds to create varieties for rice farmers in highly diverse rainfed ecosystems. The efficiency of these breeding activities is enhanced through gene discovery using functional genomics (Project 2).

The impact of Project 7 is further boosted by 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 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. Animal and human nutritional studies on the bioavailability and food safety of micronutrient-rich rice are continuing.

Output 1: Superior germplasm for rainfed lowlands developed

IRRI distributed several improved breeding materials to NARES in 2005, including lowland breeding lines with improved drought tolerance. Five varieties confirmed to have tolerance of moderate lowland stress at the reproductive stage outyielded two popular modern varieties (IR64 and IR72) by more than 50% under drought conditions. These lines are being distributed to national programs through the International Network for Genetic Evaluation of Rice (INGER) and the IRRI-India Drought Breeding Network, which was established at five drought-prone Indian locations in 2005 (see Output 6). These drought-tolerant varieties have the potential to improve yield stability and overall productivity in drought-prone upper fields. We also confirmed that hybrids are more drought tolerant, on average, than related inbred varieties, raising the possibility that hybrids can make an important contribution to productivity in drought-prone environments. IRRI hybrid IR77843H is the most drought-tolerant improved lowland cultivar available.

We developed backcross lines with the submergence tolerance *Sub1* gene (see Project 2), and these were distributed to NARES. *Sub1* was transferred to the mega-variety (a widely grown variety, typically grown on more than 1 million hectares) Swarna by marker-assisted backcrossing and this Swarna-Sub1 line was distributed to breeders in India and Bangladesh for evaluation. Submergence tolerance of this line was confirmed, and no agronomic differences were observed between Swarna-Sub1 and Swarna. Breeding *Sub1* into popular varieties seems to be effective in conferring submergence tolerance without deleterious effects on yield or quality, meaning that quick adoption of the new variety should be possible.

We identified quantitative trait loci (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)—and candidate genes for yield, pollen fertility, panicle exsertion (required for floral fertility), and tolerance of active oxygen species (molecules that are toxic to plant cells if not removed by the plant's own defense systems) with both lowland and upland (Output 3) drought stress. More than 850 inbred lines were developed by crossing the varieties IR64 and Moroberekan. We can now test hypotheses concerning the role of candidate genes in determining morphological characteristics that influence floral fertility. Detection of QTLs with large effects on yield under stress is a breakthrough in drought tolerance research. Determination of the physiological and biochemical effects of these genes will yield important basic information on the mechanisms underlying genetic variation for drought tolerance in rice. The genes, when fine-mapped, will be deployed via marker-assisted selection (MAS).

With support from the Generation Challenge Program, we also identified QTLs and candidate genes for phosphorus (P) uptake, including the Pup1 gene (see Project 2). The identification of markers linked to *Pup1* will facilitate its introgression into mega varieties.

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

In 2005, we developed lines combining increased nitrogen (N) responsiveness with improved yield in low-fertility conditions. Hybrids, which performed well under low-input management, tend to be more effective at using available soil N and could provide rainfed lowland farmers with improved yields under conditions where inorganic fertilizer cannot be economically applied.

With support from the Generation Challenge Program, an MAS system for breeding varieties with salinity tolerance (using the Saltol QTL) was implemented in India and Bangladesh. We identified eight genetic markers that appear suitable for MAS. These markers will be useful in the development of a marker-assisted breeding system to incorporate Saltol into mega varieties.

Wild rice species are a good source of useful agronomic traits. In 2005, we introduced into five breeding lines wild rice genes for tolerance of soil acidity and iron (Fe) toxicity. These lines will be useful for breeding varieties that grow well in toxic soils. IRRI line IR73678-6-9-B, released under the name AS996 in Vietnam for tolerance of acid sulfate conditions, is already performing very well in farmers' fields in the Mekong Delta.

We identified mechanisms, major genes, and QTLs for tolerance of zinc (Zn) deficiency. Intolerant lines suffer from leaf damage by reactive oxygen species as a result of stress. The amount of damage does not correlate with tissue Zn concentrations but with a high manganese:Zn ratio. Preliminary data indicated the presence of several QTLs for seedling survival, leaf bronzing, and delayed flowering. We have mapped the QTLs on the rice genome and evaluation of the best lines from this mapping population under Zn deficient/alkaline conditions in northern India identified two lines with high dual tolerance of Zn deficiency and alkalinity. The initial mapping has paved the way for further efforts in tagging important QTLs for breeding, and the lines identified are useful prebreeding material.

Output 3: Superior germplasm for infertile uplands developed

Short-to-medium duration, weed-competitive, and drought-tolerant varieties with acceptable quality were sent to NARES for advanced testing. Some 230 promising upland materials were sent to interested NARES through INGER. In the Philippines, 16 promising upland rice breeding lines have been included in national testing programs (2001-05). Some of these are being evaluated on-farm. These materials could be commercially released if they consistently perform well over several years and locations.

We confirmed the effectiveness of direct selection for drought tolerance. Direct selection for yield under drought stress resulted in average yield gains of 25–40% in four upland rice populations. Lines selected for yield under

managed reproductive-stage stress produced yields that were as high as that of the tolerant parent. Managed-stress screening for yield is now a routine part of IRRI's upland rice breeding program. Lines combining improved yield under stress and high nonstress yield potential are being distributed via the IRRI-India Drought Breeding Network and national programs are implementing direct selection for yield under stress in their breeding programs.

Functional alleles (versions of genes) for quantitative blast resistance were validated in different genetic backgrounds and environments, and the mechanisms were pyramided into breeding lines (that is, several mechanisms for blast resistance were employed in each line to confer a broader spectrum of resistance). Individual alleles of defense-response genes contribute a 14–29% reduction in disease severity. Two promising lines with resistance to seedling and neck blast provided a good source of blast resistance genes. At least six favorable alleles have been tagged, allowing us to track useful candidate gene alleles associated with partial blast resistance. Advanced lines carrying favorable combinations of defense genes showed around 90% disease reduction in blast nursery trials in the Philippines.

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

In 2005, we developed high-yielding, high-quality second-generation aerobic rice varieties with yield potential of over 5 tons per hectare under moderate drought stress. These varieties, which produce around 4 tons per hectare with 600 mm of water, will be tested in India under the IRRI-India Drought Breeding Network in 2006. Despite improving the drought tolerance of advanced aerobic rice lines—thereby improving their yield stability—there has been no major breakthrough in yield potential over the popular aerobic variety Apo. However, more drought-tolerant aerobic rice lines are more stable in environments with uncertain rainfall or water availability. These lines tolerate brief periods of stress around flowering that can cause total yield collapse of elite aerobic rice lines like Apo.

We have mapped alleles conferring aerobic adaptation as well as tolerance for reproductive-stage stress and resistance to lodging. Apo alleles at two loci, which jointly explain more than half of the genetic variation for yield, increased grain yield under aerobic conditions by 1 ton per hectare in 2005 field trials.

We confirmed the efficacy of breeding methods for aerobic weed competitiveness. Weed competitiveness in aerobic rice was associated with rapid seedling growth and erect plant type. Selection protocols for weed competitiveness have subsequently been incorporated into the IRRI aerobic rice breeding program. Improved aerobic rice varieties were demonstrated to be more weed-competitive than traditional upland varieties under researcher management in northern Lao PDR. Furthermore, there is no trade-off between weed competitiveness and high yield potential under aerobic management. We are developing cultivars that require only one hand-weeding in order to produce acceptable yields and aerobic rice varieties with improved weed competitiveness are being evaluated on-farm in northern Lao PDR.

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

In 2005, we screened a wide range of rainfed germplasm for Fe and Zn concentration in milled rice under uniform environmental conditions. We also identified potential donor varieties. Germplasm meeting the HarvestPlus target for Zn has been identified and we are in the process of identifying germplasm with higher Fe content. We will evaluate a large number of diverse accessions from IRRI's International Rice Genebank for iron and zinc content and germplasm with high zinc levels will be evaluated in different environments to assess its robustness.

Output 6: NARES-IRRI partnerships in rice breeding enhanced

IRRI continues to integrate effective, low-cost methods of plant varietal selection (PVS) into breeding programs. In this light, PVS is being institutionalized in the Lao lowland breeding program. Data on adaptability of upland rice germplasm were collected in all northern provinces of Lao PDR through mother-baby trials (the "mother" is the earlier, research-managed trial and the "baby" is the trial directly involving farmers). In 2005, we developed a low-cost farmer-managed baby trial protocol that is effective in predicting cultivar

adoption and have hence identified several promising upland genotypes. The improved methods of PVS allow farmers to select the best genotypes under their own management practices and provide feedback to researchers on farmers' varietal preferences and experiences. Expanded on-farm adaptation trials of promising materials will be conducted in two northern Lao provinces (Sayaboury and Oudomxay) in collaboration with local officials.

Biophysical and socioeconomic constraints to adoption and farmers' (both men and women) criteria for varietal selection were identified for key sites in India, including areas of submergence-prone and salt-affected environments. The lack of suitable varieties for drought-prone and submergence-prone environments, along with the lack of access to improved released varieties, was the main constraint for farmers in increasing rice productivity in these fragile environments. This research allows development of strategies to fast-track adoption of new rice varieties by poor farming communities in fragile environments.

The Eastern Indian Rainfed Lowland Shuttle Breeding Network is a collaborative NARES-IRRI network of rainfed rice breeding programs targeting flood-prone lowlands in eastern India. In 2005, the network incorporated PVS into its program. Researcher-managed trials consisting of elite lines (from rice research institutions in India, including those participating in the Eastern Indian Rainfed Lowland Shuttle Breeding Network) and farmers' local popular varieties were evaluated by farmers at the research station and in farmers' fields. Lines preferred by farmers were tested by the farmers themselves in their own fields, using their normal management practices. Social scientists and plant breeders gathered feedback from farmers, who select varieties based not only on yields but also on the duration of the variety that best fits their local environment and their cropping systems. Other important criteria for selection included postharvest quality, shape and size of grains, eating and cooking quality, and livelihood uses of rice (such as livestock feed, roof thatching, and other rice products). To further ensure continued farmer feedback into the national seed production process, strategies for institutionalizing PVS through the All-India Coordinated Rice Improvement Project are under way, thereby ensuring that future seed releases will be based on needs identified by farmers in their specific rice environments. Several lines from PVS trials, conducted by the Narendra Dev University of Agriculture and Technology, for submergence-prone ecosystems were released by the formal release system in India.

A NARES-IRRI drought-tolerance breeding network, the IRRI-India Drought Breeding Network, began in 2005 for drought-prone lowlands and was established at five drought-prone Indian locations. The network is the first to focus on multilocation field evaluation of rice varieties for drought tolerance and will allow quick and efficient evaluation of new IRRI and NARES lines, donors, and functional genomics products under a range of stress conditions. In 2005, social scientists conducted a study on the spread of new lines in Siddathnagar (a submergence-prone area) and Faizabad (a drought-prone area) in eastern Uttar Pradesh and documented reasons for adoption and nonadoption of introduced new rice lines and helped promote the acceptability of improved varieties. PVS demonstrated that farmer-selected lines spread rapidly via farmer-to-farmer exchange.

We are integrating PVS into variety testing programs in the Philippines and Indonesia. PVS trials helped promote improved varieties in Arakan, Philippines, where inaccessibility and unavailability of improved varieties are a major constraint to adoption. PVS also assisted in documenting farmers' varietal preferences. This approach was extended to Lampung, Indonesia, where PVS trials facilitated evaluation of the most promising varieties and lines. Breeders were able to determine acceptability of varieties and preferences of farmers based on crop stand, crop duration, plant height, shape or length of grains, resistance to blast, and tolerance of aluminum toxicity. In the future, breeders will also examine farmer preference for eating quality, an important trait used by farmers in choosing varieties. Local extension workers appreciated the benefits of engaging farmers in evaluating and selecting promising varieties.

Project leader

John Bennett, senior scientist, molecular biology, j.bennett@cgiar.org

PROJECT 8

Natural resource management for rainfed lowland and upland rice ecosystems

Rice farmers living in unfavorable environments are almost completely reliant on rain. If the rains in any given season are poor, so too is the resultant crop. Yields in these ecosystems—home to 80 million families who farm a total of 60 million hectares—tend, therefore, to be low and unstable. Consequently, the farm families who live and work in these environments are among the world's poorest. Poverty, in turn, makes farmers unwilling to invest in improved rice production and resource management techniques, thereby entrenching inappropriate farm practices that degrade natural resources. From this position, it does not take much—a season or two of poor conditions, for example—to drag families deeper into poverty. Many of the people living in unfavorable areas belong to ethnic minorities and, as such, their plight is often compounded through social and political marginalization. Project 8 seeks to overcome these problems by improving crop and natural resource management (NRM) practices, offering solutions that can be easily and cheaply adopted by resource-poor farmers, and finding innovative and effective ways to communicate these solutions to the people who need them most.

Project 8 now incorporates the former Project 11: Enhancing ecological sustainability and improving livelihoods through ecoregional approaches to integrated natural resource management (see Output 3). This 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. IRRI uses a systems approach, drawing on diverse expertise to integrate the many dimensions of NRM across disciplines, geography, time, and the research-development-policy continuum. Our aim is to generate integrated natural resource management knowledge and the tools with which to use such knowledge. The results are freely promoted and exchanged among researchers, policymakers, and users of natural resources. Successful integrated NRM allows stakeholders at all levels to make informed resource management choices through an improved ability to articulate objectives and negotiate demands and subsequent better use of 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

There is no disputing that drought can devastate farming communities. Successful strategies for mitigating drought's pernicious effects are urgently needed. In 2005, we analyzed the drought-coping mechanisms of rice farmers and researched the implications for research and policy. A quantification of the impact of drought on poverty indicated that, in eastern India, nearly 13 million people are pushed into poverty during drought years. The magnitude of economic loss from drought is very high—on the order of US$400 million per year in eastern India alone. Improved rice technologies and policies for promoting income diversification are vital if the poverty impact of drought is to be reduced.

With support from the Generation Challenge Program, crop intensification strategies were developed for coastal and inland salt-affected areas. One strategy, double cropping of rice using water stored in the canals used to irrigate crops in the boro (dry) season, was successfully tested in Khulna, Bangladesh.

We also examined the performance of 10 nonrice crops in a rice-based cropping system during the dry season at high and low salinity levels in coastal Orissa, India. Under high salinity, of the nonrice crops, sunflower survived, producing yields of 1.25 tons per hectare (rice equivalent of 5.0 tons per hectare). Under low salinity, watermelon, pumpkin, chili, sunflower, and okra showed promise based on crop and water productivity. Water productivity was highest for watermelon, followed by pumpkin, chilli, okra, and sunflower. Liming (applying calcium to the soil) improved crop establishment and yield of sunflower, watermelon, and okra.

In the Indian state of Uttar Pradesh, medicinal plants showed good potential and preliminary trials suggested a wet season–dry season crop rotation of sweet basil–Matricaria (chamomile), respectively, to be most profitable because of their better tolerance of sodic soils. Development of efficient rice-based cropping systems through the introduction of less water-intensive nonrice crops, based on farmers' preferences and times of good water availability, will enhance crop diversity and water productivity. This will allow dry-season cultivation of more areas with limited water availability, most of which were previously wasted.

A related project, also linked to the Generation Challenge Program, examined integrated crop and resource management strategies designed to stabilize rice yields and enhance crop intensification in coastal and inland salt-affected areas. Modern salt-tolerant rice varieties were successfully tested in the rainy season and accepted by farmers in Khulna, Bangladesh. With the Central Rice Research Institute, based in the Indian state of Orissa, we developed and validated several crop and natural resource management practices for enhancing crop and water productivity in coastal areas. These included improved nursery management and crop establishment strategies (seedling age and spacing and timing of transplanting in the dry season, for example); integrated nutrient management involving chemical fertilizer, Sesbania green manure, and *Azolla* biofertilizers; and water management strategies such as using marginally saline water for irrigation during vegetative growth in the dry season. Some of these strategies have already been initiated and will be pursued more vigorously in the coming years.

With the Central Soil Salinity Research Institute and Narendra Dev University of Agriculture and Technology in India, we are also testing low-cost technology for reclaiming sodic soils in Uttar Pradesh. The use of 25% gypsum (as opposed to 50% gypsum), to boost soil calcium content, along with a salt-tolerant variety of rice was found successful and could help double the area reclaimed without increasing resource use. In sodic soils, modern high-yielding varieties such as CSR23—which matures about 25 days earlier than CSR13, the previously best available salt-tolerant variety—were found to be more responsive to nitrogen (N) than older varieties. The new varieties also save water and help ensure timely sowing of succeeding crops such as wheat.

In farmers' fields, pressmud (a combination of straw, cow dung, and sugarcane residue from sugar mills, which is used as a manure) plus zinc substantially enhanced water productivity and improved yield in sodic soils (19–45% over the control). The yield advantage was greater in soils with higher sodicity, indicating the efficacy of this technology for the worst-affected soils.

This strategy can indirectly preserve soil health and underground water quality and allow sustainable expansion on sodic lands, particularly for the resource-poor farmers who own these lands. Potential environmental benefits include reduced gypsum mining and reduced energy costs for transportation. The residual effects of pressmud on the yield of the succeeding wheat crop are being evaluated.

The cropping season has been extended for double cropping through freshwater harvesting in Orissa, India, and Shatkhira, Bangladesh. We are also evaluating effective, highly profitable rice-shrimp systems in areas where fresh water is not available during the dry season and improved strategies for shrimp and fish cultivation in rice-shrimp and rice-fish systems are being extended in Vietnam and Bangladesh. These strategies resulted in increased water-use efficiency, and use of land that was either underused or left barren in the past.

The widespread bolon system in Bangladesh, which involves double transplanting of rice to avoid submergence in heavy flooding, is expensive in terms of labor and has low productivity. We developed strategies to improve *bolon* for submergence-prone areas and tested these in farmers' fields. Improved practices were introduced to two farmers' groups, which were formed to transfer technologies to improve rice productivity, in two villages in Rangpur, Bangladesh. Sowing at the correct date and with appropriate plant density improved yields in farmers' fields from an average 3.9 tons per hectare to 4.3 tons per hectare. We also completed a comparative study of costs, returns, and technical efficiency of the double transplanting system versus a single transplanting system, determining that double transplanting suits the ecological conditions of the region and, economically, is an equally efficient system.

Following the completion of an analysis of technology adoption patterns in rainfed areas of eastern India, we developed technology design and policy improvement guidelines based on research on biophysical and socioeconomic factors affecting rice productivity. Despite the spread of modern varieties in rainfed areas, productivity gains have been quite small in areas subject to drought and/or submergence. Most of the improved varieties grown in these areas perform poorly under stressed conditions and, hence, improved varieties specifically adapted to such stresses need to be developed.

In the drought-prone lowlands of India, Lao PDR, Thailand, and Bangladesh, we tested improved cropping systems on-farm. The results show that considerable improvements in productivity and profitability are possible and the new cropping system options have great potential for improving livelihoods in the drought-prone environments of the target areas in eastern India and Bangladesh. Because poverty and population density are both high in these regions, significant impact is possible. However, options for improving systems in Lao PDR and Thailand are currently limited and a reorientation of farming principles in these areas may be necessary.

In Raipur, in the eastern Indian state of Chhattisgarh, we tested a flexible, integrated cropping system that allows farmers to select management options suitable for the biophysical constraints of their land and their household's socioeconomic conditions. All options target the reduction of risk by allowing earlier establishment and shorter crop duration, thereby increasing the possibility of a postrice crop such as chickpea, for example. The options also address varying socioeconomic situations, such as labor requirements and available resources, as well as different soil types and availability of machinery, water resources, and labor. Elements of choice for farmers include rice variety, rice establishment practices, weed management practices, and nutrient management. Data from two seasons suggested that adopting the best site-specific solutions can increase yields by 0.5–1.5 tons per hectare over the existing practices, while increasing the possibility of a postrice crop of chickpea. Chickpea can increase farmers' food security and/or enhance their livelihood through income generation.

In northeast Thailand, we found that the farmers' practice of low rates of inorganic fertilizer often outperforms the currently recommended rates and some soils react better to organic nutrient sources. This indicates that site-specific nutrient management (SSNM) is necessary to make efficient use of inputs for risk-averse, resource-poor farmers. Based on these observations, we produced a draft decision tree for

SSNM in northeast Thailand. In highly drought-prone areas of the region, we researched the improvement of direct-seeded systems. Although considerable yield losses due to weeds were shown, the tested weed management options did not perform substantially better than farmers' management.

In Lao PDR, we validated non-chemical integrated pest management for gall midge. The integration of cultural control practices, including the use of resistant varieties, prevented massive crop loss due to gall midge outbreaks. Root aphids, *Tetraneura nigriabdominalis*, were identified as a major pest of upland rice in Luang Prabang, Lao PDR, and may be a major factor in upland rice yield decline when rice is grown repeatedly on the same land. Next, we will identify varieties with potential tolerance of or resistance to root aphids.

As part of the Fish and Rice Management System to Enable Agricultural Diversification (FARMSTEAD) project in Cambodia, we examined the effect of intensification on crop loss, finding 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.

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

In 2005, we performed an economic analysis of farmers' cropping practices and livelihood strategies in the uplands of Lao PDR and evaluated the socioeconomics of improved cropping system technologies for sloping upland systems. Several economically viable cropping systems were identified and these are now being validated under farmers' field conditions. We also conducted an economic evaluation of mulch- and cover crop–based conservation farming in the uplands of Vietnam. Results show that these mulch-based systems are not sufficiently economically attractive to be adopted by farmers when compared with classical solutions such as terraces. The data generated provide benchmark information for comparing returns from improved practices.

We studied several types of farms in Vietnam's highlands in an examination of the hierarchy of the factors of farm management that constrain changes in cropping systems, taking into account the diversity of highland farms. Most of the studied farms are undergoing a rapid transition from subsistence to market-oriented farming. It appears that innovative cropping systems are not likely to be adopted unless they simultaneously and markedly increase both labor and land productivity. More and more, off-farm activities interfere with farm management and have to be considered when designing changes in production systems.

Participatory studies and on-farm tests allowed the development of an updated list of options for the sloping uplands of Vietnam. These options were classified according to their likeliness of adoption by farmers. Dry terraces cultivated with various cropping patterns involving upland rice and maize emerge as the most attractive option where soil erosion is a problem. However, farmers were reluctant to introduce mulch and/or cover crops in their upland rice crops on the slopes.

In collaboration with farmers, we developed improved cropping systems tailored to the farmers' existing constraints. In Karnataka, India, we documented the agronomic practices and production economics of direct-seeded rice in the rainfed uplands. Improved production practices were subsequently developed. As part of the FARMSTEAD project, we developed improved cropping systems in Cambodia and tested these in 10 fields, resulting in improved rice yields and profits.

Output 3: The ecoregional concept for integrated natural resource management adopted and systems approaches applied for improving livelihoods and sustaining natural resources (formerly Project 11)

We conducted socioeconomic surveys in villages located in less productive, drought-prone, and submergence-prone fragile rice environments in Bihar, Jharkhand plateau, and eastern Uttar Pradesh in India. Female *de facto* heads of households and female farm managers were prevalent due to long-term and seasonal male out-migration to urban areas, with the exception of Bihar, where rural-to-rural migration is more common. Despite the absence of male family members, female family members maintained rice productivity and management by increasing their labor inputs into production, and borrowing money to buy inputs and pay hired laborers. Aside from gap filling, transplanting, applying farmyard manure,

and hand weeding, which were done exclusively by female family members, women had to take on tasks formerly done by men, such as cleaning dikes, irrigating fields, applying chemical fertilizers, and hauling and packing paddy. Women have also assumed managerial roles (including supervision of hired laborers) and their decision-making authority in rice production (such as choosing which varieties to plant) has also increased. We identified appropriate and available strategies and technologies to help solve the labor constraints of female-headed households. These include short-duration rice varieties that can escape drought and floods, can enable farmers to grow nonrice crops after rice, and reduce weed infestation; direct seeding using plastic drum seeders to reduce drudgery and labor costs of transplanting and weeding; mechanical implements for row seeding; the use of leaf color charts for proper timing of N application; and water-conserving techniques such as mulching. Improved nursery management and crop establishment strategies—such as seedling age, spacing and timing of transplanting in the dry season, and use of *Sesbania* green manure and pressmud to restore soil health in sodic soil areas—are also important options.

Project leader

Kong Luen Heong, senior scientist, entomology/ IPM specialist, and deputy head, Entomology and Plant Pathology Division, k.heong@cgiar.org

9

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 continued to grow mostly traditional varieties or used few inputs when they adopted modern varieties. Hence, productivity gains have been incremental and small. It is essential, if we are to meet the challenge 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, and improve household food security and livelihood without harming the environment or depleting the available natural resources. Throughout the highly diverse unfavorable environments, our strategy involves on-site work with our partners in the national agricultural research and extension systems (NARES) 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.

Working groups' progress

The fourth annual meeting of the CURE Steering Committee, held on Lombok Island, Indonesia, on 24-27 May 2005, reviewed progress reports given by its six working groups. The Steering Committee appraised working groups' progress, approved 2005 work plans, and made strategic decisions regarding future research in rainfed ecosystems. The required technical reports detailing the progress of CURE's six working groups concerning rainfed ecosystems at the nine key sites in six countries were given in the 2004 year-end and 2005 mid-year reports submitted to the Asian Development Bank on 1 February 2005 and 8 August 2005.

Drought-prone lowlands. CURE research confirmed that Thai fragrant rice variety KDML105 and its derivatives are highly tolerant of late-season drought. This is a rare documented confirmation of a highly drought-tolerant genotype adapted to the environment.

Submergence-prone lowlands. The Sub1 gene associated with submergence tolerance has been incorporated in to the popular variety Swarna for further testing on-station and on-farm (see projects 2 and 7). This advance has significantly shortened the breeding cycle from the normal 6–10 years to just 2 years.

Salt-affected environments. Scientists tested nursery and crop establishment methods that make seedlings more able to withstand the stresses of saline environments. These treatments have resulted in more vigorous seedlings that produced a higher grain yield at harvest.

Shifting rotational upland systems. Promising rice varieties for upland conditions have been identified through participatory varietal selection trials and seeds are being multiplied for distribution to farmers. These include varieties for short fallows and for intensively cropped rice-based upland systems.

Drought-prone plateau uplands. Central Rainfed Upland Rice Research Station (India) scientists received IRRISTAT (a computer program for data management and basic statistical analysis of experimental data) training at IRRI's Philippine headquarters. The training advanced participants' skills in interpreting data, selecting stable genotypes, identifying technological components across locations, and formulating a future work plan.

Intensive uplands with long growing season. Seed mixtures were shown to be more effective than row interplanting practices for reducing yield loss from disease in the endemic neck blast area of Lampung, Indonesia.

Special workshop

During its fourth annual meeting, CURE held a special workshop, *Progress in crop improvement research since 1991*, which reviewed crop improvement strategies of NARES partners and documented progress made over the past two decades. Thirteen scientists from six countries presented papers on progress in rice breeding for rainfed ecosystems in drought-prone, deepwater/*boro* (dry season), submergence-prone, tidal wetlands/problem soils, and upland areas of South and Southeast Asia and China, and identified future breeding strategies and priorities for CURE.

Project leader

Mahabub Hossain, head, Social Sciences Division, economist, and program leader, Improving Productivity and Livelihood for Fragile Environments, m.hossain@cgiar.org

Program 4

Strengthening linkages between research and development

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. There is also a growing understanding of the need for agricultural research institutions—such as IRRI and the other centers of the Consultative Group on International Agricultural Research—to increasingly involve all levels of the rice production system, from farmers to policymakers, in research planning and prioritization. This inclusive, interactive approach promises to improve our understanding of farmers' and consumers' needs and how farmers evaluate scientific knowl-

edge in the context of their traditional knowledge. This, in turn, improves the probability of research success. Further, this approach can help 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.

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. In 2005, Project 11—*Enhancing ecological sustainability and improving livelihoods through ecoregional approaches to integrated natural resource management*—was incorporated into Project 8 (see Project 8, Output 3). This program hence now contains 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 (formerly Project 12, now Project 11) aims to understand the pathways of technology dissemination, and validate and adapt promising technologies through farmer participatory research conducted in partnership with nongovernmental 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

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. Influences include people's access to and use of natural, physical, financial, human, and social resources. Further, a successful research program depends on knowledge of the influence and role of institutions that have the potential to affect lives, such as government agencies, nongovernmental organizations, and research institutions like IRRI and our national agricultural research and extension partners. If IRRI is to develop successful strategies and technologies that can help people and improve livelihoods, we must understand farmers' current practices, constraints to farmers' adoption of improved technologies in different agroecosystems, how components of farming systems and livelihood strategies interact, and farmers' criteria for evaluating scientific knowledge. Through this knowledge, we can contribute to the formulation of improved research strategies and policies.

Also crucial for research managers and policymakers is knowledge of how policies and technologies affect the well-being of various socioeconomic groups, poverty rates, and natural resource use. Without this knowledge, it is impossible to assess progress toward meeting the objectives of rice research. Understanding 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 growth in rice production. Finally, this knowledge can reveal how best to balance research on productivity enhancement and natural resource management in various countries and ecosystems.

Output 1: Rice-sector analysis conducted and a rice statistics database maintained and shared with national agricultural research and extension systems

In 2005, we completed and published reports on the assessment of food security for Indonesia, Thailand, and Bangladesh. We now have a good understanding of the factors affecting food production, trade, and consumption and the consequent impact on household-level food security. These studies indicate that increased rice production at the national level does not necessarily assure food security at the household level. In addition to agricultural research to improve the crop productivity of resource-poor households, investments in health and education are needed for enhancing income-earning capacity.

We also completed a monograph on the impact of rice trade liberalization for the Philippines. Rice trade liberalization would have both positive and negative effects. The lower rice prices stemming from liberalization would hurt larger and wealthier farmers but would benefit poor consumers, who spend more than 20% of their income on rice.

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

Women play a crucial and often unappreciated role in rice production. This role is becoming even more important as increasing numbers of men are leaving the farm for off-farm employment, especially in the industrial sector. In 2005, we completed household surveys as part of a study on the *Impact of migration and/or off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems*. Data collected from these surveys will be used in assessing the effects of off-farm employment on agricultural productivity, farm efficiency, welfare, and the changing roles of women at the household, farm, and local levels. The results indicate that rural-to-urban migration of male labor is taking place in both irrigated and rainfed rice production systems though the rates vary. This implies that labor-saving technologies are needed for women to be able to manage the farm better and technology, information, and training should be increasingly targeted to them.

In the Indian states of Bihar and Chhattisgarh, we completed analysis of data on determinants of changes in rural livelihood systems. A household-level survey in Chhattisgarh is ongoing. In Myanmar, we completed a repeat survey to assess changes in agriculture and livelihood. The data have been processed and we are drafting a report. The first draft of the manuscript of a book on rural livelihood changes in Bangladesh has been completed. We are now working on a revision to accommodate a 2004 survey and have approached the Dhaka University Press for co-publication. The results of these studies indicate that, although rice productivity growth generates equity-enhancing effects, other sources of income growth are also needed for overall poverty reduction.

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

A set of studies on constraints to the adoption of improved technologies and integrated farming methods in fragile ecosystems has been completed, including a study on the constraints to rice technology adoption in the rainfed lowlands of eastern India. Biophysical (field hydrology), not socioeconomic, characteristics of farm households were found to be the major determinants of farmers' choices of rice technologies. These findings indicate that rice technologies suited to the field hydrology of these unfavorable areas are needed for productivity enhancement.

Household-level surveys on "knowledge, decision making, and perceptions in the use of organic and chemical fertilizer by male and female farmers" (a collaboration with the South Korean Rural Development Administra-

tion) have been completed. These studies will determine whether there are knowledge gaps, differences in perceptions, and differences in participation in decision making in the use of organic and chemical fertilizer in rice-based farming systems in the Philippines. This study will allow us to identify strategies to enhance the capacity of women farmers in nutrient management for rice production.

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

In 2005, we analyzed the effect of improved rice varieties biofortified with iron and zinc on disability-adjusted life years saved in Bangladesh and the Philippines. The subsequent report has been assessed and submitted to the HarvestPlus program. Investments on rice varieties with higher iron and zinc levels in the Philippines can provide substantial social rates of return. The biofortification of rice with iron or zinc is a cost-effective and sustainable approach for improving the nutritional status of iron- and zinc-deficient people. We have also conducted focus-group discussions with farmers, traders, millers, consumers, and scientists in the Philippines and Bangladesh in an effort to identify opportunities for, constraints to, and the extent of the adoption of existing improved nontransgenic rice varieties high in iron and zinc. Farmers are likely to try hybrid and biofortified rice varieties if the grain exhibits the desired characteristics. Results of this study will serve as input in the succeeding quantitative and impact study phase of HarvestPlus.

We are compiling data on rice and food consumption, disaggregated by income class and subnational boundaries, for several Asian countries where rice is the major food staple. This has been completed for the Philippines and Bangladesh. The information will allow estimation of the regional variation in rice consumption and, consequently, the potential of iron-, zinc-, and vitamin A–fortified rice to overcome micronutrient deficiency will be analyzed at a lower geographical scale. Resulting maps can then be used to identify nutrient deficiency hotspots and target amelioration strategies.

Legislation and other initiatives that seek to improve the nutritional content of rice (e.g., brown rice) or deliver nutrients through other means (e.g., fortification of wheat flour or cooking oil, supplementation) were reviewed in 2005. We assessed the status and performance of these programs in Bangladesh and the Philippines and their potential for alleviating micronutrient deficiencies. In the Philippines, the Food Fortification Act of 2000 mandates that rice be fortified with iron. However, the costs, the fortification technology, and enforcement among millers are constraints to compliance. An analysis of the costs and benefits of the Food Fortification Act suggests a benefit-cost ratio ranging from 0.75 to 1.55, making this program relatively expensive. Thus, other alternatives such as breeding and suitable technologies for milling to enhance and retain nutrient content need to be pursued.

Knowledge of the impact of farmers' pest control practices will have implications for the future design of pest management strategies. To better understand this, we are assessing the impact of pest management technologies in the Philippines and Vietnam.

Project leader

Sushil Pandey, senior scientist, agricultural economics, deputy head, Social Sciences Division, and program leader, Strengthening Linkages Between Research and Development, sushil.pandey@cgiar.org

PROJECT 11

Facilitating rice research for impact

Developing improved rice technologies—from new varieties for cultivation through to better ways to manage a crop—is only part of the job of making rice farming more productive, more profitable, and less tedious for poor farmers, as well as reducing environmental impact. New technologies and information need to reach farmers in such a way that implementation is as easy and effective as possible. To achieve this, it is essential that the farmers themselves contribute to the process from the very beginning. Farmer feedback and participation in identifying, validating, adapting, and promoting potentially useful technologies is therefore crucial.

The challenge is enormous. Hundreds of millions of rice farmers across the world stand to benefit from improved technologies. How can we reach the greatest number possible? Further, as technologies grow more complex, they become increasingly difficult to present to farmers. Project 11 takes on this challenge by examining fundamental issues of information and technology dissemination: the problems and opportunities faced by farmers and researchers, and the optimum way to distill and present necessary and relevant messages. Through an understanding of these issues, IRRI ensures that its research focuses on what is relevant and truly helpful.

The other major piece of the puzzle is the role of the national agricultural research and extension systems (NARES). Our NARES partners—who have invaluable local, on-the-ground knowledge—are the last interface between new technologies and farmers. IRRI's partnerships with nongovernmental organizations and private-sector specialists further boost our dissemination efforts. It is vital that NARES maintain the skills needed to develop, distill, and deliver research products. It is in this light that IRRI focuses its training for NARES partners on both research and delivery methodologies to bridge the gap between technology development and its successful use.

Output 1: Develop strategies and devices for enhanced dissemination of information and knowledge-based technologies

Use and development of IRRI's Rice Knowledge Bank (RKB, www.knowledgebank.irri.org)—a comprehensive digital service containing information on rice production training and extension—continued to grow in 2005, in terms of the amount of information available, the variety of information forms suitable for different users, and the number of users. Much growth also occurred in the development of country-specific knowledge banks in which local and locally adapted RKB information is stored. In 2005, the RKB received

an average of nearly 2,000 visits per day from more than 300,000 unique visitors, almost 40,000 of whom visited more than once. The total number of hits since the RKB's inception in 2002 now exceeds 8 million, making the RKB a major contributor to global knowledge supply for the agricultural extension and research community. NARES

capacity to access and use the Rice Knowledge Bank for training and extension purposes continues to grow. The recent ADB-funded Linking Extension and Research Needs through Information Technology (LEARN-IT) program places a major emphasis on the development of the knowledge bank concept by government agencies, NGOs, and the university sector in Cambodia, Thailand, and Vietnam. We also developed 32 fact sheets on communication and impact for the RKB. These cover impact design, needs assessment, message design, formative evaluation, campaign implementation, and communication impact assessment, and provide guidelines for NARES on scaling up dissemination and technology adoption options. The continuing plan for the RKB is to institutionalize its use in countries across the region by increasing the knowledge base and the user base, and ensuring that the information at the site remains demand-driven by user needs.

Local language materials were added to the China, Lao PDR, Myanmar, Nepal, Philippines, and Vietnam RKB sites. The Bangladesh, Nepal, and Sri Lanka RKB sites are now operational and locally controlled. In Bangladesh, an RKB field laboratory has been established under a European Commission project (Food Security for Sustainable Household Livelihoods, FoSHoL) with three nongovernmental dissemination organizations and the Bangladesh Rice Research Institute (BRRI) for providing up-to-date information for farmers and field agents. The RKB will be the hub for rice and nonrice technologies. The training material has been developed by BRRI to be used by field workers under FoSHoL. At the same time, feedback by field workers and farmers will allow us to improve the suitability of the material.

In 2005, we created a series of case studies on delivery and farmer adoption of tested technologies. These, along with lessons learned, have been stored in the RKB and widely disseminated. One of the studies, performed in collaboration with the University of Southern Mindanao, Philippines, focused on tungro virus management in North Cotabato. A book documenting the case studies is being prepared and 12 studies will be included. This resource, which distills key issues in scaling up such as processes and methodologies, organizational aspects, and impact measurement and quantification, will provide extension officers and researchers with validated models for technology scale-up.

Postharvest training modules (consisting of fact sheets, reference manuals, teaching plans, and power point presentations) on harvesting, drying, storage, milling, grain quality, seed quality, and measurements were developed and posted on the RKB and are also available on a CD. These have been used for in-country training and partly translated into Khmer, Burmese, and Bahasa Indonesia. We also completed a postproduction e-learning course supplemented by fact sheets and manuals.

Ham (amateur) radio had success as a medium for dissemination of information and feedback between farmers and researchers in Tamil Nadu, India. The experience and observations on interactive ham radio communication were compiled and presented at a workshop in Thailand in August 2005. The approach has good potential in other rice-growing countries.

In collaboration with the University of Hawaii and the Timor-Leste Ministry of Agriculture, Forestry, and Fisheries, we developed a Tetun-language training and up-scaling manual on integrated crop management (ICM). Extension workers and crop production officers can use this for training and supporting farmers in Timor-Leste.

We collaboratively planned and implemented expansion programs in India, Indonesia, Myanmar, and Timor-Leste. These aimed to reach one in 20 farmers in areas where readiness to adopt technologies has been created or identified. The programs included up-scaling strategies for ICM in Tamil Nadu, India, and Indonesia; evaluation of the young seedling technique and ICM options in Myanmar (in collaboration with the Reaching Toward Optimal Productivity work group of the Irrigated Rice Research Consortium); and evaluation of the modified mat nursery and

ICM options in Timor-Leste (in collaboration with the University of Hawaii).

We worked with the private sector to commercialize the leaf color chart (LCC) in India and the Philippines. Validation and extension of the LCC were carried out in Timor-Leste, Iran, Bangladesh, Madagascar, Malaysia, Nepal, Pakistan, the Philippines, and Rwanda in collaboration with IRRI colleagues and local partners. The LCC method has been officially incorporated into a crop production manual in the Indian states of Tamil Nadu and Punjab. The government of Tamil Nadu has purchased and distributed to farmers 30,000 LCCs. Organizations in the Philippines, Malaysia, and Madagascar have also obtained LCCs for distribution.

The Department of Agriculture (DA) and the government of Tamil Nadu, along with the Indian Council of Agricultural Research (ICAR), have been convinced of the benefits of adopting ICM. Department of Agriculture staff are up-scaling in Tamil Nadu with state government funding and ICAR has authorized the evaluation and promotion of ICM throughout India.

Output 2: Validate technologies and methodologies for matching priority needs with available options through farmer participatory experiments and partnerships

In 2005, we documented an ICM impact project, implemented to optimize input use, reduce production costs, increase profits, and minimize pesticide-related health and environmental risks using participatory methods, in Central Java and West Java, Indonesia. Baseline-posttest survey analysis showed that, out of seven core ICM options promoted, four were adopted by a substantial proportion of farmers. These were planting young seedlings (15–20 days old), planting 2–3 seedlings per hill at optimum spacing, reducing N-fertilizer use, and using high-yielding locally adapted rice varieties. Significant shifts in attitudes toward crop establishment and management, nutrient management, and insecticide use were also documented.

IRRI continued to bring together NARES partners to validate jointly developed LCC and ICM projects in pilot villages. Decision makers from local and national governments are involved in the design and implementation of projects from the outset. In pilot villages, LCC and ICM have improved grain yield and food output, and brought additional profit to farmers. ICM helps farmers to fully exploit the potential of modern rice varieties. These technologies have a benevolent effect on the environment and contribute to sustainability by using resources more efficiently, reducing pesticide use, and reducing nutrient losses from the soil-water-plant system. The expansion of LCC and ICM adoption has been elevated to provincial/state and national levels in Indonesia and Tamil Nadu (India). Local, state, and national governments have provided additional funds for the wider expansion of LCC and ICM.

We documented the Three Reductions, Three Gains project—which teaches farmers to reduce their nitrogen-fertilizer rates, seed rates, and pesticide applications—in Vietnam. We initiated a Mekong-wide survey to track the diffusion of Three Reductions, Three Gains, which demonstrated how a participatory scaling-up model could achieve impact at the farmer, extension, and policy levels. Also in the Mekong Basin region, we evaluated an innovative approach using entertainment education (radio soap operas), designed to reach millions of farmers, and, as a consequence, farmers reduced their pesticide use by 38% (see Project 4).

At 125 locations in Bangladesh, we demonstrated a package of improved technologies that allow farmers to relay-crop sugarcane and rice (planting sugarcane in the same field as an established rice crop before harvesting the rice). Farmers can therefore plant sugarcane at the appropriate time without having to sacrifice the wet-season rice crop, leading to increased productivity of the available land.

In collaboration with NARES, the development and verification of hermetic sealed storage systems continued in 2005 with special focus on a hermetic storage bag, known widely as the "superbag," that allows cereal grains to be safely stored for extended periods. We verified the bag in Lao PDR, Myanmar, and Vietnam for storing farmers' seeds; in Indonesia, Vietnam, Myanmar, and Lao PDR for seed storage in large-scale

hermetic systems (5-ton capacity) for seed producers or farmer groups; and in Myanmar for the storage of commercial grains at trader and miller levels. Results showed that, by using these bags or other hermetic storage systems, farmers are able to control grain moisture levels, control grain pests without using chemicals, maintain seed germination and viability for a much longer period, and maintain grain quality longer. Hermetic storage is especially promising for improving the quality of farmers' seeds, for maintaining the quality of seed producers' seeds, and preventing pest infestation and extending the shelf life of brown rice. The bags can also be used for other commodities such as maize, coffee, pulses, and peanuts. In Indonesia, a local manufacturer has started making the *Kantong Semar*, a local version of the superbag, which has a performance similar to that of the original IRRI bag but does not need to be imported.

Output 3: Develop human capital of NARES

In 2005, we conducted or co-conducted a number of training courses and workshops. In April, we conducted training on ICM, the modified mat nursery, pests and diseases, grain quality, and postharvest management for 22 district extension and crop production staff of Timor-Leste in collaboration with the University of Hawaii in April 2005. IRRI's Rice Production Course ran twice in 2005, and was attended by 14 participants from Asia and seven from Africa. The course maintains its popularity with NARES in both Asia and Africa. A grain quality and rice production course was conducted in Sri Lanka in May/June. We conducted in-country rice production training in Antsohihy, Madagascar, in collaboration with two consultants and the Aga Khan Foundation in May, and a special rice production course and study tour for 10 Bangladeshi participants were conducted in November/December. We presented the *Scientific Writing and Presentation Skills Course* to 25 Tamil Nadu Agricultural University (TNAU) scientists at TNAU in June.

Since then, these staff have themselves conducted training courses on scientific writing and presentation skills at 10 locations throughout Tamil Nadu.

Hands-on rice mill evaluation training was conducted in Vietnam, Indonesia, and Myanmar, evaluating two rice mills in Vietnam, three in Indonesia, and one in Myanmar. The course in Indonesia led to recommendations for rice mill improvement and better understanding of the milling process and quality issues.

In collaboration with the International Potato Center, IRRI developed and conducted a course on *Participatory Research and Extension*. Participants were from IRRI and NARES research projects. We are developing a guidebook on *Participatory planning frameworks for facilitating interdisciplinary research in rice resource management*, which has been externally reviewed and is being edited for publication. The book describes the frameworks, models, and techniques used to facilitate interdisciplinary collaboration with a wide range of stakeholders at different levels, and which are applicable for communication and diffusion of technology options.

In January 2006, the Indonesian Minister of Agriculture declared the implementation of site-specific nutrient management (SSNM) in 21 provinces as recommended by the Indonesian Agency for Agricultural Research and Development. The Indonesian Institute for Rice Research has adopted the ICM approach for rainfed lowland and upland rice. More than 200 extension agents and farmers were trained in SSNM principles and using the LCC in West Java, Bali, and Banten provinces.

Project leader

Thelma Paris, senior scientist, gender specialist, Social Sciences Division, t.paris@cgiar.org

Financial Support and Special-funded Projects that Started in 2005

Summary of financial support to IRRI research agenda, 2005 (in US$'000).[a]

Asian Development Bank	789
Australia	973
Grain Biotech Australia Pty. Ltd. (GBA)	20
Canada	
Canadian International Development Agency	969
Internation Development Research Centre	16
Challenge Program	
Generation	1,745
HarvestPlus	494
Water and Food	2,653
China	140
Denmark	442
European Commission	1,930
France	472
Germany	
Federal Ministry for Economic Cooperation and Development	158
Federal Ministry for Economic Cooperation and Development/ German Agency for Technical Cooperation	1,004
India	150
International Fertilizer Industry Association (IFA)/International Potash Institute (IPI)/Phosphate Institute (PPI)/Potash and Phosphate Institute of Canada (PPIC)	146
HTSPE Limited	92
International Fund for Agricultural Development	468
Iran	78
Japan	3,035
Korea	798
Monsanto Fund	90
Netherlands	432
Norway	303
Nunhems B.V.	21
Philippines	152
Rockefeller Foundation	830
Sweden	509
Switzerland	2,013
Thailand	40
United Kingdom	2,204
United States of America	
United States Agency for International Development	3,511
United States Department of Agriculture	73
Vietnam	15
World Bank	2,077
Others	95
Total	**28,937**

[a]See Appendix 3 for audited financial statements.

- **Australian Centre for International Agricultural Research**
  - Training courses on "Leadership for Asian women in agriculture R&D and extension" and "Application of participatory approaches to agricultural research and extension" (DPPC2005-07), 2005/10/20–2005/12/23
- **Asian Development Bank**
  - Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia (DPPC2004-02), 2005/01/01–2007/12/31
  - Improving poor farmers' livelihood through postharvest technology (DPPC2002-37), 2005/07/11–2008/07/10
  - Screening the International Rice Genebank Collection for variation in carotenoid content (DPPC2002-52), 2005/04/19–2007/04/19 (through HarvestPlus)
  - Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
  - Nutrient management in aerobic rice systems (BMZ PostDoc for 2005-Dr. Christine Kreye) (DPPC2004-48), 2005/07/01–2008/06/30
- **CABI Bioscience**
  - Good Seed Initiative: South Asia (IRRI Bangladesh will handle funds for RDA-Bogra), (DPPC2005-13), 2005/03/31–2005/12/31

- Managing rice pests in Bangladesh: improving extension service information management for policy planning (Ecology and management of rice hispa in Bangladesh Phase 2) (DPPC2005-09), 2005/02/01–2006/01/31

- **Challenge Program on Water and Food (CPWF)**
  - Rice landscape management for raising water productivity, conserving resources, and improving livelihoods in upper catchments of the Mekong and Red River basins (PN 11) (IRRI-led) (DPPC2003-23), 2005/11/01–2009/10/31

- **CPWF projects managed by IRRI**
  - Conservation agriculture for the dry-land areas of the Yellow River Basin: increasing the productivity, sustainability, equity, and water use efficiency of dry-land agriculture, while protecting downstream water users-CPWF Theme 1 (PN 12) (CIMMYT-led) (DPPC2004-41), 2005/03/01–2009/02/28
  - Increased food security and income in the Limpopo Basin through integrated crop, water, and soil fertility options and public-private partnerships-CPWF Theme 1 (PN 1) (ICRISAT-led) (DPPC2004-40), 2005/01/01–2009/12/31

- **Food and Agriculture Organization of the United Nations**
  - Improved understanding of how irrigation system managers deal with effects of major droughts on farmers (DPPC2005-40), 2005/10/17–2006/04/30

- **Generation Challenge Program (GCP)**
  - Improvement of quality of existing GCP databases (SP4) (GCP-commissioned research) (DPPC2004-70), 2005/01/01–2006/05/15
  - Evaluation and deployment of transgenic drought-tolerant varieties (SP3) (GCP-commissioned research), 2005/01/01–2005/12/31
  - Development of low-cost gene-based trait assay technologies in cereals (GCP-commisioned research- Subprogram 3) (DPPC2004-74), 2005/01/01–2005/12/31
  - Creation and maintenance of GCP repository (IPGRI-led) (GCP-commissioned research) (DPPC2004-83), 2005/01/01–2005/12/31
  - GCP use case and software engineering collaboration and management (GCP-commissioned research-Subprogram 4) (DPPC2004-78), 2005/01/01–2005/12/31
  - Determination of a common genetic basis for tissue growth rate under water-limited conditions across plant organs and genomes (CIMMYT-led)-GCP Competitive Scheme (DPPC2004-87), 2005/01/01–2005/12/31
  - Targeted discovery of superior disease QTL alleles in the maize and rice genomes (Cornell University-led)-GCP Competitive Scheme (DPPC2004-88), 2005/01/01–2007/12/31
  - Systematic evaluation of rice mutant collections for conditional phenotypes with emphasis on stress tolerance (WUR-Netherlands-led) (GCP-commissioned research) (DPPC2004-81), 2005/01/01–2006/05/15
  - Implementation of web services technology in the GCP Consortium (IPGRI-led) (GCP-commissioned research) (DPPC2004-82), 2005/01/01–2005/12/31
  - Development of an integrated decision support system for marker-assisted plant breeding (ICRISAT-led) (DPPC2004-85), 2005/01/01–2005/12/31
  - Drought-tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins (CAAS-led)-GCP Competititve Scheme (DPPC2004-86), 2005/01/01–2007/12/31
  - Creation of institutional bioinformatics capacity (SP4)(IRRI proposed activities) (GCP-commissioned research) (DPPC2004-72), 2005/01/01–2005/12/31
  - Development of GCP domain (data) models. (GCP-commissioned research) (DPPC2004-80), 2005/01/01–2005/12/31
  - Development of training materials for a course in bioinformatics and design of course curriculum (GCP-commissioned research-Subprogram 5) (DPPC2005-08), 2005/01/01–2006/10/15
  - Sequencing multiple and diverse rice varieties: connecting whole-genome variation with phenotype (under GCP Subprograms 1, 2, and 3) (DPPC2005-15), 2005/01/01–2006/10/15
  - Integration of the high-performance computing facilities in the GCP toolbox (CIP-led) (GCP-commissioned research), (DPPC2004-84), 2005/01/01–2005/12/31
  - GCP Subprogram 2 Leadership (second year funding) (DPPC2005-54), 2005/01/01–2006/10/15
  - Application of MOBY for GCP Consortium (GCP-commissioned research-SubProgram 4) (DPPC2004-79), 2005/01/01–2006/05/15

- Assessing EcoTILLING as a methodology for targeted genotyping and SNP discovery (SP1)-(GCP-commissioned research) (DPPC2004-68), 2005/01/01–2006/10/15
- Development of ortholog-function display tools (SP4) (GCP-commissioned research) (DPPC2004-69), 2005/01/01–2006/10/15
- Supporting distribution of reference germplasm (GCP-commissioned research- SP1) (CIMMYT-led) (DPPC2004-89), 2005/01/01–2005/12/31
- Identifying genes responsible for failure of grain formation in rice and wheat under drought (GCP Competitive Scheme) (DPPC2004-25), 2005/01/01–2007/12/31
- Revitalizing marginal lands: discovery of genes for tolerance for saline and phosphorus-deficient soils to enhance and sustain productivity (GCP Competitive Scheme (DPPC2004-26), 2005/01/01–2007/12/31
- Development of reference molecular marker kits to analyze diversity of germplasm for the year 1 GCP crops (hosting of Mr. S.P. Reflinur) (Subprogram 5) (DPPC2005-35), 2005/06/01–2006/05/15

- **Global Crop Diversity Trust**
  - A pilot project to develop an accession level information resource (DPPC2004-60), 2005/03/01–2005/08/31

- **Grand Challenge in Global Health**
  - Engineering rice for high beta-carotene, vitamin E, and enhanced Fe and Zn bioavailability (led by the University of Freiburg) (DPPC2004-91), 2005/09/28–2010/09/27

- **HarvestPlus**
  - Breeding for iron-dense rice: a low-cost, sustainable approach to reduce anemia in Asia (with participation of Vietnam and Indonesia) (DPPC2005-25), 2005/01/01–2007/12/31

- **Information and Communications Technology-Knowledge Management Initiative**
  - Utilization of intelligent systems for plant protection (in collaboration with ICARDA), DPPC2005-12, 2005/01/01–2006/03/31

- **International Fertilizer Industry Association, Potash and Phosphate Institute/Potash and Phosphate Institute of Canada, International Potash Institute**
  - Irrigated Rice Research Consortium-Phase III (site-specific nutrient management) (DPPC2005-02), 2005/01/01–2008/12/31

- **International Fund for Agricultural Development**
  - Managing rice landscapes in the marginal highlands of Southeast Asia for household food security and environmental sustainability (DPPC2003-08), 2005/07/26–2008/09/30

- **International Union of Pure and Applied Chemistry**
  - Terminology and measurement techniques of starch components (DPPC2004-21), 2005/05/16–2007/05/15

- **Japan International Research Center for Agricultural Sciences**
  - Collaborative research on socioeconomic constraints to adoption of technology and farmer's response (DPPC2005-26), 2005/04/01–2007/03/31

- **Ministry of Agriculture, Forestry, and Fisheries, Japan**
  - Development of integrated rice cultivation system under water-saving conditions (Japan Government-IRRI Collaborative Project Phase V), (DPPC2004-19), 2005/08/09–2010/08/08

- **Malaysian Agricultural Research and Development Institute**
  - The impact of rice production on environmental sustainability (DPPC2005-66), 2005/09/01–2008/09/30

- **Ministry of Science and Technology, Spain**
  - IRRI-INIA/IVIA Collaborative Project, (DPPC2005-74), 2005/01/01–2005/12/31

- **Natural Resources Institute**
  - Promotion of weed management options for irrigated rice in India: IRRI component (DPPC2004-42), 2005/04/01–2006/01/31
  - Rice weed decision support: IRRI component (DPPC2004-45), 2005/04/01–2006/01/31

- **Natural Resources International Limited**
  - Validation and promotion of technologies for rice sheath blight management (Extension of the DPPC2000-11-management of funds) (through HRI) (DPPC2005-36), 2005/02/01–2006/01/31

- **Rural Development Administration, Korea**
  - Breeding micronutrient-dense japonica rice varieties (DPPC2005-01), 2005/04/01–2008/03/31
  - Large-scale Korean seed multiplication program (DPPC2005-84), 2005/11/01–2006/04/30

- **Rockefeller Foundation**
  - Introgression of genes for drought tolerance from *Oryza glaberrima* into indica rice (*O. sativa*) (grant for the PhD of Isaac Kofi Bimpong) (DPPC2004-76), 2005/04/01–2008/03/31
  - Support for the 5th International Rice Genetics Symposium (DPPC2005-11), 2005/05/01–2006/04/30
  - Developing and disseminating resilient and productive rice varieties for drought-prone environments in India (co-funded by GCP) (DPPC2004-32), 2005/03/01–2008/02/28
  - Pathway dissection and candidate gene identification for drought tolerance in rice by a forward genetics approach (co-funded by GCP) (DPPC2004-59), 2005/03/01–2008/02/28

- **Swiss Agency for Development and Cooperation**
  - Irrigated Rice Research Consortium Phase III (DPPC2004-30), 2005/01/01–2008/12/31

- **United States Agency for International Development**
  - Development of common querying interface for rice germplasm and genomics information between IRIS and Gramene (Cornell University) (DPPC2004-58), 2005/02/01–2007/01/31
  - Development of rice biotechnology products for Asia: technical and pre-regulatory components (DPPC2004-17), 2005/01/01–2006/12/31
  - The development of adapted germplasm for India with high levels of provitamin carotenoids (a collaboration to accelerate the pace of the Golden Rice project for India) (through CIAT) (DPPC2005-23), 2005/01/01–2007/12/31
  - Developing biofortified iron-dense rice for India (in collaboration with the HarvestPlus Challenge Program) (DPPC2004-43), 2005/07/01–2006/06/30
  - Integrated Crop Management Training Workshop in Timor-Leste (under the Soil Management Collaborative Research Support Program-Timor-Leste Agricultural Rehabilitation, Economic Growth and Natural Resource Project) (DPPC2005-16), 2005/04/23–2005/12/08

- **World Bank**
  - Environment Radio Soap Opera for Rural Vietnam (DPPC2005-18), 2005/07/01–2007/06/15

Memoranda of agreement: Partner institutions IRRI entered into agreements with in 2005

Australia

- Australian Centre for International Agricultural Research (ACIAR). Agreement between ACIAR and IRRI relative to the training courses on *Leadership for Asian women in agriculture R&D and extension* and *Application of participatory approaches to agricultural research and extension* (DPPC2005-07). 2005/11&12
- Charles Sturt University (CSU). Memorandum of Understanding between IRRI and CSU for supervision of PhD students. 2005/04/25
- Commonwealth Scientific and Industrial Research Organisation (CSIRO). Letter of Agreement between IRRI and CSIRO for the project *Potentials of water-saving technologies in rice production: an inventory and synthesis of options at farm level* (DPPC2002-26). 2005/05/06
- Commonwealth Scientific and Industrial Research Organisation (CSIRO). Collaboration Research Agreement between IRRI and CSIRO for the GCP project *Revitalizing marginal lands: discovery of genes for tolerance for saline and phosphorus-deficient soils to enhance and sustain productivity* (DPPC2004-26). 2005/06/27
- University of Adelaide. Letter of Agreement between IRRI and University of Adelaide for the project *Screening the International Rice Genebank collection for variation in carotenoid content* (DPPC2002-52). 2005/08/31
- University of Sydney. Memorandum of Understanding between IRRI and University of Sydney to further strengthen the cooperation among their scientists, in particular, the training of graduate students. 2005/02/16–2010/02/15
- University of Sydney. Amendment to the Memorandum of Understanding between the University of Sydney and IRRI regarding publication of students' theses. 2005/05

Austria

- International Atomic Energy Agency (IAEA). Research contract between IAEA and IRRI for the project *Selection for greater agronomic water-use efficiency in wheat and rice using carbon isotope discrimination* (DPPC2002-51). 2004/12/15–2005/12/14
- International Atomic Energy Agency (IAEA). Renewal of technical contract between IAEA and IRRI for the project *Simulating water and nitrogen interaction in the rice-wheat cropping system* (DPPC2003-03). 2005/09/01–2006/08/31

Bangladesh

- Bangladesh Agricultural Research Institute (BARI). Letter of Agreement between IRRI and BARI for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/03/08
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between IRRI and BRRI for the project *From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments* (DPPC2002-45). 2005/05/17

- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between IRRI and BRRI for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/03/08
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between IRRI and BRRI for the project *Irrigated Rice Research Consortium Phase III (Labor Productivity Working Group)* (DPPC2004-30). 2005/11/15
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between IRRI and BRRI for the project *Decision support frameworks for weed management in rice in Bangladesh: IRRI component* (DPPC2004-45). 2005/08/11
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between IRRI and BRRI for the project *On-farm experiments to investigate improved nutrient management options for drought-prone rainfed rice in northwest Bangladesh* (DPPC2005-57). 2005/08/12
- Bangladesh Rice Research Institute (BRRI). Letter of Agreement between IRRI and BRRI for the SIF-funded project *Arsenic-tolerant boro rice in Bangladesh* (DPPC2005-72). 2005/11/18
- Bureau of Socioeconomic Research and Training (BSERT). Letter of Agreement between BSERT and IRRI for the SIF-funded project *Arsenic-tolerant boro rice in Bangladesh* (DPPC2005-72). 2005/11/15
- Dhaka University (DU). Letter of Agreement between IRRI and DU for the GCP project *Revitalizing marginal lands: discovery of genes for tolerance for saline and phosphorus-deficient soils to enhance and sustain productivity* (DPPC2004-26). 2005/09/04
- Department of Agricultural Extension (DAE). Letter of Agreement between DAE and IRRI for the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (impact and policy analysis for HarvestPlus) (DPPC2004-16). 2005/09/21
- Socioconsult Ltd. Letter of Agreement between Socio-consult Ltd. and IRRI relative to the study on *Constraints to adoption and expected benefits of micronutrient-dense rice in Bangladesh* under the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (impact and policy analysis for HarvestPlus) (DPPC2004-16). 2005/10/01–2005/11/30
- Welfare Association for Village Environment (WAVE) Foundation. Letter of Agreement between IRRI and WAVE Foundation for the project *Accelerating technology adoption to improve rural livelihoods in the rainfed Eastern Gangetic Plains* (DPPC2002-27). 2005/06/09

Cambodia

- Mr. Oeun Sophath. Letter of Agreement between IRRI and Mr. Sophath for the purpose of implementing the research activity of the postharvest study of the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30–2005/12/31
- Battambang Provincial Department of Agriculture (BBPDA). Letter of Agreement between IRRI and BBPDA for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30– 2005/12/31
- Crenn and Associates. Letter of Agreement between IRRI and Crenn and Associates for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30–2005/12/31
- Ministry of Agriculture, Forestry, and Fisheries (MAFF). Letter of Agreement between IRRI and MAFF on the collaboration with Mr. San Vanty as the national focal person for the implementation of the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30–2008/08/29
- Prey Veng Provincial Department of Agriculture (PVPDA). Letter of Agreement between IRRI and PVPDA for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30–2005/12/31
- Small and Medium Enterprises (SME). Letter of Agreement between IRRI and SME for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30–2005/12/31

China

- China Agricultural University (CAU). Letter of Agreement between IRRI and CAU for the CPWF project *Developing a system of temperate and tropical aerobic rice (STAR) in Asia* (DPPC2003-24). 2005/01/04
- China Agricultural University (CAU). Amendment No. 1 to the Memorandum of Agreement between CAU and IRRI on the extension of the period of the agreement for

the project *Development of breeding and management technologies for aerobic rice* from 2005 to 2008.

- China National Rice Research Institute (CNRRI). Memorandum of Agreement between IRRI and CNRRI on International Network for Genetic Evaluation of Rice (INGER). 2005/01/31–2009/01/30
- China National Rice Research Institute (CNRRI). Memorandum of Agreement between IRRI and CNRRI for collaboration in the development of ChinaRice. 2005/06/27–2008/06/26
- Chinese Academy of Agricultural Sciences (CAAS). Letter of Agreement between IRRI and CAAS for the project *Pathway dissection and candidate gene identification for drought tolerance in rice by a forward genetics approach* (DPPC2004-59). 2005/09/29
- Chinese Academy of Agricultural Sciences (CAAS). Letter of Agreement between IRRI and CAAS for the project *Drought- tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins* (DPPC2004-86). 2005/05/23
- Guangdong Academy of Agricultural Sciences (GAAS). Letter of Agreement between IRRI and GAAS for the collaborative project *Integrated residue and fertilizer-N management in zero-tillage double rice in Guangdong, China*, a project under the BMZ-funded project *Managing crop residues for healthy soils in rice ecosystems* (DPPC2001-11). 2005/05/04
- Guangdong Academy of Agricultural Sciences (GAAS). Memorandum of Agreement between IRRI and GAAS for collaboration in agricultural research and training. 2005/06/14–2008/06/13
- Guangdong Academy of Agricultural Sciences (GAAS). Letter of Agreement between IRRI and GAAS for the collaborative project *Developing canopy-based crop management for achieving a healthy rice canopy* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/05/04
- Huazhong Agricultural University (HAU). Letter of Agreement between IRRI and HAU for the collaborative project *Developing canopy-based crop management for achieving a healthy rice canopy* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/12/05
- Hunan Agricultural University. Letter of Agreement between Hunan Agricultural University and IRRI for the collaborative project *Developing canopy-based crop management for achieving a healthy rice canopy* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/12/05
- Ministry of Agriculture of the People's Republic of China. Executive Agreement between IRRI and the Ministry of Agriculture of the People's Republic of China for the China-IRRI Workplan for 2006-2008. 2005/10/11–2008/12/31
- Nanjing Agricultural University (NAU). Letter of Agreement between NAU and IRRI for the GCP project *Identifying genes responsible for failure of grain formation in rice and wheat under drought* (DPPC2004-25). 2005/01/24
- Peking University (PU). Letter of Agreement between IRRI and PU for the project *Pathway dissection and candidate gene identification for drought tolerance in rice by a forward genetics approach* (DPPC2004-59). 2005/09/29
- Yangzhou University (YU). Letter of Agreement between YU and IRRI for the collaborative project *Developing canopy-based crop management for achieving a healthy rice canopy* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/12/05
- Yunnan Academy of Agricultural Sciences (YAAS). Letter of Agreement between IRRI and YAAS for the Golden Rice humanitarian research. 2005/06/10–2008/06/09
- Zhejiang University (ZU). Letter of Agreement between ZU and IRRI for the project *Reaching Towards Optimum Productivity (RTOP) Phase II* (DPPC2000-10). 2005/06/23

Colombia

- Centro Internacional de Agricultura Tropical (CIAT). Letter of Agreement between IRRI and CIAT for the project *Lao PDR-IRRI Rice Research and Training Project Phase V* (DPPC2003-06). 2005/03/04
- Centro Internacional de Agricultura Tropical (CIAT). Letter of Agreement between IRRI and CIAT for the ICT-KM project *Advanced research networking for the CGIAR* (DPPC2003-82). 2005/04/08
- Centro Internacional de Agricultura Tropical (CIAT). Agreement between CIAT, on behalf of the HarvestPlus Challenge Program, and IRRI for the project *Developing biofortified iron-dense rice for India* (DPPC2004-43). 2005/07/01–2006/06/30
- Centro Internacional de Agricultura Tropical (CIAT). Letter of Agreement between CIAT and IRRI for the USAID-funded project *Development of adapted germplasm for India with high levels of provitamin carotenoids* (a collaboration to accelerate the pace of the Golden Rice project for India) (DPPC2005-23). 2005/01/01–2007/12/31

- Centro Internacional de Agricultura Tropical (CIAT). Amendment No. 1 to the Letter of Agreement between CIAT and IRRI for the USAID-funded project *Development of adapted germplasm for India with high levels of provitamin carotenoids* (a collaboration to accelerate the pace of the Golden Rice project for India) (DPPC2005-23). 2005/09/06
- Centro Internacional de Agricultura Tropical (CIAT). Letter of Agreement between IRRI and CIAT for the GCP-commissioned research project *Evaluation and deployment of transgenic drought-tolerant varieties* (DPPC2004-73). 2005/09/08

France

- Centre for International Cooperation in Agricultural Research for Development (CIRAD). Memorandum of Agreement among IRRI, CIRAD, IRD, and Vietnam Agricultural Science Institute (VASI) relative to the SAM Program (Mountain Agrarian Systems Program). 2005/04/06–2006/04/30
- Centre for International Cooperation in Agricultural Research for Development (CIRAD). Amendment to the Protocol of Agreement between IRRI and CIRAD on the secondment of Dr. Tanguy Lafarge. 2005/06/26–2008/06/25
- Institut de recherche pour le développement (IRD). Amendment no. 4 to the Protocol of Agreement between IRRI and IRD on the secondment of Dr. Georges Reversat for year 2005. 2005/03/09–2006/02/08
- Institut de recherche pour le développement (IRD). Memorandum of Agreement among IRRI, IRD, Centre for International Cooperation in Agricultural Research for Development (CIRAD), and Vietnam Agricultural Science Institute (VASI) relative to the SAM Program (Mountain Agrarian Systems Program). 2005/04/06–2006/04/30
- International Fertilizer Industry Association (IFA). Agreement between IFA and IRRI for the project *Irrigated Rice Research Consortium Phase III (site-specific nutrient management)* (DPPC2005-02). 2005/01/01–2008/12/31

Germany

- Albert Ludwigs University of Freiburg (ALUF). Subcontract between ALUF, acting as grantee of the Grand Challenges in Global Health Project, and IRRI for the project *Engineering rice for high beta-carotene, vitamin E, and enhanced iron and zinc bioavailability* (DPPC2004-91). 2005/09/28
- Christian Albrecht University of Kiel (CAU-Kiel). Letter of Agreement between CAU-Kiel and IRRI for the CPWF project *Developing a system of temperate and tropical aerobic rice (STAR) in Asia* (DPPC2003-24). 2005/01/04
- Deutsche Gessellschaft für Technische Zusammenarbeit (GTZ) GmbH. Research contract between GTZ and IRRI for the research program *Nutrient management in aerobic rice systems* (Postdoc program–Dr. Christine Kreye) (DPPC2004-48). 2005/07/01–2008/06/30
- University of Hohenheim (UH). Letter of Agreement between UH and IRRI for the project *From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments* (DPPC2002-45). 2005/01/11

India

- Anand Agricultural University (AAU). Letter of Agreement between AAU and IRRI for the purpose of implementing the research activities of the 2005 Upland Rice Shuttle Breeding Network (URSBN) under the projects *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32) and *Drought-tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins* (DPPC2004-86). 2005/08/25
- Assam Agricultural University (AAU). Letter of Agreement between IRRI and AAU for the project *Managing rice landscapes in the marginal highlands of Southeast Asia for household food security and environmental sustainability* (DPPC2003-08). 2005/06/07
- Assam Agricultural University (AAU). Letter of Agreement between IRRI and AAU for the purpose of implementing the research activities of the 2005 Eastern Indian Rainfed Lowland Shuttle Breeding Network (EIRLSBN) under the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32).2005/10/14
- Banaras Hindu University (BHU). Letter of Agreement between IRRI and BHU for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/03/08
- Birsa Agricultural University (BAU). Letter of Agreement between BAU and IRRI for the purpose of implementing the research activities of the 2005 Upland Rice Shuttle Breeding Network (URSBN) under the projects *Developing and disseminating resilient and productive rice*

varieties for drought-prone environments in India (DPPC2004-32) and *Drought-tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins* (DPPC2004-86). 2005/08/25

- Central Rice Research Institute (CRRI). Letter of Agreement between IRRI and CRRI for the project *From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments* (DPPC2002-45). 2005/05/30
- Central Soil Salinity Research Institute (CSSRI). Research agreement between CSSRI and IRRI for the CPWF project *Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong, and Nile River basins* (DPPC2003-21). 2005/01/17
- Chandra Shekhar Azad University of Agriculture and Technology (CSAUAT). Letter of Agreement between IRRI and CSAUAT for the project *Promotion of weed management options for irrigated rice in India: IRRI component* (DPPC2004-42). 2005/06/09
- Chinsurah Rice Research Station (CRRS). Letter of Agreement between IRRI and CRRS for the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (impact and policy analysis for HarvestPlus) (DPPC2004-16). 2005/04/26
- Chinsurah Rice Research Station (CRRS). Letter of Agreement between IRRI and CRRS for the purpose of implementing the research activities of the 2005 Eastern Indian Rainfed Lowland Shuttle Breeding Network (EIRLSBN) under the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/10/14
- GB Pant University of Agriculture and Technology (GBPUAT). Letter of Agreement between IRRI and GBPUAT for the project *Irrigated Rice Research Consortium Phase III (Labor Productivity Working Group)* (DPPC2004-30). 2005/11/15
- GB Pant University of Agriculture and Technology (GBPUAT). Letter of Agreement between IRRI and GBPUAT for the project *Promotion of weed management options for irrigated rice in India: IRRI component* (DPPC2004-42). 2005/06/09
- GB Pant University of Agriculture and Technology (GBPUAT). Letter of Agreement between IRRI and GBPUAT for the collaborative project *Dissemination of site-specific nutrient management (SSNM) in rice-wheat systems in northern India* under *Irrigated Rice Research Consortium Phase III (SSNM)* (DPPC2005-02). 2005/06/23
- Haryana Agricultural University (HAU). Letter of Agreement between HAU and IRRI for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/03/08
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Letter of Agreement between IRRI and ICRISAT for the project *Identification and functional validation of genes conditioning broad-spectrum disease resistance in rice and pearl millet* (DPPC2003-10). 2005/12/13
- Indian Agricultural Research Institute (IARI), Water Technology Center (WTC). Letter of Agreement between IARI-WTC and IRRI for the CPWF project *Developing a system of temperate and tropical aerobic rice (STAR) in Asia* (DPPC2003-24). 2005/01/04
- Indian Council of Agricultural Research (ICAR). Executive Agreement between ICAR and IRRI for the ICAR-IRRI Workplan 2005-2006. 2005/06/22–2008/12/31
- Indira Gandhi Agricultural University (IGAU). Letter of Agreement between IRRI and IGAU for the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/06/29
- Indira Gandhi Agricultural University (IGAU). Letter of Agreement between IRRI and IGAU for the purpose of implementing the research activities of the 2005 Upland Rice Shuttle Breeding Network (URSBN) under the projects *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32) and *Drought-tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins* (DPPC2004-86). 2005/08/25
- Jawaharlal Nehru Viswavidyalaya (JNKVV). Letter of Agreement between IRRI and JNKVV for the purpose of implementing the research activities of the 2005 Upland Rice Shuttle Breeding Network (URSBN) under the projects *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32) and *Drought-tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins* (DPPC2004-86). 2005/08/25

- Maharana Pratap University of Agriculture and Technology (MPUAT). Letter of Agreement between IRRI and MPUAT for the purpose of implementing the research activities of the 2005 Upland Rice Shuttle Breeding Network (URSBN) under the projects *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32) and *Drought-tolerant rice cultivars for north China and South/Southeast Asia by highly efficient pyramiding of QTLs from diverse origins* (DPPC2004-86). 2005/08/25
- Mahyco Research Foundation (MRF). Memorandum of Agreement between IRRI and MRF for collaboration in agricultural research and training. 2005/06/30–2008/05/31
- Narendra Deva University of Agriculture and Technology (NDUAT). Letter of Agreement between IRRI and NDUAT for the project *From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments* (DPPC2002-45). 2005/05/17
- Narendra Deva University of Agriculture and Technology (NDUAT). Letter of Agreement between IRRI and NDUAT for the project *Promotion of weed management options for irrigated rice in India: IRRI component* (DPPC2004-42). 2005/06/09
- Narendra Deva University of Agriculture and Technology (NDUAT). Letter of Agreement between IRRI and NDUAT for the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/08/09
- Narendra Deva University of Agriculture and Technology (NDUAT). Letter of Agreement between IRRI and NDUAT for the purpose of implementing the research activities of the 2005 Eastern Indian Rainfed Lowland Shuttle Breeding Network (EIRLSBN) under the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/12/01
- Orissa University of Agriculture and Technology (OUAT). Letter of Agreement between IRRI and OUAT for the purpose of implementing the research activities of the 2005 Upland Rice Shuttle Breeding Network (URSBN) under the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/08/25
- Orissa University of Agriculture and Technology (OUAT). Letter of Agreement between IRRI and OUAT for the purpose of implementing the research activities of the 2005 Eastern Indian Rainfed Lowland Shuttle Breeding Network (EIRLSBN) under the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/10/14
- Project Directorate for Cropping Systems Research (PDCSR). Letter of Agreement between PDCSR and IRRI for the collaborative project *On-farm evaluation of site-specific nutrient management (SSNM) for rice-wheat cropping systems* under *Irrigated Rice Research Consortium Phase III (SSNM)* (DPPC2005-02). 2005/09/13
- Rajendra Agricultural University (RAU). Letter of Agreement between IRRI and RAU for the purpose of implementing the research activities of the 2005 Eastern Indian Rainfed Lowland Shuttle Breeding Network (EIRLSBN) under the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/10/14
- Rajendra Agricultural University (RAU). Letter of Agreement between IRRI and RAU for the project *Promotion of weed management options for irrigated rice in India: IRRI component* (DPPC2004-42). 2005/06/10
- Sandar Vallabh Bhai Patel University of Agriculture and Technology (SVBPUAT). Letter of Agreement between SVBPUAT and IRRI for the project *Applying genetic diversity and genomic tools to benefit rice farmers at risk from drought* (DPPC2003-41). 2005/08/31–2009/08/30
- Sandar Vallabh Bhai Patel University of Agriculture and Technology (SVBPUAT). Letter of Agreement between SVBPUAT and IRRI for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/08/31–2009/08/30
- Tamil Nadu Agricultural University (TNAU). Letter of Agreement between TNAU and IRRI for the project *Reaching Towards Optimum Productivity (RTOP) Phase II* (DPPC2000-10). 2005/04/22
- Tamil Nadu Agricultural University (TNAU). Letter of Agreement between TNAU and IRRI for the GCP project *Identifying genes responsible for failure of grain formation in rice and wheat under drought* (DPPC2004-25). 2005/02/07
- Tamil Nadu Agricultural University (TNAU). Letter of Agreement between IRRI and TNAU for the project *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/01/26

- Tamil Nadu Agricultural University (TNAU). Letter of Agreement between IRRI and TNAU for the collaborative project *Dissemination of SSNM in the Cauvery Delta, Tamil Nadu* under the *Irrigated Rice Research Consortium Phase III (SSNM)* (DPPC2005-02). 2005/06/23
- Tamil Nadu Agricultural University (TNAU). Letter of Agreement between IRRI and TNAU for the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/08/01
- University of Agricultural Sciences (UAS). Letter of Agreement between IRRI and UAS for the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/06/08

Indonesia

- Indonesian Center for Agricultural Post Harvest Research and Development (ICAPRD). Research Agreement between IRRI and ICAPRD for the project *Post Harvest Systems Development under Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/01/01–2005/04/30
- Indonesian Center for Agricultural Biotechnology and Genetic Resources and Research Development (ICABGRRD). Letter of Agreement between IRRI and ICABGRRD for the GCP project *Revitalizing marginal lands: discovery of genes for tolerance for saline and phosphorus-deficient soils to enhance and sustain productivity* (DPPC2004-26). 2005/03/30
- Indonesian Institute for Rice Research (IIRR). Letter of Agreement between IIRR and IRRI for the project *Reaching Towards Optimum Productivity (RTOP) Phase II* (DPPC2000-10). 2005/06/23
- Indonesian Institute for Rice Research (IIRR). Letter of Agreement between IIRR and IRRI for the collaborative project *Evaluation of the effects of crop establishment practices on weed rice infestation and recording shifts in weed species in the Muda area* under the *Irrigated Rice Research Consortium Phase III (Labor Productivity Workgroup)* (DPPC2004-30). 2005/07/01
- Indonesian Institute for Rice Research (IIRR). Letter of Agreement between IIRR and IRRI for the collaborative project *Long-term NPK management for rice* under the *Irrigated Rice Research Consortium Phase III (SSNM)* (DPPC2005-02). 2005/12/06

Iran

- University of Mazandaran. Memorandum of Agreement between the University of Mazandaran and IRRI for collaborative graduate program. 2005/04/20–2010/04/19

Italy

- Food and Agriculture Organization of the United Nations (FAO). Letter of Agreement between FAO and IRRI for the project *Improved understanding of how irrigation system managers deal with the effects of major droughts on farmers* (DPPC2005-40). 2005/10/17–2006/04/30

Japan

- Japan International Research Center for Agricultural Sciences (JIRCAS). Memorandum of Agreement between JIRCAS and IRRI for the project *Development of integrated rice cultivation system under water-saving conditions* (DPPC2004-19). 2005/12/16
- National Institute of Agrobiological Sciences (NIAS). Letter of Agreement between NIAS and IRRI for the GCP project *Identifying genes responsible for failure of grain formation in rice and wheat under drought* (DPPC2004-25). 2005/04/15

Kenya

- International Center for Research in Agroforestry (ICRAF). Memorandum of Agreement between ICRAF and IRRI for provision of services in Southeast Asia. 2005/10/07–2008/10/06

Korea

- Rural Development Administration (RDA). Letter of Agreement between RDA and IRRI on the extension of collaboration in training workshops on rice technology transfer systems (RTTS) in Asia. 2005/04/20–2010/04/19
- Rural Development Administration (RDA). Letter of Agreement between RDA and IRRI extending the Memorandum of Understanding on scientific and technical collaboration in research and training on temperate irrigated (japonica) rice ecosystems. 2005/08/29–2010/08/28
- Rural Development Administration (RDA). Memorandum of Agreement between RDA and IRRI for the *Large-scale Korean seed multiplication project* (LSKSMP) (DPPC2005-84). 2005/11/21–2008/11/22

- Rural Development Administration (RDA). Agreement on the cooperative research project between IRRI and NICS of RDA for the project *Breeding for micronutrient enriched japonica rice for improving human health* (DPPC2005-01). 2005/04/01–2008/03/31
- Yeongnam Agricultural Research Institute (YARI). Agreement on the cooperative research project between IRRI and YARI for the project *Identification of resistance genes for biotic stresses in rice through the location/*expression candidate association approach (DPPC2005-93). 2006/01/01–2008/12/31

Lao PDR

- National Agriculture and Forestry Research Institute (NAFRI). Letter of Agreement between IRRI and NAFRI for the project *Managing rice landscapes in the marginal highlands of Southeast Asia for household food security and environmental sustainability* (DPPC2003-08). 2005/06/07
- National Agriculture and Forestry Research Institute (NAFRI). Letter of Agreement between IRRI and NAFRI for the CPWF project *Developing a system of temperate and tropical aerobic rice (STAR) in Asia* (DPPC2003-24). 2005/01/04
- National Agriculture and Forestry Research Institute (NAFRI). Letter of Agreement between IRRI and NAFRI for the project *Rice Post Harvest Systems Development–Lao* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/05/26

Malaysia

- Malaysian Agricultural Research and Development Institute (MARDI). Letter of Agreement between MARDI and IRRI for the collaborative project *Evaluation of the effects of crop establishment practices on weed rice infestation and recording shifts in weed species in the Muda area* under the *Irrigated Rice Research Consortium Phase III (Labor Productivity Workgroup)* (DPPC2004-30). 2005/07/01
- Malaysian Agricultural Research and Development Institute (MARDI). Letter of Agreement between MARDI and IRRI for the project *A pilot project to develop an accession-level information resource* (under the Global Crop Diversity fund) (DPPC2004-60). 2005/02/02
- Malaysian Agricultural Research and Development Institute (MARDI). Letter of Agreement between MARDI and IRRI for the project *Genetic enhancement for high-quality rice* (DPPC2005-64). 2005/10/28
- Malaysian Agricultural Research and Development Institute (MARDI). Letter of Agreement between MARDI and IRRI for the project *The impact of rice production on environmental sustainability* (DPPC2005-66). 2005/10/28
- National University of Malaysia (Universiti Kebangsaan Malaysia) (UKM). Letter of Agreement between UKM and IRRI for the purpose of implementing the research activities of IRRI's core program and the Labor Productivity Workgroup of the Irrigated Rice Research Consortium Phase III (DPPC2004-30). 2005/12/16
- WorldFish Center. Research Agreement between WorldFish Center and IRRI for the CPWF project *Managing water and land resources for sustainable livelihoods at the interface between fresh and saline water environments* (DPPC2003-29). 2004/06/01–2007/05/30

Mexico

- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Letter of Agreement between CIMMYT and IRRI for the ICT-KM project *Advanced research networking for the CGIAR* (DPPC2003-82). 2005/04/29
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Letter of Agreement between CIMMYT and IRRI for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/08/24
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Amendment to the Agreement between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the project *Identifying genes responsible for failure of grain formation in rice and wheat under drought* (DPPC2004-25). 2005/01/19
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Amendment to the Agreement between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the project *Revitalizing marginal lands: discovery of genes for tolerance for saline and phosphorus-deficient soils to enhance and sustain productivity* (DPPC2004-26). 2005/01/19
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Agreement between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the project *Developing and disseminating resilient and productive rice varieties for drought-prone environments in India* (DPPC2004-32). 2005/07/01

- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Agreement between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the 2005 GCP-commissioned research projects. 2005/03/14
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Amendment to the agreement between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the 2005 GCP-commissioned research projects. 2005/04/19
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Subcontract between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the GCP competitive project *Determination of a common genetic basis for tissue growth rate under water-limited conditions across plant organs and genomes* (DPPC2004-87). 2005/08/26
- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Agreement between CIMMYT, acting as the host agent for the Generation Challenge Program, and IRRI for the 2005 GCP-commissioned research project *Development of reference molecular marker kits to analyze diversity of germplasm for year 1 GCP crops* (DPPC2005-35). 2005/06/10

Myanmar

- Myanmar Rice and Paddy Traders Association (MRPTA). Letter of Agreement between MRPTA and IRRI for the collaborative project *Rice Post Harvest Systems Development – Myanmar* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/11/07
- Plant Protection Department, Myanma Agriculture Service (PPD-MAS). Letter of Agreement between PPD-MAS and IRRI for the collaborative project *Rice Post Harvest Systems Development – Myanmar* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/04/20

Nepal

- Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)–Nepal. Letter of Agreement between CIMYT-Nepal and IRRI regarding assistance in handling the financial management of the IRRI-Nepal office. 2005/03/11
- Nepal Agricultural Research Council (NARC). Letter of Agreement between IRRI and NARC for the project *Managing rice landscapes in the marginal highlands of Southeast Asia for household food security and environmental sustainability* (DPPC2003-08). 2005/06/07
- Nepal Agricultural Research Council (NARC). Letter of Agreement between IRRI and NARC for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/03/08
- Tribhuvan University (TU), Institute of Agriculture and Animal Science (IAAS). Letter of Agreement between IRRI and TU-IAAS for the project *Managing rice landscapes in the marginal highlands of Southeast Asia for household food security and environmental sustainability* (DPPC2003-08). 2005/06/07

Pakistan

- Pakistan Agricultural Research Council (PARC). Letter of Agreement between IRRI and PARC for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/03/04

Philippines

- Asian Development Bank (ADB). Technical Assistance Agreement for the project *Enhancing farmers' income and livelihoods through integrated crop and resource management in the rice-wheat system in South Asia* (DPPC2004-02). 2005/01/01–2007/12/31
- Advanced Science Technology Institute (ASTI). Letter of Agreement between ASTI and IRRI for the ICT-KM project *Advanced research networking for the CGIAR* (DPPC2003-82). 2005/04/18
- Central Mindanao University (CMU). Letter of Agreement between IRRI and CMU for the purpose of implementing the project *Rice germplasm exchange and evaluation for iron toxicity, zinc, and phosphorus deficiency tolerance* (DPPC2005-60). 2005/09/12
- Diliman Computer Science Foundation, Inc. (DCSFI). Letter of Agreement between IRRI and DCSFI for the 2005 GCP-commissioned research projects. 2005/05/17
- Diliman Computer Science Foundation, Inc. (DCSFI). Letter of Agreement between IRRI and DCSFI for the 2005 GCP-commissioned research projects. 2005/06/01
- National Irrigation Administration (NIA). Letter of Agreement between NIA and IRRI for the CPWF project *Developing a system of temperate and tropical aerobic rice (STAR) in Asia* (DPPC2003-24). 2005/03/09
- Philippine Rice Research Institute (PhilRice). Letter of Agreement between IRRI and PhilRice for the CPWF project *Developing a system of temperate and tropical aerobic rice (STAR) in Asia* (DPPC2003-24). 2005/01/04

- Philippine Rice Research Institute (PhilRice). Letter of Agreement between PhilRice and IRRI for the project *A survey on farmers' and consumers' acceptance of rice biotechnology products in the Philippines*, a subproject under the USDA-funded project *Participatory assessment of social and economic impacts of biotechnology* (DPPC2001-49). 2005/01/20
- Philippine Rice Research Institute (PhilRice). Letter of Agreement between PhilRice and IRRI for the DA-BAR-supported project *Developing new plant types for direct seeding rice production systems in the Philippines* (DPPC2003-69). 2005/06/23
- Philippine Rice Research Institute (PhilRice). Letter of Agreement between PhilRice and IRRI for the project *Development of direct seeding and weed management options* under the *Irrigated Rice Research Consortium Phase III (Labor Productivity Workgroup)* (DPPC2004-30). 2005/06/17
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Letter of Agreement between IRRI and UPLBFI for the project *The Global Comparative Cereal Crop (Gloc3) Network: an information system to link genotype to phenotype comparatively across diverse cereal crops* (DPPC2003-09). 2005/06/17
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Amendment to the Memorandum of Agreement between IRRI and UPLBFI for the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (impact and policy analysis for HarvestPlus) (DPPC2004-16). 2005/02/01
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Letter of Agreement between UPLBFI and IRRI for the project *Development of rice biotechnology products for Asia: technical and pre-regulatory components* (DPPC2004-17). 2005/08/03
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Letter of Agreement between UPLBFI and IRRI for the 2005 GCP-commissioned research projects. 2005/05/16
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Letter of Agreement between UPLBFI and IRRI for the 2005 GCP-commissioned research projects. 2005/11/15
- University of Southern Mindanao (USM). Letter of Agreement between USM and IRRI for the purpose of implementing the research activities of CURE working group on intensive upland systems. 2005/10/01–2008/09/30
- West Visayas State University (WVSU). Letter of Agreement between WVSU and IRRI for the collaborative project *Soil- and plant-based approaches in formulating fertilizer recommendations for rice in the province of Iloilo, Philippines* under the *Irrigated Rice Research Consortium Phase III (SSNM)* (DPPC2005-02). 2005/07/21

Sri Lanka

- Challenge Program on Water and Food (CPWF). Project Agreement between IWMI acting on behalf of CPWF and IRRI for the CPWF 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). 2005/11/01–2009/10/31
- International Water Management Institute (IWMI). Amendment to Letter of Agreement between IWMI and IRRI for the project *Potentials of water-saving technologies in rice production: an inventory and synthesis of options at farm level* (DPPC2002-26). 2005/04/07–2006/03/31
- International Water Management Institute (IWMI). Amendment No. 1 to the Agreement between IWMI and IRRI for the CPWF project *Managing water and land resources for sustainable livelihoods at the interface between fresh and saline water environments* (DPPC2003-29). 2005/07/13
- International Water Management Institute (IWMI). Letter of Agreement between IWMI and IRRI for the provision of funds for 2005 for the CPWF Theme 1 Leadership (DPPC2003-87). 2005/04/08
- Rice Research and Development Institute (RRDI). Letter of Agreement between RRDI and IRRI for the project *Development of direct seeding and weed management options* under the *Irrigated Rice Research Consortium Phase III (Labor Productivity Workgroup)* (DPPC2004-30). 2005/05/07

Switzerland

- International Potash Institute (IPI). Agreement between IPI and IRRI for the project *Irrigated Rice Research Consortium Phase III (site-specific nutrient management)* (DPPC2005-02). 2005/01/01–2008/12/31
- Swiss Agency for Development and Cooperation (SDC). Amendment to the Memorandum of Agreement between SDC and IRRI on the no-cost extension of the project *Lao PDR-IRRI Rice Research and Training Project Phase V* (DPPC2003-06). 2005/11/30–2006/03/31

- Swiss Agency for Development and Cooperation (SDC). Agreement between SDC and IRRI for the project *Irrigated Rice Research Consortium, Phase III* (DPPC2004-30). 2005/01/01–2008/12/31

Syria

- International Center for Agricultural Research in the Dry Areas (ICARDA). Letter of Agreement between ICARDA and IRRI for the ICT-KM project *Advanced research networking for the CGIAR* (DPPC2003-82). 2005/12/01
- International Center for Agricultural Research in the Dry Areas (ICARDA). Memorandum of Understanding between ICARDA and IRRI for the ICT-KM project *Utilization of intelligent systems for plant protection* (DPPC2005-12). 2005/01/01–2006/03/31

Thailand

- Ubon Ratchathani Rice Research Center (URRRC). Letter of Agreement between URRRC and IRRI for the purpose of implementing the research activities of CURE working group on intensive upland systems. 2005/10/01–2008/09/30

UK

- CABI Bioscience. Agreement between CABI Bioscience and IRRI for the Good Seed Initiative Program in South Asia (DPPC2005-13). 2005/03/01–2005/12/31
- Horticulture Research International (HRI). Letter of Agreement between HRI and IRRI for the project *Validation and promotion of technologies for rice sheath blight management* (DPPC2005-36). 2005/02/01–2006/01/31
- International Fund for Agricultural Development (IFAD). Technical Assistance Grant Agreement between IFAD and IRRI for the project *Managing rice landscapes in the marginal highlands of Southeast Asia for household food security and environmental sustainability* (DPPC2003-08). 2005/07/01–2009/03/31
- Natural Resources Institute (NRI) of the University of Greenwich. Agreement between NRI and IRRI for the services of Dr. David E. Johnson relative to the project *Promotion of weed management options for irrigated rice in India: IRRI component* (DPPC2004-42). 2005/04/01–2006/01/31
- Natural Resources Institute (NRI) of the University of Greenwich. Agreement between NRI and IRRI for the services of Dr. David E. Johnson relative to the project *Decision support frameworks for weed management in rice in Bangladesh: IRRI component* (DPPC2004-45). 2005/04/01–2006/01/31

USA

- Cornell University. Letter of Agreement between IRRI and Cornell University for the project *Identification and functional validation of genes conditioning broad-spectrum disease resistance in rice and pearl millet* (DPPC2003-10). 2005/01/13
- Cornell University. Letter of Agreement between Cornell University and IRRI for the project *USAID Linkage Program to strengthen the International Rice Functional Genomics Consortium Phase III* (DPPC2004-49). 2005/02/01–2007/01/31
- Cornell University. Agreement between Cornell University and IRRI for the GCP Competitive Scheme Project *Targeted discovery of superior disease QTL alleles in the maize and rice genomes* (DPPC2004-88). 2005/01/01–2007/12/31
- HarvestPlus Challenge Program (HarvestPlus). Letter of Agreement between Centro Internacional de Agricultura Tropical (CIAT) and the International Food Policy Research Institute (IFPRI), acting on behalf of HarvestPlus and IRRI for a grant to support the project *Screening the International Rice Genebank collection for variation in carotenoid content* (DPPC2002-52). 2005/04/19–2007/04/19
- HarvestPlus Challenge Program (HarvestPlus). Amendment No. 2 to HarvestPlus Contract #5007 between Centro Internacional de Agricultura Tropical (CIAT) and the International Food Policy Research Institute (IFPRI), acting on behalf of HarvestPlus and IRRI for the project *Challenge Program on Biofortified Crops for Improved Human Nutrition (Micronutrient-dense rice to reduce malnutrition)* (DPPC2003-70). 2005/08/16
- HarvestPlus Challenge Program (HarvestPlus). Amendment No. 1 to HarvestPlus Contract #7007 between Centro Internacional de Agricultura Tropical (CIAT) and the International Food Policy Research Institute (IFPRI), acting on behalf of HarvestPlus and IRRI on the no-cost extension of the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast Asia* (impact and policy analysis for HarvestPlus) (DPPC2004-16). 2005/02/28–2005/04/30
- HarvestPlus Challenge Program (HarvestPlus). Amendment No. 2 to HarvestPlus Contract #7007 between Centro Internacional de Agricultura Tropical (CIAT) and the International Food Policy Research Institute (IFPRI), acting on behalf of HarvestPlus and IRRI on the no-cost extension of the project *Assessing the potential of biofortification to address micronutrient malnutrition in rice-based cropping systems of South and Southeast*

Asia (impact and policy analysis for HarvestPlus) (DPPC2004-16). 2005/04/30–2005/12/31

- HarvestPlus Challenge Program (HarvestPlus). Letter of Agreement between Centro Internacional de Agricultura Tropical (CIAT) and the International Food Policy Research Institute (IFPRI), acting on behalf of HarvestPlus and IRRI for a grant to support the project *Breeding for iron-dense rice: a low-cost, sustainable approach to reduce anemia in Asia (with participation of Vietnam and Indonesia)* (DPPC2005-25). 2005/01/01–2007/12/31
- International Bank for Reconstruction and Development (IBRD) (World Bank). Letter of Agreement between IBRD and IRRI for a grant provided by the United States of America to support the project *Development of rice biotechnology products for Asia: technical and pre-regulatory components* (DPPC2004-17). 2005/04/06
- International Bank for Reconstruction and Development (IBRD) (World Bank). Letter of Agreement between IBRD and IRRI for a grant to support the project *Environment radio soap opera for rural Vietnam* (DPPC2005-18). 2005/07/01–2007/06/30
- Kansas State University (KSU). Letter of Agreement between IRRI and KSU for the project *Identification and functional validation of genes conditioning broad-spectrum disease resistance in rice and pearl millet* (DPPC2003-10). 2005/12/13
- Kansas State University (KSU). Subaward Agreement Modification No. 2 between KSU and IRRI for the project *The Global Comparative Cereal Crop (Gloc3) Network: an information system to link genotype to phenotype comparatively across diverse cereal crops* (DPPC2003-09). 2005/08/25–2006/02/28
- Kansas State University (KSU). Subaward Agreement Modification No. 3 between KSU and IRRI for the project *The Global Comparative Cereal Crop (Gloc3) Network: an information system to link genotype to phenotype comparatively across diverse cereal crops* (DPPC2003-09). 2005/11/17–2006/09/30
- Kansas State University (KSU). Subaward Agreement Modification No. 2 between KSU and IRRI for the project *Identification and functional validation of genes conditioning broad-spectrum disease resistance in rice and pearl millet* (DPPC2003-10). 2005/23/25–2006/02/28
- Kansas State University (KSU). Subaward Agreement Modification No. 3 between KSU and IRRI for the project *Identification and functional validation of genes conditioning broad-spectrum disease resistance in rice and pearl millet* (DPPC2003-10). 2005/11/17–2006/09/30
- Kansas State University (KSU). Letter of Agreement between IRRI and KSU for the project *Cereals comparative genomics initiative* (DPPC2003-02). 2005/03/14
- Perlegen Sciences, Inc. (PSI). Research Collaboration Agreement between PSI and IRRI for the GCP project *Sequencing multiple and diverse rice varieties: connecting whole-genome variation with phenotype* (DPPC2005-15). 2005/08/15
- Public Intellectual Property Resource for Agriculture (PIPRA). Memorandum of Understanding between PIPRA and IRRI to promote the management of intellectual property related to agriculture and to achieve freedom to utilize agricultural innovations for research. 2005/01/04–2008/12/31
- Research Corporation of the University of Hawaii (RCUH). Subgrant Amendment No. 3 to the Agreement between RCUH and IRRI for the project *Testing, comparing, and adapting NuMass: the nutrient management support system* (DPPC2003-72). 2005/11/14
- Research Corporation of the University of Hawaii (RCUH). Letter of Agreement between RCUH and IRRI for conducting the Integrated Crop Management Training Workshop in Timor-Leste, 23-30 April 2005 (DPPC2005-16). 2005/04/01
- Research Corporation of the University of Hawaii (RCUH). Letter of Agreement between RCUH and IRRI for conducting the Integrated Crop Management Training Workshop in Timor-Leste, 21-27 Nov 2005 (DPPC2005-16). 2005/10/10
- Research Corporation of the University of Hawaii (RCUH). Amendment to Letter of Agreement between RCUH and IRRI on the change of date for conducting the Integrated Crop Management Training Workshop in Timor-Leste, 2-8 Dec 2005 (DPPC2005-16). 2005/11/17
- University of California-Davis (UCD). Letter of Agreement between IRRI and UCD for the CPWF project *Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong, and Nile River basins* (DPPC2003-21). 2005/05/13
- University of California-Davis (UCD). Letter of Agreement between IRRI and the Regents of the UCD for the GCP project *Revitalizing marginal lands: discovery of genes for tolerance for saline and phosphorus-deficient soils to enhance and sustain productivity* (DPPC2004-26). 2005/03/30
- University of Minnesota (UM). Memorandum of Understanding between UM and IRRI for the internship

program for Doctor of Philosophy and Master of Science students. 2005/11/17

Vietnam

- Bac Lieu Department of Agriculture and Rural Development (BLDARD). Letter of Agreement between BLDARD and IRRI for project *Rice postharvest systems development* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/02/24
- Hue University of Agriculture and Forestry (HUAF). Letter of Agreement between HUAF and IRRI for the project *Reaching Towards Optimum Productivity (RTOP) Phase II* (DPPC2000-10). 2005/01/17
- Hue University of Agriculture and Forestry (HUAF). Letter of Agreement between IRRI and HUAF for the project *Rice postharvest systems development–central Vietnam* under the *Irrigated Rice Research Consortium Phase III* (DPPC2004-30). 2005/11/07
- Hue University of Agriculture and Forestry (HUAF). Letter of Agreement between IRRI and HUAF for the collaborative project *Development and evaluation of site-specific nutrient management (SSNM) for rice in 2005 second season in Central Vietnam* under the *Irrigated Rice Research Consortium Phase III (SSNM)* (DPPC2005-02). 23 Jun 2005
- Hue University of Agriculture and Forestry (HUAF). Letter of Agreement between IRRI and HUAF for the collaborative project *Development, evaluation, and dissemination of site-specific nutrient management for rice in Central Vietnam* under the *Irrigated Rice Research Consortium Phase III (Productivity and Sustainability Workgroup)* (DPPC2004-30). 2005/12/06
- Plant Protection Department (PPD), Ministry of Agriculture and Rural Development. Letter of Agreement between PPD and IRRI for the project *Using entertainment education (EE) approach to motivate rice farmers to reduce pesticide use in the Mekong Basin* (DPPC2002-30). 2005/07/21
- Vietnam Agricultural Research Institute (VASI). Memorandum of Agreement among IRRI, VASI, CIRAD, and IRD relative to the SAM Program (Mountain Agrarian Systems Program. 2005/04/06–2006/04/30
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between IRRI and VIAEP and the Nam Dinh Department of Agriculture and Rural Development for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/10/30–2006/01/30
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between IRRI and VIAEP for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/10/30–2006/02/28
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between IRRI and VIAEP and Dr. Nguyen Duy Lam for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/10/30–2006/02/28
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between IRRI and VIAEP and the Long An Department of Agriculture and Rural Development for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/10/30–2006/01/30
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between IRRI and VIAEP on the collaboration with Dr. Tran Thi Mai as the national coordinator for the purpose of implementing the activities of the national coordinator for the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/10/30–2008/10/29
- Vietnam Institute of Agricultural Engineering and Post Harvest (VIAEP). Letter of Agreement between IRRI and VIAEP on the collaboration with Dr. Phan Thanh Tinh as the national focal person for the purpose of implementing the ADB-funded project *Improving poor farmers' livelihoods through improved postharvest technology* (DPPC2002-37). 2005/08/30–2008/08/29
- Voice of Ho Chi Minh (VOH) Radio Station. Letter of Agreement between VOH and IRRI (English and Vietnamese versions) for the project *Using entertainment education (EE) approach to motivate rice farmers to reduce pesticide use in the Mekong Basin* (DPPC2002-30). 2005/01/03

Honors, awards, and appointments for IRS, NRS, and BOT in 2005

Olivyn Angeles, Sarah Johnson, and Roland Buresh, CSWS

- Won second prize for the poster, *Soil solution sampling methods for organic acids in paddy soils*, East and Southeast Asia Federation of Soil Science Societies, Quezon City, Philippines, June.

Anindya Bandyopadhay, PhD scholar, PBGB

- Won the Best Poster Award for *Genetic engineering for introducing C4 trait into indica rice*, Federation of Crop Science Societies of the Philippines, May.

Darshan Brar, senior scientist, PBGB

- Named honorary scientist of the Rural Development Administration, Republic of Korea, January.

Mark Bell, head, TC/IPMO

- Presented a Gratitude Plate in recognition of his outstanding contributions to the successful implementation of the RTTS and the further strengthening of the collaboration between Korea and IRRI, from the Rural Development Administration, Republic of Korea, April.

Herminigildo Gines (PhilRice), Roland Buresh (IRRI), Mirasol Pampolino (IRRI), and Leocadio Sebastian (PhilRice)

- Won the National R&D Paper Award for *Opportunities for site-specific nutrient management in the Philippines*, 17th National Research Symposium, Bureau of Agricultural Research, Department of Agriculture, Quezon City, Philippines, October.

Herminigildo Gines, Roland Buresh, Mirasol Pampolino, and Leocadio Sebastian

- Won third prize for the poster, *Site-specific nutrient management for rice in the Philippines*, East and Southeast Asia Federation of Soil Science Societies, Quezon City, Philippines, June.

Gene Hettel, head, CPS

- Presented the 2005 Service Award for more than 33 years of outstanding volunteer efforts and service, Association for Communication Excellence in Agriculture, Natural Resources, and Life and Human Sciences, Texas, USA, June.

Gene Hettel and Tess Rola, CPS

- Won the Gold Award in the Editing Class for the IRRI/WARDA publication, *Rice-feeding insects and selected natural enemies in West Africa*, Association for Communication Excellence in Agriculture, Natural Resources, and Life and Human Sciences, USA, May.

K.L. Heong, senior scientist, EPPD

- Appointed visiting professor to the China Jillian University School of Life Sciences, China, April.

K.L. Heong, EPPD, and Monina Escalada, international research fellow, IPMO

- Won the World Bank Development Marketplace Award for the *Environmental soap opera for rural Vietnam*, the project, Washington, D.C., USA, May.

IRRI (institutional)

- Won 2nd and 3rd places, respectively, for success stories with IRRI ties, *Three Reductions, Three Gains Program to Improve Environment and Livelihood of Millions of Rice Farmers in Vietnam* (IRRI, Vietnam) and *Genuinely Lao, the Story of the Project that Revolutionized Rice Production in Laos* (IRRI, Laos), Swiss Agency for Development and Cooperation, March.
- Received Certificate of Appreciation as participant in the ASEAN Ritech Expo 2005, State Ministry of Research and Technology, Jakarta, Indonesia, August.
- Presented a Certificate of Recognition for contribution to the successful celebration of the 390th foundation anniversary of the Municipality of Los Baños and the promotion of tourism, community spirit and pride, Laguna, Philippines, September.
- Won The Center of the Year Award from the CGIAR's Gender and Diversity Program for Policy Goal Achievements in 2005 for an outstanding series of family-friendly policies that included: adoption, maternity leave, paternity leave, nursing with on-campus facilities, increased support for solo parents, and expanded compassionate leave. The award also recognized IRRI's "diversity positive" progress in prevention of harassment and discrimination, diversity positive recruitment and appointment, and the annual gender and diversity report to the BOT, December.

Ali Jamil, PhD scholar, CSWS

- Conferred lifetime membership for his continued interest in the advancement of agriculture and allied disciplines, Gamma Sigma Delta Honor Society of Agriculture, University of the Philippines Chapter, December.

J.K. Ladha, senior scientist, CSWS

- Received a Plaque of Honor, Indian Society of Soil Science, Ludhiana, India, September.
- Received the Outstanding Agricultural Scientist Award for 2005 for his significant research contribution to sustainable management of agriculture and natural resources, Association of Agricultural Scientists of Indian Origin, Salt Lake City, Utah, USA, November.

Ruben Lampayan, associate scientist, CSWS

- Received the Outstanding Filipino Agricultural Engineer Award in the field of irrigation research and development, Philippine Society of Agricultural Engineers, April.

Hei Leung, senior scientist, plant pathology, EPPD

- Elected Fellow of the American Association for the Advancement of Science (AAAS) for his contributions to science, September.

Teodoro Migo, Ofelia Namuco, A.M. Mortimer, and David Johnson, CSWS

- Won the Best Paper Award (weed science) for *Response of lowland rice weeds to submergence and the effect of herbicide dose*, Pest Management Council of the Philippines, May.

Charina Garrido-Ocampo, VIS

- Presented the 2005 Dangal ng Wika Award for promoting and popularizing the Philippine national language, Commission on the Filipino Language, September.

William G. Padolina, Deputy Director General for Partnerships

- Received the 2005 ASEAN Science and Technology Meritorious Award for his qualifications and significant contributions to the development and application of science and technology in the ASEAN region, Jakarta, Indonesia, August.

Mirasol Pampolino and Roland Buresh (IRRI), Ireneo Manguiat (UPLB), Herminigildo Gines (PhilRice), S. Ramanathan and Ramasamy Rajendran (Tamil Nadu Rice Research Institute, India), and Pham Sy Tan and Truong Thi Ngoc Chi (Cuu Long Delta Rice Research Institute, Vietnam)

- Won first prize for the poster, *Economic and environmental assessment of site-specific nutrient management in integrated rice systems*, East and Southeast Asia Federation of Soil Science Societies, Quezon City, Philippines, June.

Sushil Pandey, senior scientist, SSD

- Conferred the title of visiting professor, Yunnan Academy of Agricultural Sciences, China, October.
- Conferred the title of visiting professor in agricultural economics, Huazhong Agricultural University and Zhongzhan University of Economics and Law, China, November.

Thelma Paris, senior scientist/gender specialist, SSD

- Received the Honorary Fellow Award, Federation of Crop Science Societies of the Philippines, May.

Shaobing Peng, crop physiologist, CSWS

- Named Fellow of the Crop Science Society of America, Salt Lake City, Utah, USA, November.

Shaobing Peng, John Sheehy, Rebecca C. Laza, Romeo Visperas, Grace S. Centeno, and Gurdev Khush (IRRI), Jianliang Huang (Huazhong Agricultural University, China), Xuhua Zhong (Guangdong Academy of Agricultural Sciences, China), and Ken Cassman, University of Nebraska)

- Won the 2005 CGIAR Science Award for Outstanding Scientific Article, *Rice yields decline with higher night temperature from global warming*, Marrakech, Morocco, December.

George Reyes, Emmanuel Panisales, Juan Lazaro IV, Tess Rola, and Gene Hettel, CPS

- Won the Bronze Award in the Technical Publications Class for the IRRI/WARDA publication, *Rice-feeding insects and selected natural enemies in West Africa*, Association for Communication Excellence, in Agriculture, Natural Resources, and Life and Human Sciences USA, May.

Emerlinda R. Roman, member, Board of Trustees

- Conferred the 2005 Outstanding Citizen of Los Baños Award for exemplary service, experience, and commitment as university administrator, Municipal Government of Los Baños, Laguna, Philippines, September.

Marianne Samson, Eufrocino Laureles, Wenceslao Larazo, and Roland Buresh, CSWS

- Won the Best Paper competition, downstream research category, for *Benefits of real-time N-fertilizer management during four years in two long-term experiments,* Federation of Crop Science Societies of the Philippines, May.

Sant Virmani, principal plant breeder, PBGB

- Received the Pravasi Bharatiya Samman Award for his efforts to assuage India's concerns, food security, and related issues, Mumbai, India, January.
- Received the International Koshihikari Rice Prize for his development of hybrid rice technology in the tropics, Japan, February.
- Recognized by the Government of India, Indian Seed Industry Association, and Seedsmen Association for contributions to the development and dissemination of hybrid rice, Bangalore, India, April.
- Presented a Plaque of Gratitude for devoting more than 25 years to developing hybrid rice technologies suited to the Philippines and doing extensive research on hybrid rice, Department of Agriculture, June.
- Received the 2005 Monsanto Crop Science Distinguished Career Award, Salt Lake City, USA, November.

Publications and seminars in 2005

Journal articles (refereed)

Alam MM, Ladha JK, Khan RS, Foyjunessa HR, Khan AH, Buresh RJ. 2005. Leaf color chart for managing nitrogen fertilizer in lowland rice in Bangladesh. Agron. J. 97:949-959.

Alberto MCR, Larazo WM, Laureles EV, Pasuquin JMCA, Buresh RJ. 2005. Long-term effects of water regimes, straw management, and fertilizer inputs on fertility of an intensively cultivated rice soil. Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines. Philipp. J. Crop Sci. (suppl.):43.

Almazan MSR, Naredo MEB, Banaticla MCN, Hamilton NRS. 2005. Management of wild rice collections in the International Rice Genebank at IRRI. J. Nat. Stud. 4 (1):29-35.

Altpeter F, Baisakh N, Beachy R, Bock R, Capell T, Christou P, Daniell H, Datta K, Datta S, Dix PJ, Fauquet C, Huang N, Kohli A, Mooibroek H, Nicholson L, Thi Thanh Nguyen, Nugen G, Raemakers K, Romano A, Somers DA, Stoger E, Taylor N, Visser R. 2005. Particle bombardment and the genetic enhancement of crops: myths and realities. Mol. Breed. 15(3):305-327.

Arthur AD, Pech RP, Singleton GR. 2005. Predicting the effect of virally vectored recMCMV immunocontraception on house mice (*Mus musculus domesticus*) in mallee wheatlands. Wildlife Res. 32:631-637.

Bainville S, Affholder F, Figuie M, Neto MJ. 2005. Changes in small-scale farms of Silvania: a small agrarian revolution in the Brazilian cerrados (Les transformations de l'agriculture familiale de la commune de Silvania: une petite revolution agricole dans les Cerrados bresiliens.) Cahiers Agric. 14:103-110.

Bandong JP, Litsinger JA. 2005. Rice crop stage susceptibility to the rice yellow stem borer *Scirpophaga incertulas* (Walker)(Lepidoptera: Pyralidae). Int. J. Pest Manage. 51(1):37-43.

Barah BC, Pandey S. 2005. Rainfed rice production systems in eastern India: an on-farm diagnosis and policy alternatives. Indian J. Agric. Econ. 60(1):110-136.

Belder P, Bouman BAM, Spiertz JHJ, Peng SB, Castañeda AR, Visperas R. 2005. Crop performance and nitrogen use in flooded and aerobic rice. Plant Soil 273:167-182.

Belder P, Spiertz JHJ, Bouman BAM, Guoan L, Tuong TP. 2005. Nitrogen economy and water productivity of lowland rice under water-saving irrigation. Field Crops Res. 93:169-185.

Bi XZ, Khush GS, Bennett J. 2005. Rice nucellin gene orthologue *OsAsp1* encodes an active aspartic protease without a plant-specific insert and is strongly expressed in early embryo. Plant Cell Physiol. 46:87-98.

Bijay-Singh, Yadvinder-Singh, Ladha JK. 2005. Management of crop residues in rice-wheat cropping system in the Indo-Gangetic Plains of South Asia. Jpn. Assoc. Int. Collab. Agric. For. 28:17-24.

Bouman BAM, Peng S, Castañeda AR, Visperas RM. 2005. Yield and water use of irrigated tropical aerobic rice systems. Agric. Water Manage. 74:87-105.

Brown PR, Tuan NP, Singleton GR, Hue DT, Hoa PT, Ha PTT, Tan TQ, Tuat NV. 2005. Population dynamics of *Rattus argentiventer, R. losea* and *R. rattus* inhabiting a mixed farming system in the Red River Delta, Vietnam. Popul. Ecol. 47:247-256.

Buresh RJ, Witt C, Ramanathan S, Chandrasekaran B, Rajendran R. 2005. Site-specific nutrient management: managing N, P, and K for rice. Fert. News 50(3):25-28, 31-37.

Cabunagan RC, Choi IR. 2005. Rice tungro disease incidence in mixed planting of resistant and susceptible rice varieties. Philipp. J. Crop Sci. 30(1):84. (abstr.)

Castro JV, Dumas C, Chiou H, Fitzgerald MA, Gilbert RG. 2005. Mechanistic information from analysis of molecular weight distributions of starch. Biomacromolecules 6(4):2248-2259.

Castro JV, Ward RM, Gilbert RG, Fitzgerald MA. 2005. Measurement of absolute molecular weight distributions of starches. Biomacromolecules 6(4):2260-2270.

Castañeda AR, Bouman BAM, Peng S, Reversat G, Fernandez L, Visperas RM, Acosta J, Lactaoen A, Norte T, Lampayan R, De Mesa De Jr. 2005. Experimental performance of the aerobic rice system in three soil types in the Philippines. Philipp. J. Crop Sci. 30:42 (suppl.)

Castella JC, Boissau S, Trung TT, Quang DD. 2005. Agrarian transition and lowland-upland interactions in mountain areas in northern Vietnam: application of a multi-agent simulation model. Agric. Sys. 86(3):312-332. http://dx.doi.org/10.1016/j.agsy.2004.11.001

Castella JC, Eguienta YK, Hieu TT. 2005. Facilitating the diffusion of alternative cropping systems for mountain agriculture in Vietnam. J. Sustainable Agric. 27(4):137-157. http://dx.doi.org/10.1300/J064v27n04_10

Castella JC, Gevraise V, Novosad P. 2005. Centralized planning and economic reforms in a mountainous region of Vietnam. J. Contemp. Asia 35(2):166-182.

Castella JC, Hieu TT, Eguienta YK. 2005. Participatory landscape analysis for community-based livestock management in Vietnam. Particip. Learning Action 51:82-89.

Castella JC, Manh PH, Kam SP, Villano L, Tronche NR. 2005. Analysis of village accessibility to markets, schools and health services and its impact on land use dynamics in a mountainous province of northern Vietnam. Appl. Geogr. 25(4):308-326. http://dx.doi.org/10.1016/j.apgeog.2005.07.003

Castella JC, Tronche NR, Nguyen V. 2005. Impact of land use changes on mountain landscapes in northern Vietnam during the 1990s. Cybergo: Eur. J. Geogr. 297:13 Jan 2005. http://193.55.107.45/articles/297res.htm

Castella JC, Trung TN, Boissau S. 2005. Participatory simulation of land-use changes in the northern mountains of Vietnam: the combined use of an agent-based model, a role-playing game, and a geographic information system. Ecol. Soc. 10(1):27. http://www.ecologyandsociety.org/vol10/iss1/art27/

Chen YH, Welter SC. 2005. Crop domestication disrupts a native tritrophic interaction associated with the sunflower, *Helianthus annuus* (Asterales: Asteraceae). Ecol. Entomol. 30:673-683.

Chiou H, Fellows CM, Gilbert RG, Fitzgerald MA. 2005. Study of rice-starch structure by dynamic light scattering in aqueous solution. Carbohydr. Polymer. 61(1):61-71.

Choi IR, Horken KM, Stenger DC, French R. 2005. An internal RNA element in the P3 cistron of wheat streak mosaic virus revealed by synonymous mutations that affect both movement and replication. J. Gen. Virol. 86:2605-2614.

Chu HY, Hosen Y, Yagi K, Okada K, Ito O. 2005. Soil microbial biomass and activities in a Japanese Andisol as affected by controlled release and application depth of urea. Biol. Fertil. Soils 42 (2):89-96.

Chye ML, Zhao KJ, He ZM, Ramalingam S, Fung KL, 2005, An agglutinating chitinase with two chitin-binding domains confers fungal protection in transgenic potato. Planta 220(5):717-730.

Das KK, Sarkar RK, Ismail AM. 2005. Elongation ability and non-structural carbohydrate levels in relation to submergence tolerance in rice. Plant Sci. 168(1):131-136.

Dawe D. 2005. Increasing water productivity in rice-based systems in Asia – past trends, current problems, and future prospects. Plant Prod. Sci. 8(3):221-230.

Du PV, Cabunagan RC, Choi IR. 2005. Rice "yellowing syndrome" in Mekong River Delta. Omon Rice 13:135-138.

Ebron LA, Fukuta Y, Imbe T, Kato H, Yanoria MJ, Tsunematsu H, Khush GS, Kobayashi N, Yokoo M. 2005, Identification of blast resistance genes in elite Indica-type varieties of rice (*Oryza sativa L.*) SABRAO J. Breed. Genet. 37(1): 19-31.

Ereful N, Peng S, Laza RC. 2005. Performance of second-generation new plant type lines. Philipp. J. Crop Sci. 30 (suppl. 1):70.

Estudillo J, Sawada Y, Hossain M. 2005. Socioeconomic changes and decline in poverty: a view from three villages in the Philippines, 1985-1997. Asian Econ. J. 19(4):383-406.

Farroway LN, Gorman S, Lawson MA, Harvey NL, Jones DA, Shellam GR, Singleton GR. 2005. Transmission of two Australian strains of murine cytomegalovirus (MCMV) in enclosure populations of house mice (*Mus domesticus*). Epidemiol. Infect. 133:701-710.

Flores NRL, Ismail AM, Dionisio-Sese M. 2005. Gas exchange and leaf water status of constrasting rice (*Oryza sativa* L.) genotypes as affected by salt stress. Philipp. Agric. Sci. 88(1):40-48.

Fukuta Y, Hayashi N, Kobayashi N, Ando I. 2005 Genetic background of a blast susceptible breeding line US2. Jpn. J. Trop. Agric. 49(suppl. 2). [in Japanese]

Gragasin M, Maruyama A, Marciano E, Fujie M, Kikuchi M. 2005. Irrigators' association and farm productivity: a comparative study of two Philippine irrigation systems. Jpn. J. Rural Econ. 7:1-17.

Haas JD, Beard JL, Murray-Kolb LE, del Mundo AM, Felix A, Gregorio G. Iron-biofortified rice improves the iron stores of nonanemic Filipino women. J. Nutr. 135:2823-2930.

Haefele SM, Wopereis MCS. 2005. Spatial variability of indigenous supplies for N, P and K and its impact on fertilizer strategies for irrigated rice in West Africa. Plant Soil 274:57-72.

Heong KL, Escalada M.M. 2005. Scaling up communication of scientific information in rural communities. J. Sci. Commun. 4(3).

Hossain M, Naher F, Shahabuddin Q. 2005. Food security and nutrition in Bangladesh: progress and determinants. J. Agric. Econ. Dev. 2(2):103-132.

Hu WX, Peng SB, Gao RF, Ladha JK. 2005. Photosynthetic efficiency of a new plant type of rice developed by the International Rice Research Institute. Sci . Agric. Sin. 38(11):2205-2210.

Huan NH, Thiet LV, Chien HV, Heong KL. 2005. Farmers' participatory evaluation of reducing pesticides, fertilizers and seed rates in rice farming in the Mekong Delta, Vietnam. Crop Prot. 24:457-464.

Hwang HG. 2005. Reaction of resistance genes of monogenic lines to rice blast. Korean J. Breed. 37(3): 155-161.

International Rice Genome Sequencing Project. 2005. The map-based sequence of the rice genome. Nature 436:793-800.

Islam S, Peng S, Visperas RM. 2005. Physiological traits of hybrid rice for high grain yield in the wet season: analysis of characters related to lodging. Philipp. J. Crop Sci. 30:23 (suppl).

Jahn GC, Almazan LP, Pacia J. 2005. Effect of nitrogen fertilizer on the intrinsic rate of increase of the rusty plum aphid, *Hysteroneura setariae* (Thomas) (Homoptera: Aphididae) on rice (*Oryza sativa* L.). Environ. Entomol. 34(4):938-943.

Jansen HGP, Bouman BAM, Schipper RA, Hengsdijk H, Nieuwenhuyse A. 2005. An interdisciplinary approach to regional land use analysis using GIS, with applications to the Atlantic Zone of Costa Rica. Agric. Econ. 32:1-18.

Jeong EG, Brar DS, Kang KH, Hwang HG, Jena KK, Kim HY, Ahn SN, Yi GH, Nam MH. 2005. Cytological characterization of interspecific hybrids in rice (*Oryza sativa* L.). Korean J. Breed. 37(1):52-56.

Jeung JU, Hwang HG, Moon HP, Jena KK. 2005. Fingerprinting temperate japonica and tropical indica rice genotypes by comparative analysis of DNA markers. Euphytica 10.1007/s10681-005-9022-2. (online edition)

Ji XM, Raveendran M, Oane R, Ismail A, Lafitte R, Bruskiewich R, Cheng SH, Bennett J. 2005. Tissue-specific expression and drought responsiveness of cell-wall invertase genes of rice at flowering. Plant Mol. Biol. 59:945-64.

Ji XM, Van den Ende W, Van Laere A, Cheng SH, Bennett J. 2005. Structure, evolution and expression of the two invertase gene families of rice. J. Mol. Evol. 60:615-634.

Johnson SE, Lauren JG, Welch RM, Duxbury JM. 2005. A comparison of the effects of micronutrient seed priming and soil fertilization on the mineral nutrition of chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), rice (*Oryza sativa*), and wheat (*Triticum aestivum*) in Nepal. Exp. Agric. 41:427-448.

Juliano AB, Naredo MEB, Lu BR, Jackson MT. 2005. Genetic differentiation in *Oryza meridionalis* Ng based on molecular and crossability analyses. Genet. Resour. Crop Evol. 52:435-445.

Kam SP, Hossain M, Bose ML, Villano LS. 2005. Spatial patterns of rural poverty and their relationship with welfare-influencing factors in Bangladesh. Food Policy 30:551-567.

Khush GS. 2005. What it will take to feed 5.0 billion rice consumers in 2030. Plant Mol. Biol. 59(1):1-6.

Kiambi DK, Ford-Lloyd BV, Jackson MT, Guarino L, Maxted N, Newbury HJ. 2005. Collection of wild rice (*Oryza* L.) in east and southern Africa in response to genetic erosion. Plant Genet. Resour. Newsl. 142:10-20.

Kim SY, Madrid AV, Park ST, Yang SJ, Olofsdotter M. 2005. Evaluation of rice allelopathy in hydroponics. Weed Res. 45(1):74-79.

Kim KS, Kang, HJ, Hwang, IK, Hwang HG, Kim,TY, Choi, HC. 2005. Fibrillar microfilament associated with a high-amylose rice, Goami 2, a mutant of Ilpumbyeo, a high quality japonica rice. J. Agric. Food Chem. 53:2600-2608.

Knauth S, Hurek T, Brar D, Reinhold-Hurek B. 2005. Influence of different *Oryza* cultivars on expression of *nifH* gene pools in roots of rice. Environ. Microbiol. 7:1727-1733.

Kobayashi N. 2005. Development of a new universal standard of differential varieties for resistance to rice blast disease. Breed. Res. 7(suppl.1-2):84-85. [in Japanese]

Kondo M, Singh CV, Agbisit R, Murty MVR. 2005. Yield response to urea and controlled-released urea as affected by water supply in tropical upland rice. J. Plant Nutr. 28(2):201-219.

Ladha JK, Pathak HP, Krupnik TJ, Six J, van Kessel C. 2005. Efficiency of fertilizer nitrogen in cereal production: retrospect and prospect. Adv. Agron. 87:86-156.

Laureles EV, Samson MI, Larazo WP, Dizon MA, Peng S, Buresh RJ. 2005. Efficient nitrogen fertilizer management for irrigated rice cultivars: how do management options compare? Philipp. J. Crop Sci. 30:44 (suppl).

Li J, Xu M, Qin D, Li D, Hosen Y, Yagi K. 2005. Effects of chemical fertilizer application combined with manure on ammonia volatilization and rice yield in red paddy soil. Plant Nutr. Fert. Sci. 11(1):51-56.

Li ZC, Mu,P, Li, CP, Zhang HL, Li ZK, Gao, YM, Wang XK. 2005. QTL mapping of root traits in a double-haploid population from a cross between upland and lowland japonica rice under three environments. Theor. Appl. Genet. 110(7):1244-1252.

Litsinger JA, Bandong JP, Canapi BL, dela Cruz CG, Pantua PC, Alviola AL, Batay-an III EH. 2005. Evaluation of action thresholds for chronic rice insect pests in the Philippines. I. Less frequently occurring pests and overall assessment. Int. J. Pest Manage. 51(1):45-61.

Lu Z, Yu X, Heong KL, Hu C. 2005. Effects of nitrogen on the behavior of feeding and oviposition of the brown planthopper *Nilaparvata lugens* on IR64. J. Zhejiang Univ. 31:62-70.

Lu Z, Yu X, Heong KL, Hu C. 2005. Effects of nitrogenous fertilization in rice fields on the predatory function of *Cyrtorhinus lividipennis* Reuter to *Nilapavarta lugens* Stål. Acta Entomol. Sin. 48:48-56.

Luo YC, Wu S, Wang SH, Li CQ, Zhang DP, Zhang Q, Zhao KJ, Wang CL, Wang DZ, Du SY, Wang WX. 2005. Pyramiding two bacterial blight resistance genes into a CMS line R106A in rice. Sci. Agric. Sin. 38(11):2157-2164. [in Chinese]

Luong Minh Chau, Heong KL. 2005. Effects of organic fertilizers on insect pest and diseases of rice. Omon Rice 13:25-32.

McLaren CG, Bruskiewich RM, Portugal AM, Cosico AB. 2005. The International Rice Information System. a platform for meta-analysis of rice crop data. Plant Physiol. 139 (2):637-642.

Mei HW, Ki ZK, Shu QY, Guo LB, Wang YP, Yu XQ, Ying CS, Luo LJ. 2005. Gene actions of QTLs affecting several agronomic traits resolved in a recombinant inbred rice population and two backcross populations. Theor. Appl. Genet. 110:649-659.

Murchie EH, Hubbart S, Peng S, Horton P. 2005. Acclimation of photosynthesis to high irradiance in rice: gene expression and interactions with leaf development. J. Exp. Bot. 56:449-460.

Nas TMS, Sanchez DL, Diaz MG, Mendioro MS, Virmani, SS. 2005. Pyramiding of thermosensitive genetic male sterility (TGMS) genes and identification of a candidate *tms5* gene in rice. Euphytica 145:67-75.

Padre Tirol A, Tsuchiya K, Inubushi K, Ladha JK. 2005. Enhancing soil quality through residue management in a rice-wheat system in Fukuoka, Japan. Soil Sci. Plant Nutr. 51:849-860.

Paris T, Chi TTN. 2005. The impact of row seeder technology on women labor: a case study in the Mekong Delta, Vietnam. Gender Technol. Dev. 9(2):157-184.

Paris TR, Singh A, Luis J, Hossain M. 2005. Labor out-migration, livelihood of rice farming households and women left behind: a case study of eastern Uttar Pradesh. Econ. Polit. Weekly 40(25):2522-2529.

Parkhi V, Rai M, Tan J, Oliva N, Rehana S, Bandyopadhyay A, Torrizo L, Ghole V, Datta K, Datta SK. 2005. Molecular characterization of marker-free transgenic lines of indica rice that accumulate carotenoids in seed endosperm. Mol. Gen. Genomics 274(4):325-336.

Phoung LT, Denich M, Vlek PLG, Balasubramanian V. 2005. Suppressing weeds in direct-seeded lowland rice: effects of methods and rates of seeding. J. Agron. Crop Sci. 191: 185-194.

Praba ML, Thangaraj M. 2005. Effect of growth regulators and chemicals on pollen sterility in TGMS lines in rice. Plant Growth Regul. 46(2):117-124.

Ramos M, Ali KM. 2005. Maximizing library resources through consortial subscriptions: the case of the CGIARLIS Consortium. IAALD Q. Bull. L(1/2):5-9.

Ranathunge K, Steudle E, Lafitte R. 2005. Blockage of apoplastic bypass-flow of water in rice roots by insoluble salt precipitates analogous to a Pfeffer cell. Plant Cell Environ. 28(2):121-133.

Rao ZM, Wu JL, Zhuang JY, Chai RY, Fan YY, Hei L, Zheng KL 2005. Genetic dissections of partial resistances to leaf and neck blast in rice (*Oryza sativa* L.). Acta Genet. Sin. 32(6):555-565.

Regmi AP, Ladha JK. 2005. Enhancing productivity of rice-wheat system through integrated crop management in the Eastern-Gangetic plains of South Asia. J. Crop Improv. 15:147-170.

Samal P, Pandey S. 2005. Climatic risks, rice production losses and risk coping strategies: a case study of rainfed village in coastal Orissa. Agric. Econ. Res. Rev. 18:61-72.

Samejima H, Kondo M, Ito O, Nozoe T, Shinano T, Osaki M. 2005. Characterization of root systems with respect to morphological traits and nitrogen-absorbing ability in the new plant type of tropical rice lines. J. Plant Nutr. 28(5):835-850.

Sanchez DL, Virmani SS. 2005. Identification of thermosensitive genic male sterile lines with low critical sterility point for hybrid rice breeding. Philipp. J. Crop Sci. 30:19-30.

Sasaki K, Fukuta Y, Sato T. 2005. Mapping of quantitative trait loci controlling seed longevity of rice (*Oryza sativa* L.) after various periods of seed storage. Plant Breed. 124(4):361-366.

Savary S, Castilla NP, Elazegui FA, Teng PS. 2005. Multiple effects of two drivers of agricultural change, labour shortage and water scarcity, on rice pest profiles in tropical Asia. Field Crops Res. 91:263-271.

Segda Z, Haefele SM, Wopereis MCS, Sedogo MP, Guinko S. 2005. Combining field and simulation studies to improve fertilizer recommendations for irrigated rice in Burkina Faso. Agron. J. 97:1429-1437.

Sharma G, Patil SK, Buresh RJ, Mishra VN, Das R, Haefele SM, Shrivastava LK. 2005. Rice establishment method affects nitrogen use and crop production of rice-legume systems in drought-prone eastern India. Field Crops Res. 92:17-33.

Sheehy JE, Elmido A, Centeno HGS, Pablico P. 2005. Searching for new plants for climate change. J. Agric. Meteorol. 60(5):463-468.

Sheehy JE, Mnzava M, Cassman KG, Mitchell PL, Ferrer AB, Robles RP, Pablico P. 2005. Temporal origin of nitrogen in the grain of tropical wet-season rice. Agron. J. 97:698-704.

Sheehy JE, Sinclair TR, Cassman KG. 2005. Curiosities, nonsense, non-science and SRI. Field Crops Res. 91(2/3): 355-356.

Sheehy JE, Mitchell PL, Kirk GJD, Ferrer AB. 2005. Can smarter nitrogen fertilizers be designed? Matching nitrogen supply to crop requirements at high yields using a simple model. Field Crops Res. 94(1):54-66.

Shimizu A, Guerta CA, Gregorio GB, Ikehashi H. 2005. Improved mass screening of tolerance to iron toxicity in rice by lowering temperature of culture solution. J. Plant Nutr. 28 (9):1481-1493.

Shimizu A, Guerta CQ, Gregorio GB, Kawasaki S, Ikehashi H. 2005. QTLS for nutritional contents of rice seedlings (*Oryza sativa* L.) in solution cultures and its implication to tolerance to iron toxicity. Plant Soil 275(1/2):57-66.

Shoji K, Kawamura T, Horio H, Nakayama K, Kobayashi N. 2005. Variability of micro-elevation, yield, and protein content within a transplanted paddy field. Precision Agric. 6:73-86.

Singleton GR, Brown PR, Pech RP, Jacob J, Mutze GJ, Krebs CJ. 2005. One hundred years of eruptions of house mice in Australia – a natural biological curio. Biol. J. Linn. Soc. 84:617-627.

Singleton GR, Sudarmaji, Jacob J, Krebs CJ. 2005. Integrated management to reduce rodent damage to lowland rice crops in Indonesia. Agric. Ecosyst. Environ. 107: 75-82.

Siopongco JDLC, Yamauchi A, Salekdeh H, Bennett J, Wade LJ. 2005. Root growth and water extraction response of doubled-haploid rice lines to drought and rewatering during the vegetative stage. Plant Prod. Sci. 8(5):497-508.

Sreevidya VS, Hernandez-Oane JR, Rollando S, Sullia SB, Stacey G, Ladha JK, Reddy PM. 2005. Expression of the legume symbiotic lectin genes *psl* and *gs52* promotes rhizobial colonization of roots in rice. Plant Sci. 169:726-736.

Sutherland DR, Spencer PBS, Singleton GR, Taylor A. 2005. Kin interactions and changing social structure during a population outbreak of feral house mice. Mol. Ecol. 14:2803-2814.

Takai T, Fukuta Y, Shiraiwa T, Horie T. 2005. Time-related mapping of quantitative trait loci controlling grain-filling in rice (*Oryza sativa* L.). J. Exp. Bot. 56(418):2107-2118.

Tan J, Baisakh N, Oliva N, Parkhi V, Rai M, Torrizo L, Datta K, Datta SK. 2005. The screening of rice germplasm, including those transgenic rice cultivars which accumulate beta-carotene in their polished seeds, for their carotenoid profile. Int. J. Food Sci. Technol. 40(5):563-569.

Telebanco-Yanoria MJ, Fukuta Y, Imbe T, Tsunematsu H, Kato H, Ebron LA, Kobayashi N. 2005. A new set of differential varieties with japonica-type variety Lijiangxintuaheigu (LTH) genetic background for blast resistance in rice (*Oryza sativa* L.) Philipp. J. Crop Sci. 30 (suppl. 1):53.

Templeton DJ, Griffith GR, Piggot RR, O'Donnell C. 2005. Change in wool grower profits from adopting staple strength-enhancing management strategies. Int. J. Sheep Wool Sci. 53:1-23.

Tsubo M, Fukai S, Basnayake J, Tuong TP, Bouman BAM, Harnpichitvitaya D. 2005. Estimating percolation and later water flow on sloping land in rainfed lowland rice ecosystem. Plant Prod. Sci. 8(3):354-357.

Tuong TP, Bouman BAM, Mortimer M. 2005. More rice, less water—integrated approaches for increasing water productivity in irrigated rice-based systems in Asia. Plant Prod. Sci. 8(3):231-241.

Vera Cruz C, Carrillo G, Webb K, Oña I, Begum S, Goodwin P, Wu J, Bin L, Sugiyama N, Jianfa B, Leach J, Leung H. 2005. Sources of genes for crop improvement by biotechnology. Phytopathology 95(6):S132-133.

Visperas RM, Peng S, Bouman BAM, Castañeda AR. 2005. Another proof of the yield decline in the continuous aerobic rice systems. Philipp. J. Crop Sci. 30:69 (suppl).

Walia H, Wilson C, Condamine P, Liu X, Ismail AM, Zeng L, Wanamaker SI, Mandal J, Xu J, Cui X, Close TJ. 2005. Comparative transcriptional profiling of two contrasting rice (*Oryza sativa* L.) genotypes under salinity stress during vegetative growth stage. Plant Physiol. 139:822-835.

Wang CL, Qi HX, Pan HJ, Li JB, Fan YL, Zhang Q, Zhao KJ. 2005. EST-markers flanking the rice bacterial blight resistance gene *Xa23* and their application in marker-assisted selection. Sci. Agric. Sin. 38(10):1996-2001. [in Chinese]

Wang J, Wang CL, Fan JJ, Zhang Q, Kong FL, Zhao KJ. 2005. Isolation of cDNA clones related to bacterial blight resistance of rice by mRNA differential display. Acta Agron. Sin. 31(10):1373-1376. [in Chinese]

Wang L, E ZG, Yu HY, Tang SX, McLaren GC. 2005. Introduction to International Rice Information System and its application. Chin. J. Rice Sci. 19(2):193-194.

Wang X, Zhu J, Mansueto L, Bruskiewich R. 2005. Identification of candidate genes for drought stress tolerance in rice by the integration of a genetic (QTL) map with the rice genome physical map. J. Zhejiang Univ. Sci. 6B(5):382-388.

Wilby A, Villareal SC, Lan LP, Heong KL, Thomas MB. 2005. Functional benefits of predator species diversity depend on prey identity. Ecol. Entomol. 30:497-501.

Wilman D, Olmos F, Sackville Hamilton RS. 2005. The potential of seed-shedding and seedling development to contribute to the persistence of white clover (*Trifolium repens*) in grazed swards in Uruguay. J. Agric. Sci. 143:493-501.

Wing RA, Ammiraju JSS, Luo MZX, Kim H, Yu YS, Kudrna D, Goicoechea JL, Wang WM, Nelson W, Rao K, Brar D, Mackill DJ, Han B, Soderlund C, Stein L, SanMiguel P, Jackson S. 2005. The Oryza Map Alignment Project: the golden path to unlocking the genetic potential of wild rice species. Plant Mol. Biol. 59:53-62.

Wissuwa M, Gamat G, Ismail AM. 2005. Is root growth under phosphorus deficiency affected by source or sink limitations? J. Exp. Bot. 56:1943-1950.

Wissuwa M. 2005. Combining a modeling with a genetic approach in establishing associations between genetic and physiological effects in relation to phosphorus uptake. Plant Soil 269(1/2):57-68.

Witt C, Fairhurst TH, Sheehy JE, Dobermann A, Gfroerer-Kerstan A. 2005. A nutrient decision support system software for irrigated rice. Better Crops 89(4):26-28.

Witt C, Pasuquin JMCA, Mutters R, Buresh RJ. 2005. New leaf color chart for effective nitrogen management in rice. Better Crops 89(1):36-39.

Wu J, Wu C, Lei C, Baraoidan M, Bordeos A, Madamba MRS, Pamplona MR, Mauleon R, Portugal R, Ulat V, Bruskiewich R, Wang G, Leach J, Khush GS, Leung H. 2005. Chemical- and irradiation-induced mutants of indica rice IR64 for forward and reverse genetics. Plant Mol. Biol. 59(1):85-97.

Wu JL, Fan YY, Li DB, Zheng KL, Leung H, Zhuang JY. 2005. Genetic control of rice blast resistance in the durably resistant cultivar Gumei 2 against multiple isolates. Theor. Appl. Genet. 111(1):50-56.

Xu C, Li ZK, Xu SZ. 2005. Joint mapping of quantitative trait loci for multiple binary characters. Genetics 169:1045-1059.

Xu JL, Lafitte HR, Gao YM, Fu BY, Torres RO, Li ZK. 2005. QTLs for drought escape and tolerance identified in a random set of introgression lines of rice. Theor. Appl. Genet. 111:1642-1650.

Xu M, Sun X, Zou C, Qin D, Yagi K, Hosen Y. 2005. Effects and rational application of controlled release nitrogen fertilizer in paddy field of southern China. Plant Nutr. Fert. Sci. 11(4):487-493.

Xue CY, Yang XG, Bouman BAM, Feng LP, van Laar G, Wang HQ, Wang P, Wang ZM. 2005. Preliminary approach on adaptability of Oryza2000 model for aerobic rice in Beijing region. Acta Agron. Sin. 31(12):1567-1571.

Yang XE, Li H, Kirk GJD, Dobermann A. 2005. Room-induced changes of potassium in the rhizosphere of lowland rice. Commun. Soil Sci. Plant Anal. 36(13/14): 1947-1963.

Yang Xiaoguang, Bouman BAM, Wang Huaqi, Wang Zhimin, Zhao Junfang, Bin C. 2005. Performance of temperate aerobic rice under different water regimes in North China. Agric. Water Manage. 74(2):107-122..

Yi GH, Choi JH, Jeong EG, Chon NS, Jena KK, Ku YC, Kim DH, Eun MY, Jeon JS, Nam MH. 2005. Morphological and molecular characterization of a new frizzy panicle mutant, "fzp-9(t)", in rice (*Oryza sativa* L.). Hereditas 10.1111/j.2005.0018-0661.01915.x.

Yu LQ, Mortimer AM, Xuan SN, Lu YL, Zhou YJ. 2005. Stress-resistance of weed rice Luolijing (*Oryza sativa*). Chin. J. Appl. Ecol. 16(4):717-720.

Zhu YY, Fang H, Wang YY, Fa JX, Yang SS, Mew TW, Mundt CC. 2005. Panicle blast and canopy moisture in rice cultivar mixtures. Phytopathology 95(4):433-443.

Zuo Y, Hosen Y, Chu H. 2005. Effects of soil moisture on nitrification activities of a Chinese Chao soil and a Japanese Andisol. Soil Fert. 5:21-24.

Books

Bousquet F, Trebuil G, Hardy B, editors. 2005. Companion modeling and multiagent systems for integrated natural resource management in Asia. Los Baños (Philippines): International Rice Research Institute. 360 p.

Khush GS, Virk PS. 2005. IR varieties and their impact. Los Baños (Philippines): International Rice Research Institute. 163 p.

Puckridge DW, Buu BC, Heong KL, Tuong TP, Bo NV. 2005. Rice environmental and livelihood for the poor. Proceedings of the Mekong Rice Conference to commemorate the International Year of Rice, Ho Chi, Minh City, Vietnam, 15-17 Oct 2004. Ha Noi (Vietnam): Ministry of Agriculture and Rural Development.

Book chapters

Bousquet F, Trebuil G, Boissau S, Baron C, d'Aquino P, Castella JC. 2005. Knowledge integration for participatory land management: the use of multi-agent simulations and a companion modeling approach. In: Neef A, editor. Participatory approaches for sustainable land use in Southeast Asia. Bangkok: White Lotus Publishers. p 291-310.

Brar DS, Khush GS. 2005. Cytogenetic manipulation and germplasm enhancement of rice (*Oryza sativa* L.) In: Singh RJ, Jauhar P, editors. Genetic resources, chromosome engineering and crop improvement. Boca Raton (USA): CRC Press. p 115-158.

Castañeda AR, Bouman BAM, Peng S, Visperas RM. 2005. Aerobic rice in the tropics and its impact on water productivity. In: Thiyagarajan TM, Hengsdijk H, Bindraban PS, editors. Transitions in agriculture for enhancing water productivity. Proceedings of an international symposium held in Killikulam, Tamil Nadu, India, 23-25 Sep 2003. Tamil Nadu (India): Agricultural College and Research Institute. p 71-88.

Choudhury BU, Singh AK, Bouman BAM. 2005. Effect of establishment techniques on yield, crop-water relationship in rice and wheat. In: Thiyagarajan TM, Hengsdijk H, Bindraban PS, editors. Transitions in agriculture for enhancing water productivity. Proceedings of an international symposium held in Killikulam, Tamil Nadu, India, 23-25 Sep 2003. Tamil Nadu (India): Agricultural College and Research Institute. p 19-37.

Datta SK, Parkhi V, Rai M, Torrizo L, Oliva N, Roy S, Bandyopadhyay A, Julian R, Krishnan S, Tan J, Datta K. 2005. Nutrition-rice for human nutrition. In: Lee K.S, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 2004. Suwon (Korea): Rural Development Administration. p 179-190.

Gallagher K, Ooi P, Mew T, Borromeo E, Kenmore P, Ketelaar JW. 2005. Ecological basis for low-toxicity integrated pest management (IPM) in rice. In: Pretty J, editor. The earthscan reader in sustainable agriculture. London; Sterling, VA: Earthscan. p 206-220.

Gallagher K, Ooi P, Mew T, Borromeo E, Kenmore P, Ketelaar JW. 2005. Ecological basis for low-toxicity integrated pest management (IPM) in rice and vegetables. In: Pretty J, editor. The pesticide detox: towards a more sustainable agriculture. London; Sterling, VA: Earthscan. p 116-134.

Gregorio GB, Cabuslay G. 2005. Recent developments in abiotic stress tolerance breeding in rice In: Ashraf M, Harris PJC, editors. Abiotic stresses: plant resistance through breeding and molecular approaches. New York: Food Products Press, Inc. p 513-534.

Heong KL. 2005. Strategies to attain ecologically sustainable pest management in rice systems. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 2004. Suwon (Korea): Rural Development Administration. p 111-123.

Hossain M. 2005. Economic prosperity, globalization, and the prospects of rice industry in Asia. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 2004. Suwon (Korea): Rural Development Administration. p 215-231.

Hosen Y. 2005. Evaluation and development of methods for sustainable agriculture and environmental conservation. In: Koyama O, editor. Development of sustainable production and utilization of major food resources in China. JIRCAS Working Report No. 42. Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. p 89-100.

Khush GS. 2005. Feed five billion rice consumers—the role of rice breeding. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 2004. Suwon (Korea): Rural Development Administration. p 3-15.

Khush GS. 2005. Scientific breakthroughs and plant breeding. In: Kang MS, editor. Genetic and production innovations in field crop technology: new developments in theory and practice. Binghamton, New York: Food Products Press. p 23-28.

Koo BW, Pardey PG, Jackson MT. 2005. IRRI genebank. In: Koo BW, Pardey PG, Wright BD, editors. Saving seeds: the economics of conserving crop genetic resources ex situ in the future harvest centres of the CGIAR. Wallingford, Oxon, England; Cambridge, MA: CABI Publishing. p 89-103.

Lafitte R, Bennett J, Kathiresan A. 2005. Drought tolerance in rice. In: Ribaut J-M, editor. New York (USA): Haworth's Food Products Press.

Leach JE, Liu B, Manosalva P, Wu CJ, Wu JL, Bordeos A, Bai JF, Lee SW, Ryba-White M, Bruce M, Hulbert S, Hopkins C, Vera Cruz C, Leung H. 2005. Dissection of durable resistance in rice. In: Tsuyumu S, Leach JE, Shiraishi T, Wolpert T. editors. Genomic and genetic analysis of plant parasitism and defense. St. Paul (USA): APS Press. p 164-173.

Liu JX, Raveendran M, Mushtaq R, Ji XM, Yang XE, Bruskiewich R, Katiyar S, Cheng SH, Bennett J. 2005. Proteomic analysis of drought-responsiveness in rice: *OsADF5*. In: Tuberosa R, Phillips RL, Gale M, editors. In the wake of the double helix: from the green revolution to the gene revolution. Bologna: Edizioni Avenue Media. p 491-505.

Mackill DJ, McNally KL. 2005. A model crop species: molecular markers in rice. In: Lorz H, Wenzel G, editors. Molecular marker systems in plant breeding and crop improvement. Berlin & New York: Springer-Verlag. p 39-54.

Paris T, Dayo HF, Malasa RB. 2005. Gender and farming systems. In: Vergara BS, editor. Philippine rice centennial: research and development. Muñoz (Philippines): Philippine Rice Research Institute. p 59-105.

Paris T, Nabi SA, Salahuddin A, Magor NP. 2005. The right to learn: women want more agricultural advice. In: Van Mele P, Salahuddin A, Magor NP, editors. Innovations in rural extension: case studies from Bangladesh. Los Baños (Philippines): International Rice Research Institute, and Wallingford (UK): CABI Bioscience. p 15-27.

Paris T, Singh A, Singh HN, Luis J, Hossain M. 2005. Using participatory tools in setting gender-sensitive criteria for acceptable rice varieties in eastern India. In: Gonsalves, J, Becker T, Braun A, Campilan D, De Chavez H, Fajber E, Kapiriri M, Rivaca-Caminade J, Vernooy R, editors. Participatory research and development for sustainable agriculture and natural resource management: a sourcebook. Vol. 3. Doing participatory research and development. Laguna (Philippines): International Potato Center-Users' Perspectives with Agricultural Research and Development, and Ottawa (Canada): International Development Research Centre. p 11-17.

Rajendran R, Ravi V, Ramanathan S, Chandrasekara B, Jayaraj T, Balasubramanian V. 2005. Evaluation of selected crop management components for enhancing rice productivity and profitability in Tamil Nadu, India.

Rajotte EG, Norton GW, Luther GC, Barrera V, Heong KL. 2005. IPM transfer and adoption. In: Norton GW, Heinrichs EA, Luther GC, Irwin ME, editors. Globalizing integrated pest management: a participatory research process. Ames (Iowa): Blackwell Publishers. p 143-157.

Ramos M. 2005. Sharing digital knowledge with end-users: case study of the International Rice Research Institute Library and Documentation Service in the Philippines. In: Theng YL, Foo S, editors. Design and usability of digital libraries: case studies in the Asia Pacific. Hershey, PA: Information Science Publishing. p 216-237.

Singh Y, Singh G, Singh VP, Singh P, Hardy B, Johnson DE, Mortimer M. 2005. Direct seeding of rice and weed management in the irrigated rice-wheat cropping system of the Indo-Gangetic Plains. Pantnagar (India): Directorate of Experiment Station, G.B. Pant University of Agriculture and Technology. 39 p.

Singh RK, Mishra B, Sharma DK. 2005. CSR 30: first basmati rice variety for salt-affected soils. In: Singh RK, Singh US, editors. Scented rice of Uttar Pradesh and Uttaranchal. New Delhi (India): Kalayani Publishers. p 75-84.

Templeton DJ. 2005. Outcomes: evaluating agricultural research projects to achieve and to measure impact. In: Metcalf I, Holloway B, McWilliam J, Inall N, editors. Research management in agriculture: a manual for the 21st century. Australia: University of New England.

Tuong TP. 2005. Technologies for efficient water utilization in rice production. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 2004. Suwon (Korea): Rural Development Administration. p 141-161.

Virmani SS. 2005. Hybrid rice technology for increasing yield, input-use efficiency, and employment generation. In: Lee K.S, Jena KK,Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 2004. Suwon (Korea): Rural Development Administration. p 17-29.

Wissuwa M, Gatdula K, Ismail A. 2005. Candidate gene characterization at the *Pup 1* locus: a major QTL increasing tolerance for phosphorus deficiency. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 83-85.

Wissuwa M. 2005. Mapping nutritional traits in crop plants. In: Broadley MR, White PJ, editors. Plant nutritional genomics. Oxford (UK): Blackwell. p 220-241.

Witt C, Haefele, SM. 2005. Paddy soils. In: Hillel D, editor. Encyclopedia of soils in the environment. Amsterdam; Boston: Elsevier Academic Press. p 141-150.

Yang XG, Bouman BAM, Wang HQ, Wang ZM, Zhao JF, Chen B. 2005. Water use efficiency of aerobic rice in North China. In: Thiyagarajan MT, Hengsdijk H, Bindraban PS, editors. Transitions in agriculture for enhancing water productivity. Proceedings of an international symposium held in Killikulam, Tamil Nadu, India, 23-25 Sep 2003. Tamil Nadu (India): Agricultural College and Research Institute. p 89-96.

Occasional/discussion papers

Patil SG, Sivaprasad B, Aladakatti YR, Siddalinga D, Gupta RK, Ladha JK. 2005. Agronomic practices and production economics of direct seeded rice in Karnataka, India. Rice-Wheat Consortium Paper Series 19. New Delhi, India: Rice-Wheat Consortium for the Indo-Gangetic Plains. 36 p.

Conference and workshop papers—proceedings

Ahmed GJU, Bhuiyan MKA, Riches CR, Mortimer M, Johnson D. 2005. Farmers' participatory studies of integrated weed management systems for intensified lowland rice (*Oryza sativa* L.) in Bangladesh. In: Proceedings of the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam. p 524-528.

Azmi M, Chin DV, Vongsaroj P, Johnson DE. 2005. Emerging issues in weed management of direct-seeded rice in Malaysia, Vietnam, and Thailand. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, 4-7 Nov 2004, Tokyo and Tsukuba, Japan. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 196-198.

Azmi M, Muhamad H, Johnson DE. 2005. Impact of weedy rice infestation on rice yield and influence of crop establishment technique. In: Proceedings of the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam. p 507-513.

Bagchi B, Abedin MZ, Nasar SKT. 2005. Farmer participatory evaluation of nitrogen management technololy: the leaf color chart in West Bengal, India. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Banos (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 395-397.

Bouman BAM, Humphreys L, Barker R, Tuong TP, Molden D. 2005. A comprehensive assessment of water and rice: trends, conditions and response options. In: Management of paddy and water environment for sustainable rice production. Proceedings of PAWEES 2005 International Conference, 7-8 Sep 2005. Kyoto (Japan): Paddy and Water Environment Engineering Society. p 73-74.

Bousquet F, Trebuil G. 2005. Companion modeling and multiagent systems for collective learning and resource management in Asian rice ecosystem. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Banos (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 401-404.

Brar DS. 2005. Utilization of wild species of *Oryza*: conventional and molecular approaches. In: Proceedings of the International Symposium on Plant Genetic Resources, 2-6 May 2005, Jeju, Korea. p 64-70.

Bruskiewich R, McLaren CG. 2005. Bioinformatics for rice research at the International Rice Research Institute. In: Proceedings of the National Conference on AgriICT 2005, 17-28 Sep 2005, Kuala Lumpur, Malaysia.

Buresh RJ, Larazo WM, Pampolino MF, Dizon MA, Witt C, Olk D. 2005. Long-term changes in soil nitrogen-supplying capacity in rice-maize and rice-rice cropping systems. In: Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA.

Buresh RJ, Larazo WM, Samson MI, Laureles EV, Gines HC, Thuy NH, Pampolino MF, Alberto MCR. 2005. Sustainable soil and nutrient management of lowland rice ecosystems: experiences from long-term experiments. In: Proceedings of the International Symposium on Sustainability of Paddy Farming Systems. Seventh International Conference of the East and Southeast Asia Federation of Soil Science Societies, 1-2 Jun 2005, Quezon City, Philippines. p. 52-53.

Carrillo G, Wu J, Liu B, Sugiyama N, Oña I, Variar M, Courtois B, Leach JE, Goodwin PH, Leung H, Vera Cruz CM. 2005. Association of candidate defense genes with quantitative resistance to rice blast and in silico analysis of their characteristics. In: Proceedings of the World Rice Research Conference, 4-7 Nov 2004, Tokyo and Tsukuba,

Japan. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 479-481.

De los Reyes AS, Malabayabas AJ, Sombilla M. 2005. Sustaining higher efficiency in rice production. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Banos (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 428-431.

Heong KL. 2005. Strategies to attain ecologically sustainable pest management in rice systems. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, 13-15 Sep 2004, Seoul, Korea. Suwon (Korea): Rural Development Administration. p 111-123.

Hoanh CT, Tuong TP, Khiem NT, Nhan NV. 2005. Management of conflicts in rice-fishery production in the coastal zone of the Mekong Delta and impacts on rural livelihood. In: Puckridge DW, Buu BC, Heong KL, Tuong TP, Bo NV, editors. Rice environment and livelihood for the poor. Proceedings of the Mekong Rice Conference to commemorate the International Year of Rice, 15-17 Oct 2004, Ho Chi Minh City, Vietnam. p 140-150.

Hossain M. 2005. Economic prosperity, globalization and the prospect of rice industry in Asia. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, 13-15 Sep 2004, Seoul, Korea. Suwon (Korea): Rural Development Administration.

Hossain M. 2005. Food security and nutrition in Bangladesh: progress and determinants. In: Proceedings of the Symposium on Nutrition Security in South Asia, 7-9 Mar 2005, New Delhi, India. p 167-178.

Hossain M. 2005. Growth of rural nonfarm economy in Bangladesh: determinants and impact on poverty reduction. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the Word Rice Conference, 4-7 Nov 2005, Tokyo and Tsukuba, Japan. Los Baños (Philippines): International Rice Research Institute and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD.

Ismail AM. 2005. Revitalizing marginal lands: discovery of genes for tolerance of saline and phosphorus-deficient soils to enhance and sustain productivity. In: Proceedings of the Generation Challenge Program Annual Research Meeting, 29 Sep-1 Oct 2005, Rome, Italy. p 3-4.

Janiya JD, Johnson DE. 2005. Reducing herbicide rate by exploiting water regimes. In: Proceedings of the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam. p 275-281.

Johnson DE, Mortimer AM. 2005. Issues for integrated weed management and decision support in direct-seeded rice. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 211-214.

Johnson SE, Angeles OR, Alberto MCR, Buresh RJ. 2005. Optimum redox potential: greenhouse gas emissions and nutrient relationships at various depths in flooded soils. In: Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA,

Johnson SE, Angeles OR, Cabiles DMS, Brar DS, Buresh RJ. 2005. Faster straw decomposition of a brittle stem mutant of rice: implications for residue management. In: Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA.

Ladha JK, Gupta RK. 2005. Overview of permanent raised beds in the Indo-Gangetic Plain. In: Proceedings of an international workshop on the evaluation and performance of permanent raised bed systems in Asia and Australia. Australian Centre for International Agricultural Research. CSIRO Land & Water, 1-3 Mar 2005, Griffith Laboratory, New South Wales, Australia.

Ladha JK. 2005. Developing alternative tillage and crop establishment strategies for higher resource use efficiencies in rice-wheat system. In: Proceedings of the Third Research Coordinating Meeting of the IAEA-coordinated Research Project on Integrated Soil, Water, and Nutrient Management for Sustainable Rice-Wheat Cropping System in Asia, 9-15 Jul 2005, Dhaka, Bangladesh.

Liu JX, Raveendran M, Mushtaq R, Ji XM, Yang XE, Bruskiewich R, Katiyar S, Cheng SH, Bennett J. 2005. Proteomic analysis of drought responsiveness in rice: *OsADF5*. In: Tuberosa R, Phillips RL, Gale M, editors. In the wake of the double helix: from the green revolution to the gene revolution. Proceedings of an international congress, 27-31 May 2005, University of Bologna, Italy. Bologna (Italy): Avenue Media.

Manguiat IJ, Pampolino MF, Ramanathan S, Gines HC, Tan PS, Chi TN, Rajendran R, Buresh RJ. 2005. Economic and environmental assessment of site-specific nutrient

management (SSNM) in irrigated rice systems. In: Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA.

McLaren CG, Bruskiewich R, Sackville-Hamilton R, Metz T. 2005. The role of crop information systems in the management and utilization of plant genetic resources for food and agriculture. In: Proceedings of the National Conference on AgriICT 2005, 17-28 Sep 2005, Kuala Lumpur, Malaysia.

McNally KL, Macatangay M, Juliano A, Naredo ME, Wang H, Banzuela N, Rodriguez M, Quilloy SM, Caspillo B, Detras J, Mamiit G, Cadion J, Castanar L, Reaño R, Banaticla MC, Almazan MS, Alcantara A, de Guzman F, Leung H, Vera Cruz C, Lafitte R, Atlin G, Fitzgerald M, Park YJ, Ma KH, Sackville Hamilton NR. 2005. GR9. Allele mining the IRGC. In: Proceedings of the International Symposium on Plant Genetic Resources, 2-6 May 2005, Jeju City, Korea. p 71-79.

Migo TR, Namuco OS, Mortimer AM, Johnson DE. 2005. Emergence and growth strategies of some common lowland rice (*Oryza sativa* L.) weeds to submergence. In: Proceedings of the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam. p 131-136.

Mortimer AM, Namuco O, Johnson DE. 2005. Seedling recruitment in direct-seeded rice: weed biology and water management. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference held in Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 202-205.

Mortimer M, Riches CR, Mazid MA, Pandey S, Orr A, Johnson DE. 2005. Issues related to direct seeding of rice in rainfed cropping systems: a case study in northwest Bangladesh. In: Direct seeding of rice and weed management in the irrigated rice-wheat cropping systems of the Indo-Gangetic Plains. Pantnagar (India): Directorate of Experiment Station, GB Pant University of Agriculture and Technology.

Naher F, Hossain M. 2005. Effect of demographic and socioeconomic factors on dietary diversity: evidence from Bangladesh. In: Proceedings of the Symposium on Nutrition Security in South Asia, 7-9 Mar 2005, New Delhi, India. p 229-239.

Nelson J, Zeigler RS. 2005. Generation Challenge Program: linking the green revolution to the gene revolution. In: Tuberosa R, Phillips RL, Gale M, editors. In the wake of the double helix: from the green revolution to the gene revolution. Proceedings of an international congress, 27-31 May 2005, University of Bologna, Italy. Bologna (Italy): Avenue Media. p 711-722.

Okada K, Wissuwa, M. 2005. Soil acidity and related problems in upland rice in the tropics. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 454-456.

Padre AT, Ladha JK. 2005. Integrating rice and wheat productivity trends using the SAS mixed-procedure and meta analysis. In: Annual meeting abstracts. Salt Lake City (USA): ASA/CSSA/SSSA.

Padre AT, Tsuchiya K, Inubushi K, Ladha JK. 2005. Long-term effects of organic residue incorporation on soil quality in a rice-wheat system in Japan. In: Annual meeting abstracts. Salt Lake City (USA): ASA/CSSA/SSSA.

Palis FG, Hossain M, Bouman BAM, Cenas PAA, Lampayan RM, Lactaoen AT, Norte TM, Vicmudo VR, Castillo GT. 2005. A farmer participatory approach in the adaptation and adoption of controlled irrigation for saving water: a case study in Canarem, Victoria, Tarlac, Philippines. In: dd Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, November 4-7. Tsukuba: International Rice Research Institute and Japan International Research Center for Agricultural Sciences. CD-ROM. P. 397-401.

Palis FG, Hossain M, Chi T. 2005. Impact of integrated pest management in south Vietnam. In: Puckridge DW, Buu BC, Heong KL, Tuong TP, Bo NV, editors. Proceedings of the Mekong Rice Conference, 15-17 Oct 2004, Ho Chi Minh City, Vietnam.

Pandey S, Troesch K, Douangsavanh L, Phuyyavong K, Linquist B. 2005. The role of paddy rice in the Lao uplands: food security, farmer livelihoods and economics. Juth Pakai. Perspectives on Lao development. Vientiane (Laos): United Nations. p 17-27.

Pandey S, Velasco L. 2005. Trends in crop establishment methods in Asia and research issues. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Conference, 4-7 Nov 2005, Tokyo and Tsukuba, Japan. Los Baños (Philippines): International

Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 178-181.

Pane H, Noor ES, Jatmiko SY, Johnson DE, Mortimer M. 2005. Weed communities of gogorancah and walik jerami rice in Indonesia and reflections on management. In: Proceedings of the BCPC International Congress on Crop Science and Technology, Glasgow, UK. p 533-538.

Paris TR, Abedin MZ. 2005. IRRI's approach to participatory research for development: advances and limitations. In: Toriyama K, Heong K, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Conference, 4-7 Nov 2005, Tokyo and Tsukuba, Japan. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 408-411.

Pathak H, Ladha JK, Gupta RK. 2005. Simulation of application dynamics in the rice-wheat systems of the Indo-Gangetic Plains. In: Proceedings of the Third Research Coordination Meeting of the IAEA-coordinated Research Project on Integrated Soil, Water, and Nutrient Management for Sustainable Rice-Wheat Cropping System in Asia, 9-15 Jul 2005, Dhaka, Bangladesh.

Ramanathan F, Chandrasekaran B, Rajendran R, Stalin P, Ravi V, Chellaiah N, Jayaraj T, Balasubramanian V, Buresh RJ. 2005. Integrated crop- and site-specific N and K management and productivity and profitability of irrigated rice in Tamil Nadu, India. In: Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA.

Rukumundin IH, Abu Bakar UM, Hamid MN, Wan CC, Othman MI, Ahmad MZ. 2005. Revolutionizing agriculture through ICT. In: Bruskiewich R, McLaren CG, editors. Bioinformatics for rice research at the International Rice Research Institute. Proceedings of the National Conference on AgriICT 2005, 17-28 Sep 2005, Kuala Lumpur, Malaysia.

Sheehy JE, Elmido AV, Pablico P, Dionora MJA, Ferrer AB. 2005. Possibility and constraints for improving canopy photosynthesis. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004, Los Baños (Philippines): International Rice Research Institute, Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 127-129.

Singh G, Singh Y, Singh VP, Johnson DE, Mortimer M. 2005. System-level effects in weed management in rice-wheat in India. In: Proceedings of the BCPC International Congress on Crop Science and Technology, Glasgow, UK. p 545-550.

Singh Y, Singh G, Johnson D, Mortimer M. 2005. Changing from transplanted rice to direct seeding in the rice-wheat cropping system in India. In: Toriyama K, Heong KL, Hardy B, editors. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, Tokyo and Tsukuba, Japan, 4-7 Nov 2004. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. p 198-201.

Sivaprasad B, Ladha JK. 2005. Long-term sustainability of rice-wheat cropping system in Indo-Gangetic Plains. In: Abstracts of the workshop on direct seeded rice and weed management in the irrigated rice-wheat system of the Indo-Gangetic Plains, 1-2 Feb 2005, Pantnagar, India. Pantnagar (India): G.B. Pant University of Agriculture and Technology.

Tuong TP. 2005. Technologies for efficient utilization of water in rice production. In: Lee KS, Jena KK, Heong KL, editors. Advances in rice science. Proceedings of the International Rice Science Conference, Korea, 13-15 Sep 2004. Suwon (Korea): Rural Development Authority. p 141-161.

Virmani SS. 2005. IRRI's role and achievements in the development and dissemination of hybrid rice technology. In: Yuan LP, Peng JM, editors. Hybrid rice and world food security. Beijing (China): China Science and Technology Press. p 16-23.

Yu L, Johnson DE, Zhou Y, Zhang J. 2005. Biology of a weedy rice Luolijing (*Oryza sativa* L.) in China. In: Proceedings of the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam. p 195-199.

Monographs (or monograph series)

Bhowmick BC, Barah BC, Pandey S, Barthakur N. 2005. Changing patterns of rice production systems and technology in Assam. Policy Paper No. 22. New Delhi (India): National Center for Agricultural Economics and Policy Research.

Toriyama K, Heong KL, Hardy B, editors. 2005. Rice is life: scientific perspectives for the 21st century. Proceedings of the World Rice Research Conference, 4-7 Nov 2004, Tokyo and Tsukuba, Japan. Los Baños (Philippines): International Rice Research Institute, and Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. CD. 595 p.

Conference and workshop posters

Agarcio JMS, Borines LM, Ordoñez SA, Natural MP, Porter BW, White F, Vera Cruz CM, Leung H, Redoña ED. 2005. Development of bacterial blight-resistant hybrid rice parental lines through bidirectional marker-aided selection. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Angeles MR, Aquino C, Juliano A, Macatangay M, McNally KL. 2005. Development of oligomeric hybridization to genomic DNA arrays for varietal classification of rice (*Oryza sativa* L.). Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Angeles OR, Cabiles DMS, Johnson SE, Brar DS, Buresh RJ. 2005. Faster straw decomposition of a brittle stem mutant of rice: implications for residue management. Poster presented at the American Society of Agronomy Annual Meeting, 6-10 Nov 2005, Salt Lake City, Utah.

Angeles OR, Johnson SE, Buresh RJ, Brar DS. 2005. Faster decomposition of rice straw in paddy soil using a brittle mutant of IR68: implications for residue management. Poster presented at the International Symposium on the Sustainability of Paddy Farming Systems, East and South East Asia Federation of Soil Science Societies 7th International Conference, 1-2 Jun 2005, Quezon City, Philippines.

Angeles OR, Johnson SE, Buresh RJ. 2005. Soil solution sampling methods for organic acids in paddy soils. Poster presented at the International Symposium on the Sustainability of Paddy Farming Systems, East and South East Asia Federation of Soil Science Societies 7th International Conference, 1-2 Jun 2005, Quezon City, Philippines.

Araki E, Fukuta Y, Ebron L, Cuevas P, Escueta DM, Khush G, Sheehy JE, Tsunematsu H, Kato H. 2005. Fine-mapping of a low tillering gene in a Japonica-type rice (*Oryza sativa* L.) Aikawa 1. Poster presented at the World Rice Research Conference, 4-7 Nov 2004, Tokyo and Tsukuba, Japan.

Banaticla MCN, Almazan MSR, Naredo MEB, Mukema I, Hamilton NRS. 2005. Restoring wild rice diversity in the Philippines. Poster presented at the 5th Philippine Society for the Study of Nature Conference, 30 Apr-2 May 2005, Pampanga Agricultural College, Magalang, Pampanga.

Banaticla MCN, Naredo MEB, Almazan MSR, Quilloy SME, McNally KL, Hamilton NRS. 2005. Taxonomic authentication of wild *Oryza* accessions in the International Rice Genebank. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Begum SN, Oña I, Resurreccion A, Virk P, Vera Cruz CM. 2005. Introgression of effective bacterial blight resistance genes into basmati-derived elite lines. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Bennett J, Liu JX, Ji XM, Raveendran M, Oane R, Liao DQ, Shobbar Z, Chen JX, Tuberosa R, Satoh KJ, Kikuchi SS, Bruskiewich R, Lafitte R, Leung H. Flowering-stage drought stress in rice: proteome, metabolome, and transcriptome of anther and peduncles. Poster presented at the Second International Conference on Integrated Approaches to Sustain and Improve Plant Production under Drought Stress, 24-28 Sep 2005, Rome, Italy.

Brar DS. 2005. Wild species of *Oryza*: a valuable genetic resource for rice breeding and genomics research. Poster presented at the Symposium on Rice Genetics and Genomics, Academia Sinica, Taiwan.

Cabangon RJ, Castillo EG, Tuong TP. 2005. Real-time N management in rice under alternate wetting and drying irrigation. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro, Philippines.

Cabiles DMS, Johnson SE, Samonte HP, Brar DS, Buresh RJ. 2005. Rates of anaerobic decomposition of IR68 and its brittle mutant. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Carrillo G, Wu J, Liu B, Sugiyama N, Oña I, Variar M, Courtois B, Leach J, Goodwin P, Leung H, Vera Cruz C. 2005. In silico and molecular approaches for associating candidate defense genes with quantitative resistance to rice blast. Poster presented at the Annual Meeting of the American Phytopathological Society, 30 Jul-3 Aug, 2005, Austin, Texas, USA. (Phytopathology 95(6):S16-17.)

Carrillo G, Reveche M, Goodwin P, Leach J, Leung H, Vera Cruz CM. 2005. In silico analysis and molecular characterization of rice oxalate oxidase, a candidate gene associated with quantitative resistance to rice blast. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Carrillo G, Wu J, Liu B, Sugiyama N, Oña I, Variar M, Bhatt JC, Javier E, Goodwin P, Courtois B, Leach J, Leung H, Vera Cruz C. 2005. Associating candidate defense genes

with quantitative resistance to rice blast. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Castillo E, Tuong TP, Inubushi K, Ismail AM. 2005. The importance of the osmotic component of salinity stress on rice cv IR64. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Chandrasekar V, Gummert M, Thangavel K, Aquino E. 2005. Effect of mixing different paddy samples and aeration on head rice recovery. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Chun HK, Kim GW, Lee JR, Ma KH, Kim EH, Lee DY, Kang HK, McNally KL, Hamilton NRS, Cho EG, Park YJ. 2005. A new approach for developing core sets with maximized genetic diversity and minimized redundancy using a heuristic algorithm in rice (*Oryza sativa* L.). Poster presented at the International Symposium on Plant Genetic Resources, 2-6 May 2005, Jeju City, Korea.

Chung HK, Cho YH, Lee JH, Dixit A, Lee JK, Lee JR, Ma KH, Kang HK, Gwag JG, McNally KL, Park YJ. 2005. Discovery of genes responsible for endosperm and embryo mutants of rice: detection of sequence variation of candidate genes. Poster presented at the International Symposium on Plant Genetic Resources, 2-6 May 2005, Jeju City, Korea.

Collard B, Reveche MY, Mercado E, Carrillo G, Bernardo M, Wu J, Chen J, Babu R, Redoña E, Kadirvel P, Bustamam M, Valerie V, William M, Vera Cruz CM. 2005. Development of non gel-based, low-cost technologies for marker-assisted selection in rice and maize. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Congdang Y, Pingrong Y, Khush GS, Virk PS. 2005. Development of new varieties utilizing IRRI's new plant type lines. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Dimayuga G, Lafitte HR, Cairns JE. 2005. Condition drought-tolerant deletion mutants. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Ferrer AB, Sheehy JE, Mitchell PL, Centeno HGS. 2005. The simple three-equation rice model (TERM). Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Ferreyra C, Alvare L, Ramos MM. 2005. Virtual library services resources. Poster presented at the 5th CGIAR-LIS Consortium Meeting, 2-6 Oct 2005, ICARDA, Aleppo, Syria.

Guan Y, Lafitte HR, Li ZK, Xu JL, Cairns JE. 2005. Investigating drought tolerance in superior backcross lines. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Haefele SM. 2005. Factors affecting fertilizer response in rice-based rainfed lowlands of northeast Thailand and consequences for fertilizer recommendations. Poster presented at the ASA-CSSA-SSSA International Annual Meetings, 6-10 Nov 2005, Salt Lake City, Utah, USA.

Han SS, Roh JH, Cho YC, Kim BR, Vera Cruz CM, Leung H. 2005. Durable resistance of Korean rice cultivars against rice blast in Korea and the Philippines. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Han SS, Roh JH, Cho YC, Kim BR, Yun DW, Raghavan C, McNally K, Vera Cruz CM, Leung H. 2005. Enhancing broad-spectrum blast resistance in Korean germplasm using SNPs in candidate defense genes. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Hayashi K, Nishimura S, Akiyama H, Itahashi N, Daito K, Kimura S, Sudo S, Hosen Y, Kamiyama K, Yagi K. 2005. Ammonia volatilization from a gray lowland soil paddy field as affected by N application. Poster presented at the Annual Meeting of the Japanese Society of Soil Science and Plant Nutrition, 6-8 Sep 2005, Matsue, Japan.

Ismail AM, Flores NRL, Egdane JA, Dionisio-Sese M. 2005. ABA-mediated early stomatal response to salt stress enhances salinity tolerance in rice. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines. (Philipp. J. Crop Sci. 30 (suppl. 1):68.)

Javier EL, Toledo MCU. 2005. Three decades of worldwide sharing and utilization of rice genetic resources through INGER. Poster presented at the 10th International Congress of the Society for the Advancement of Breeding Researches in Asia and the Oceania (SABRAO), 21-24 Aug 2005, Japan.

Jeung JU, Han SS, Kim BR, Moon Hp, Lee YT, Jena KK. 2005. Fine mapping of a new gene conferring broad-spectrum resistance to blast isolates in Korea. Poster presented at the 5th International Rice Genetics Symposium, 18-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Jeung JU, Shin MS, Noh TH, Heu SK, Lee KS, Jena KK. 2005. Development of a broad spectrum of resistance to bacterial blight isolates in Korea. Poster presented at the 5th International Rice Genetics Symposium, 18-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Johnson SE, Angeles OR, Alberto MCR, Jacob JDC, Buresh RJ. 2005. Quest for healthy redox potential: the challenge of depth gradients for greenhouse gas emissions from flooded rice soils. Oral presentation at the American Society of Agronomy Annual Meeting, 6-10 Nov 2005, Salt Lake City, Utah.

Kaur J, Gao G, Jia J, McNally KL, Leung H. 2005. Optimization of wheat EST-derived SSRs across monocots–an initial step to develop conserved orthologous markers. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Macatangay M, Castanar L, Cadion J, Mamiit G, Atienza G, Redondo M, Lacorte V, Zaidem M, Manzano R, Juliano A, Hamilton NRS (IRRI), Benoit L, Rivallan R, Courtois B, Billot C (CIRAD), Garavito A, Lorieux M, Martinez CP (CIAT), Borba T, Brondani RV, Brondani C (EMBRAPA), Cissoko M, Ndjiondjop MN (WARDA), Famoso A, McCouch SR (Cornell), Han LZ (CAAS), McNally KL. 2005. Progress on genotyping the rice composite set. Poster presented at the Generation Challenge Program Annual Review Meeting, 29 Sep-1 Oct 2005, Rome, Italy.

Macatangay M, Juliano A, Naredo ME, Wang H, Banzuela N. Rodriguez M, Quilloy SM, Caspillo B, Detras J, Mamiit G, Cadion J, Castanar L, Reaño R, Banaticla MC, Almazan MS, Alcantara A, de Guzman F, Leung H, Vera Cruz C, Lafitte R, Atlin G, Fitzgerald M, Hamilton NRS, McNally KL. 2005. Allele mining the IRGC, a pipeline for high-throughput molecular characterization of rice genetic resources. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Macatangay M, Juliano A, Naredo ME, Wang H, Rodriguez M, Quilloy SM, Caspillo B, Detras J, Pabale D, Atienza G, Redondo M, Lacorte V, Zaidem M, Manzano R, Kaur J, Reano R, Banaticla MC, Almazan MS, Alcantara A, de Guzman F, Leung H, Vera Cruz C, Lafitte R, Atlin G, Fitzgerald M, Park YJ, Ma KH, Hamilton NRS, McNally KL. 2005. Allele mining the IRGC. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Maghirang-Rodriguez R, Pamplona A, Neeraja C, Sanchez A, Heuer S, Ismail A, Mackill D. 2005. Using modern genetics to reinforce plant breeding: a marker-assisted backcrossing approach to submergence tolerance in rice. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines. (Philipp. J. Crop Sci. 30 (suppl. 1):19.)

Mazid MA, Johnson DE, Mortimer AM, Riches CR. 2005. Direct seeding and weed control for rainfed and irrigated rice in northwest Bangladesh. Poster presented at the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam.

Namuco O, Cope A, Migo T, Johnson D. 2005. Rice seedling growth and its impact on weeds. Poster presented at the 20th Asian-Pacific Weed Science Society Conference, 7-11 Nov 2005, Ho Chi Minh City, Vietnam.

Naredo MEB, Atienza GA, Hamilton NRS, McNally KL. 2005. EcoTILLING the wild *Oryza* germplasm. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Naredo MEB, Wang H, Carrillo GC, Till BJ, Greene EA, Henikoff S, Comai L, Vera Cruz C, Leung H, McNally KL. 2005. EcoTILLING stress tolerance genes in cultivated and wild rice. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Neeraja CN, Mishra B, Rao KS, Singh RK, Padmavathi G, Shenoy VV. 2005. Genetic diversity and linkage disequilibrium in salt-tolerant genotypes of rice (*Oryza sativa* L.). Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Nozoe T, Agbisit R, Fukuta Y, Hosen Y, Rodriguez R, Yanagihara S. 2005. Translocation of iron from rice root to shoot as a mechanism of tolerance of elite breeding lines for iron toxicity. Plant nutrition for food security, human health, and environmental protection. Poster presented at the 15th International Plant Nutrition Coloquium, 14-19 Sep 2005, Beijing, China.

Raghavan C, Naredo E, Wang HH, Atienza G, McNally KL, Leung H. 2005. Rapid method for detecting SNPs on agarose gels. Poster presented at the Generation Challenge Program Annual Review Meeting, 29 Sep-1 Oct 2005, Rome, Italy.

Raghavan C, Naredo E, Wang HH, Atienza G, McNally KL, Leung H. 2005. Rapid method for detecting SNPs on agarose gels. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Ramos M, Srinivas S, Ali K, Hesse E, Soeripto Y, De Silva R, Garruccio, Maliha N. 2005. The CGIAR libraries and Information Services Consortium: five years of interna-

tional collaboration and knowledge exchange. Poster presented at the 11th IAALD World Congress/2005 USAIN Biennial Conference 15-18 May 2005, Lexington, Kentucky.

Raveendran M, Ji XM, Bruskiewich R, Bennett J. 2005. Proteomic analysis of drought responsiveness in rice peduncles. Poster presented at the Second International Conference on Integrated Approaches to Sustain and Improve Plant Production under Drought Stress, 24-28 Sep 2005, Rome, Italy.

Rodriguez RC, Nozoe T, Agbisit R, Hosen Y. 2005. Effects of water and straw management during fallow season on rice growth under a double-crop system. Poster presented at the Seventh International Conference of the East and Southeast Asia Federation of Soil Science Societies, 1-5 Jun 2005, Quezon City, Philippines.

Rodriguez RC, Nozoe T, Agbisit R. 2004. Physiological evaluation of tolerance of elite rice breeding lines for iron (Fe) toxicity using Fe-excluding power. Poster presented at the 35th Annual Scientific Conference of the Crop Science Societies of the Philippines, Davao City, Philippines. (Philipp. J. Crop Sci. 29(suppl. 1):116.)

Rodriguez RC, Nozoe T, Fukuta Y, Yanagihara S, Agbisit R. 2005. Analyzing the mechanism of iron toxicity tolerance in elite rice breeding lines. Poster presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines. (Philipp. J. Crop Sci. 30 (suppl. 1):99.)

Sharma N, Bruskiewich R, Lafitte HR, Cairns JE. 2005. Understanding the genetic basis of drought tolerance in gain of function deletion mutants. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Singh OV, Virk PS, Singh BB. 2005. Evaluation of IRRI's new plant type lines. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Singh RK, Adorada DL, Magsino C, Roque Z, Tamayo N, Gregorio GB. 2005. Temperature and relative humidity affect salinity tolerance in rice. Poster presented at the 10th International Congress of SABRAO, 22-23 Aug 2005, Tsukuba, Japan.

Torres RO, Cairns JE, Namuco O, Johnson DE. 2005. The genetic basis of seedling vigor. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Variar M, Courtois B, Javier E, Vera Cruz C, Bhatt JC, Sangar RBS. 2005. Multienvironment testing reveals site-specific QTLs against blast in rice. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Virk PS, Barry G, Das A,Tan J. 2005. Transferring beta-carotene loci into IR64 and IR36 through marker-aided backcrossing. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Virk PS, Khush GS, Evangelista A, Romena B, Lopena V, Pamplona A. 2005. Genetic enhancement for increasing the yield potential of rice. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Wang H, Cairns JE, Lafitte HR, McNally KL, Leung H. 2005. Association between molecular variation in a rice *ERF3* gene and phenotypic responses to drought stress. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Wissuwa M, Gatdula K, Ismail A. 2004. Candidate gene characterization at the *Pup1* locus: a major QTL increasing tolerance for phosphorus deficiency. Poster presented at the International Rice Functional Genomics Symposium, Nov 2004, Tucson, Arizona.

Xuemei Ji, Raveendran M, Oane R, Bennett J. 2005. Tissue-specific expression and drought responsiveness of cell-wall invertase genes of rice at flowering. Poster presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila Philippines.

Conference and workshop papers–presented

Abedin Z, Hossain M, Paris T, Bool R. 2005. Fast-tracking technology adoption of direct seeding using a plastic drum seeder: the case of Bangladesh. Paper presented at the workshop on scaling-up case studies in agriculture, 16-18 Aug 2005, Bangkok, Thailand.

Buresh RJ. 2005. Introduction to SSNM and developing a SSNM recommendation. Paper presented at a workshop on site-specific nutrient management for rice in central Vietnam, 28 Oct 2005, Hue, Vietnam.

Buresh RJ. 2005. Introduction to SSNM and experiences from other countries on dissemination of SSNM. Paper presented at the Vietnam-IRRI dialogue on planning the delivery of site-specific nutrient management (SSNM) for rice, 24 Oct 2005, Hanoi, Vietnam.

Buresh RJ. 2005. Nutrient balance for rice. Paper presented at the FAI-IPI-PPI round table conference on potassium in balanced fertilization in Maharashtra, 6 Oct 2005, Pune, India.

Buresh RJ. 2005. Nutrient management for rice: principles and practice of site-specific nutrient management (SSNM). Paper presented at the Rice Production Training Course, 10 Mar 2005, IRRI, Los Baños, Philippines.

Buresh RJ. 2005. Nutrient management for rice: principles and practice of site-specific nutrient management (SSNM). Paper presented at the Rice Production Training Course, 22 Sep 2005, IRRI, Los Baños, Philippines.

Buresh RJ. 2005. Site-specific nutrient management (SSNM) for rice. Paper presented at the Brainstorming and Planning Meeting on Site-specific Nutrient Management Project, Directorate for Cropping Systems Research, 19 Mar 2005, Modipuram, Meerut, India.

Buresh RJ. 2005. Site-specific nutrient management (SSNM) for rice. Paper presented at the orientation program for Luzon-based technical staff of AFC Fertilizer and Chemicals, Inc., 14 Apr 2005, Los Baños, Philippines.

Buresh RJ. 2005. Site-specific nutrient management (SSNM) in intensive rice-based production systems. Paper presented at the IRRI-China Rice Science Forum, 10 Oct 2005, Hangzhuo, China.

Buresh RJ. 2005. Site-specific nutrient management for rice. Paper presented during a study tour of the Bangladesh Department of Agricultural Extension staff, 28 Feb 2005, IRRI, Los Baños, Philippines.

Buresh RJ. 2005. Site-specific nutrient management: managing N, P, and K for rice. Paper presented at the meeting of the Fertiliser Association of India Advisory Committee on Agricultural Sciences, 21 Mar 2005, New Delhi, India.

Buresh RJ, Agus F, Las I, Witt C. 2005. Approaches to improving nutrient management for rice. Paper presented at the International Rice Conference, 12 Sep 2005, Bali, Indonesia.

Buresh RJ, Larazo WM, Samson MI, Laureles EV, Thuy NH, Gines HC, Pampolino MF. 2005. Sustainable soil and nutrient management for lowland rice ecosystems: experiences from long-term experiments. Paper presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Buresh RJ, Pampolino MF, Larazo WM, Laureles EV, Samson MI. 2005. Sustainable nutrient and crop management of lowland rice-based ecosystems: experiences from long-term experiments. Paper presented at the First International Symposium on Sustainable Agriculture for Subtropical Regions, 23-25 Nov 2005, Changsha, China.

Buresh RJ, Witt C, Alam MM, Ramanathan S, Chandrasekaran B, Laureles EV, Samson MI. 2005. Site-specific nutrient management (SSNM) for rice: principles and implementation. Paper presented at the 15th International Plant Nutrition Colloquium, 14-19 Sep 2005, Beijing, China.

Cabangon RJ, Tuong TP, Janiya JD. 2005. Rice grown on raised beds: effect of water regime and bed configuration on rice yield, water input, and water productivity. Paper presented at the ACIAR Workshop on Permanent Raised Beds, 1-3 Mar 2005, CSIRO Land and Water, Griffiths, NSW, Australia.

Castella JC, Verburg PH. 2005. Combination of process-oriented with pattern-oriented models of land use in a mountainous area of Vietnam. Paper presented at the 6th Open Meeting of the Human Dimensions of Global Environmental Change Research Community, 9-13 Oct 2005, University of Bonn, Bonn, Germany.

Centeno HGS, Sheehy JE. 2005. Weather, climate, and rice sowing dates. Paper presented at the 18th Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Chandrasekar V, Gummert M, Thangavel K, Rickman JF. 2005. Development of rice hull furnace for preheating the air for paddy drying. Paper presented at the International Conference on Science and Technology for Sustainable Development, 10-13 Sep 2005, Kottayam, Kerala, India.

Chea S, Yasunobu K. 2005. Development of the farmer water user community (FWUC) for irrigated rice in Cambodia: a result from a preliminary survey. Paper presented at the Annual Meeting of the Farm Management Society of Japan, 15-18 Sep 2005, Nagoya University, Nagoya, Japan.

Chen YH. 2005. Brown planthopper resistance: a study of variation of three trophic levels. Paper presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Cuevas R, Gilbert RG, Fitzgerald MA. 2005. Towards an understanding of the functional properties of waxy rice. Paper presented at the AACC International Annual Meeting, 11-14 Sep 2005, Kissimmee, Florida, USA.

Feng L, Bouman BAM, Tuong TP, Yalong Li, Guoan L, Feng YH. 2005. Effects of groundwater depth and water-saving irrigation on rice yield and water balance in Liuyuankou Irrigation System, Henan. Paper presented at the 19th International Congress of the International Commission on Irrigation and Drainage, 10-18 Sep 2005, Beijing, China.

Fitzgerald MA, Castro JV, Cuevas R, Gilbert RG. 2005. Quantitative information on starch synthesis from molecular weight distributions using rice as the model. Paper presented at the AACC International Annual Meeting, 11-14 Sep 2005, Kissimmee, Florida, USA.

Fuitzgerald MA. 2005. IUPAC and its opportunities to contribute to food chemistry. Paper presented at the IUPAC General Assembly, 13-21 Aug 2005, Beijing, China.

Fitzgerald MA, Roferos L, Giai J. 2005. Genetic options for maximizing satiety in rice-based diets. Paper presented at the 5th International Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Fitzgerald MA, Willoughby D, Cuevas R. 2005. Discovering natural variability in the starch of waxy rice. Paper presented at the Biopolymers Conference, 4-7 Jun 2005, Mauritius.

Gines HC, Buresh RJ, Pampolino MF, Sebastian LS. 2005. Opportunities for site-specific nutrient management in the Philippines. Paper presented at the 17th National Research Symposium, 5 Oct 2005, Bureau of Agricultural Research, Department of Agriculture, Quezon City, Philippines.

Gines HC, Buresh RJ, Pampolino M, Sebastian LS. 2005. Site-specific nutrient management for rice in the Philippines. Paper presented at the Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Gines HC, Buresh RJ, Pampolino MF, Sebastian LS. 2005. Site-specific nutrient management for rice in the Philippines. Paper presented at the International Symposium on Sustainability of Paddy Farming Systems. Seventh International Conference of the East and Southeast Asia Federation of Soil Science Societies, 1-2 Jun 2005, Quezon City, Philippines.

Gowing JW, Tuong TP, Hoanh CT, Khiem NT. 2005. Social and environmental impact of rapid change in the coastal zone of Vietnam: an assessment of sustainability issues. Paper presented at the conference on the Environment and Livelihoods in Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 28 Feb-3 Mar 2005, Bac Lieu, Vietnam.

Gummert M, Chandrasekar V, Hien PH, Nghi NT, Ban LV, Aquino E, Rickman JF. 2005. Adaptation of an automatic downdraft rice husk furnace for use with commercial paddy dryers. Paper presented at the 4th Asia Pacific Drying Conference, 13-15 Dec 2005, Science City, Kolkata.

Hoanh CT, Phong ND, Gowing JW, Tuong TP, Ngoc NV. 2005. Hydraulic and water quality modeling: a tool for managing land use conflicts in inland coastal zones. Paper presented at the conference on the Environment and Livelihoods in Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 28 Feb-3 Mar 2005, Bac Lieu, Vietnam.

Hosen Y, Rodriguez R, Agbisit R, Kobayashi N. 2005. What would be brought by water-saving condition to paddy field?—from the environmental point of view. Paper presented at the Annual Meeting of the Japanese Society of Soil Science and Plant Nutrition, 8 Sep 2005, Matsue, Japan.

Hossain M. 2005. Asian rice economy: a long-term perspective. Paper presented at the International Rice Research Conference, 12-13 Sep 2005, Bali, Indonesia.

Hossain M. 2005. Can Asia sustain growth in rice production and further improve food security in the 21st century? Paper presented at the Awaji Conference, October 2005, Awaji Island, Japan.

Hossain M. 2005. Rice supply and demand in Asia: implications for technology development. Paper presented at the Steering Committee Meeting of the Hybrid Rice Research Consortium, 30 Sep-2 Oct 2005, Yangon, Myanmar.

Hossain M. 2005. Rice supply and demand: trends and outlook. Paper presented at the IRRI-China Rice Science Forum and Workplan Meeting, 10-12 Oct 2005, Huangzhou, China.

Hossain M. 2005. Role of infrastructure in rural development. Paper presented at the International Rural Development Seminar for Sustainable Development, 3-5 Sep 2005, Dhaka, Bangladesh.

Hossain M. 2005. Urbanization, migration, and feminization of agriculture: trends and issues. Paper presented at the Workshop on Migration and Gender Roles, 26 Apr 2005, IRRI, Los Baños, Philippines.

Hossain M, Bayersaihan T. 2005. Hybrid rice for sustaining food security in Asia. Paper presented at the Regional Workshop for Development and Diffusion of Hybrid Rice Technology, 6-8 Jun 2005, Asian Development Bank, Manila, Philippines.

Hossain M, Palis F, Ngoc Chi T. 2005. Assessment of the impact of IPM in southern Vietnam. Paper presented at the CGIAR Impact Assessment Workshop, IRRI, Los Baños, Philippines.

Hossain M, Ut Tran Thi, Bose ML. 2005. Livelihood systems and dynamics of poverty in coastal Vietnam. Paper presented at the international conference on Environ-

ment and Livelihoods in Tropical Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 1-3 Mar 2005, Bac Lieu, Vietnam.

Hu Ruifa, Hossain M, Haiming Li. 2005. IRRI's contribution to germplasm improvement in China. Paper presented at the China-IRRI Workplan Meeting, 10-12 Oct 2005, Huangzhou, China.

Ismail AM. 2004. Enhancing and stabilizing productivity in unfavorable rainfed environments: an integrated approach. Paper presented at a conference on Rice Production in UP: Key to Food and Nutritional Security and Improvement of Farmers' Livelihood, 13-14 Dec 2004, Lucknow, India.

Janiya JD, Johnson DE, Bouman BAM, Lampayan R, Lactaoen A, Caramihan L. 2005. Determining suitable weed management options for aerobic rice in Dapdap, Paniqui, Tarlac. Paper presented at the 36th Annual Scientific Conference of the Pest Management Council of the Philippines, 3-6 May 2005, Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

Jena KK. 2005. Marker discovery and MAS for biotic stress resistance. Paper presented at an IRRI workshop, 21-24 Feb 2005, Los Baños, Philippines.

Jena KK. 2005. Role of the IRRI-Korea Office. Paper presented at the RDA-IRRI Training Workshop on Rice Technology Transfer Systems in Asia, 2 Sep 2005, ITCC, Rural Development Administration, Republic of Korea.

Jena KK. 2005. Trends of rice research in IRRI and the role of the IRRI-Korea Office. Paper presented at the Training on Rice Production Technology for ASEAN Countries, 29 Jul 2005, ITCC, Rural Development Administration, Republic of Korea.

Jena KK, Jeung JU, Han SS, Kim BR, Lee YT. 2005. Identification and fine mapping of a novel gene conferring resistance to the Korean blast isolates. Paper presented at the International Blast Workshop, 19-20 Aug 2005, Seoul National University, Seoul, Republic of Korea.

Jena KK, Mackill DJ. 2005. Molecular breeding for genetic improvement of japonica rice and its potential for japonica hybrid development. Paper presented at the Symposium on Development of Japonica Hybrid Rice, 10-13 Sep 2005, Tianjin, People's Republic of China.

Jeung JU, Shin MS, Noh TH, Lee YT, Jena KK. 2005. Development of three-gene pyramid lines and marker-assisted selection (MAS) for improving japonica rice cultivar resistance to bacterial blight isolate of Korea. Paper presented at the International Symposium on Genomics-based Plant Germplasm Research, 25-28 Apr 2005, Beijing, People's Republic of China.

Johnson SE, Alberto MCR, Angeles OR, Buresh RJ. 2005. Optimum redox potential in flooded paddy soil: managing rice (*Oryza sativa* L.) straw and irrigation for sustainable enhancement of productivity. Paper presented at the Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Kam SP, Nhan NV, Tuong TP, Hoanh CT, Be Nam VT, Maunahan A. 2005. Applying the resource management domain (RMD) concept to land and water use and management in the coastal zone: case study of Bac Lieu Province, Vietnam. Paper presented at the conference on the Environment and Livelihoods in Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 28 Feb-3 Mar 2005, Bac Lieu, Vietnam.

Khan S, Hafeez M, Luo Yufeng, Cui Yuanlai, Feng L, Bouman BAM, Tuong TP. 2005. Evaluating system-level impacts of alternative water-saving options. Paper presented at the 19th International Congress of the International Commission on Irrigation and Drainage, 10-18 Sep 2005, Beijing, China.

Khiem NT, Nhan NV, Tuong TP, Hoanh CT. 2005. Managing land and water resources for the production of agriculture-aquaculture in coastal zones of the Mekong River Delta of Vietnam. Paper presented at the conference on the Environment and Livelihoods in Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 28 Feb-3 Mar 2005, Bac Lieu, Vietnam.

Ladha JK. 2005. Direct seeded rice–lessons from two contrasting case studies: Belgaun, Karnataka, India and Sri Lanka. Paper presented at the 13th Regional Technical Coordination Committee Meeting, Dhaka.

Ladha JK. 2005. Managing nitrogen for crop productivity and environmental quality. Paper presented at the meeting of the Delhi Chapter of Indian Society of Soil Science, 26 Apr 2005, Division of Soil Science and Agricultural Chemistry, Indian Agricultural Research Institute, New Delhi, India.

Ladha JK. 2005. Managing nitrogen for crop productivity and environmental quality. Paper presented at the University of Faisalabad, 29 Oct 2005, Faisalabad, Pakistan.

Ladha JK. 2005. Resource-conserving technologies: a new paradigm transforming agriculture. Paper presented at the GTZ-sponsored project workshop on Managing Crop Residue for Healthy Soils in Rice Ecosystems, Institute of Subtropical Agriculture, Changsha, China.

Ladha JK. 2005. Soil quality indicators. Paper presented at the GTZ-sponsored project workshop on Managing Crop Residue for Healthy Soils in Rice Ecosystems, Institute of Subtropical Agriculture, Changsha, China.

Ladha JK. 2005. Sustainability of post-green revolution agriculture: the rice-wheat system of Indo-Gangetic Plain. Paper presented at the 2005 ASA/CSSA/SSSA Annual Meetings, 6-9 Nov 2005, Salt Lake City, USA.

Ladha JK, Gupta RK. 2005. Resource-conserving technologies: a new paradigm transforming agriculture. Paper presented at the IRRI-Chinese Ministry of Agriculture Workshop on Resource Conservation Technologies for Rice Production, 1-2 Aug 2005, Guilin, China.

Laureles EV, Samson MI, Larazo WM, Dizon MA, Peng S, Buresh RJ. 2005. Efficient nitrogen fertilizer management for irrigated rice cultivars: how do management options compare? Paper presented at the Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Leung H, McNally KL. 2005. Sequencing multiple and diverse rice varieties: connecting whole genome variation with phenotype. Paper presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, Manila, Philippines.

Manguiat IJ, Pampolino MF, Gines HC, Chi TTN, Rajendran R, Tan PS, Ramanathan RS, Buresh RJ. 2005. Economic and environmental assessment of site-specific nutrient management in irrigated rice systems. Paper presented at the International Symposium on Sustainability of Paddy Farming Systems. Seventh International Conference of the East and Southeast Asia Federation of Soil Science Societies, 1-2 Jun, 2005, Quezon City, Philippines.

McNally KL. 2005. Allele mining the IRGC. Paper presented at the Symposium on Understanding of ITPGRFA and Trends of Research on Plant Genetic Resources, 16-18 Jun 2005, Jeju, Korea.

McNally KL. 2005. Connecting genotype to phenotype in rice germplasm through allele mining. Paper presented at the First International Symposium on Genomics-based Plant Germplasm Research, 24-28 Apr 2005, CAAS, Beijing, China.

McNally KL. 2005. Genome-wide SNP detection. Paper presented at the Generation Challenge Program Annual Review Meeting, 29 Sep-1 Oct 2005, Rome, Italy.

McNally KL. 2005. Report on ecotilling. Paper presented at the Generation Challenge Program Workshop on Molecular Markers for Allele Mining, 22-26 Aug 2005, MS Swaminathan Research Foundation, Chennai, India.

McNally KL, Billot C. 2005. Assessing ecotilling as a methodology for targeted genotyping and SNP discovery. Paper presented at the Generation Challenge Program Annual Review Meeting, 29 Sep-1 Oct 2005, Rome, Italy.

McNally KL, Naredo MEB, Quilloy SME, Banaticla MCN, Almazan MSR, Hamilton NRS. 2005. Adding value to *Oryza* germplasm through biosystematic research: series Latifoliae in focus. Paper presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, Manila, Philippines.

Migo TR, Namuco OS, Mortimer AM, Johnson DE. 2005. Response of lowland rice weeds to submergence and the effect of herbicide dose. Paper presented at the 36th Annual Scientific Conference of the Pest Management Council of the Philippines, 3-6 May 2005, Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

Molden D, Dong Bin, Loeve R, Barker R, Tuong TP. 2005. Implications of environment and institutions for water productivity and water savings: lessons from two research sites in China. Paper presented at the 19th International Congress of the International Commission on Irrigation and Drainage, 10-18 Sep 2005, Beijing, China.

Mondal MK, Tuong TP, Ritu SP, Choudhury MHK, Chasi AM, Majumder PK, Islam MM, Adhikary SK. 2005. Coastal water resource use for higher productivity: participatory research for increasing cropping intensity in Bangladesh. Paper presented at the conference on the Environment and Livelihoods in Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 28 Feb-3 Mar 2005, Bac Lieu, Vietnam.

Mussgnug F, Becker M, Son TT, Buresh RJ, Vlek PLG. 2005. Improving potassium use efficiency in rice-based cropping systems on degraded soils in the Red River Delta of Vietnam. Deutscher Tropentag, 11-13 Oct 2005, University of Hohenheim, Stuttgart. Germany. http://www/tropentag.de/notify.php?code=XHsgQEuO

Mussgnug F, Becker M, Son TT, Buresh RJ, Vlek PLG. 2005. Yield gaps, P and K balances and soil changes in irrigated, rice-based cropping systems on degraded soils in the Red River Delta of Vietnam. Deutscher Tropentag, 11-13 Oct 2005, University of Hohenheim, Stuttgart, Germany. http://www.tropentag.de/notify.php?code=BFmS4zmd

Mustafi BAA, Hossain M. 2005. Economic evaluation of hybrid rice cultivation in Bangladesh. Paper presented at the Regional Workshop for Development and Diffusion of Hybrid Rice Technology, 6-8 Jun 2005, Asian Development Bank, Manila, Philippines.

Naredo MEB, Banaticla MC, Quilloy SM, Almazan MS, McNally KL, Hamilton NRS. 2005. Adding value to *Oryza* germplasm through biosystematic research: series Latifoliae in focus. Paper presented at the Annual

Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

O'Nolan P. 2005. Seat management as a starting point for ITIL to reduce complexity and costs associated with IT management. Paper presented at the IQPC Conference on IT Service Management, 21-22 Sep 2005, Singapore.

Pandey S. 2005. Coping with drought in developing countries agriculture. Paper presented at the 2nd International Conference on Integrated Approaches to Sustain and Improve Plant Production under Drought Stress, 24-28 Sep 2005, Rome, Italy.

Pandey S. 2005. IRRI perspective on upland research strategies. Paper presented at the workshop on managing rice landscapes in marginal uplands for household food security and environmental sustainability, 18-20 Apr 2005, International Rice Research Institute, Los Baños, Laguna.

Pandey S. 2005. Poverty, food insecurity and environmental degradation in uplands: perspectives and strategies. Paper presented at the planning workshop on Farmer-participatory evaluation, demonstration and transfer of improved technologies for rice-based systems in uplands of Laos, 27-28 Oct 2005, Oudomxay Province, Lao PDR.

Pandey S, Bhandari HN, Ding S, Prapertchob P, Sharan R, Naik D, Taunk SD, Sastri ASRAS. 2005. Coping with drought in agriculture of developing countries, insights from rice farming in Asia. Paper presented at the Interdrought II, 26-20 Sep 2005, Rome, Italy.

Pandey S, Lapar L, Waibel H. 2005. Soil conservation in the Philippine uplands. Paper presented at the combined workshop of the standing panel on impact assessment (SPIA) of the CGIAR and the 6th meeting of the CGIAR task force on integrated natural resources management, 13-16 Jun 2005, International Rice Research Institute, Los Baños, Laguna.

Paris T. 2005. Asian women in agricultural research and development (AWARD). Paper presented at the International Women's Symposium, 3 Jun 2005, Seoul, Korea.

Paris T. 2005. The role of farmers in scaling up of biodiversity technologies. Paper presented at the Workshop on Research Prioritization on Genetic Diversification to Sustain Rice Productivity, 9-10 May 2005.

Paris T. 2005. The role of farmers in technology development and dissemination. Paper presented at the Irrigated Rice Research Consortium (IRRC) Steering Committee Meeting, 30 Sep-2 Oct 2005, Yangon, Myanmar.

Paris T, Luis J, Hossain M. 2005. Impact of labor outmigration in eastern India, Bihar and West Bengal: a synthesis of findings. Paper presented at the Workshop on Impact of Labor Out-Migration on Rice Household Economy and Gender Roles, 26-28 Apr 2005, IRRI, Los Baños, Philippines.

Paris T, Singh A, Singh VN, Atlin G. 2005. Assessing the impact of participatory research in rice breeding on poor rice-farming households with emphasis on women farmers: a case study in selected districts in eastern Uttar Pradesh, India. Paper presented at the Impact Assessment Workshop, 19-21 Oct 2005, CIMMYT, Mexico.

Peng S. 2005. Comparison between aerobic and flooded rice in the tropics: agronomic performance in a long-term (8-season) experiment. Paper presented at the ASA-CSSA-SSSA International Annual Meeting, 6-10 Nov 2005, Salt Lake City, Utah, USA.

Peng S. 2005. 15 years' research on crop physiology in intensive rice ecosystem at IRRI. Paper presented at the 11th China National Conference on Theories and Practices of Rice Production for Good Quality and High Yield, 22-24 Aug 2005, Huazhong Agricultural University, Wuhan, China.

Peng S. 2005. Impact of global warming in rice yield. Paper presented at the workshop on Reducing Food Insecurity Associated with Natural Disasters in Asia and the Pacific, 27-28 Jan 2005, Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific, Bangkok, Thailand.

Peng S. 2005. Overapplication of nitrogen fertilizer in intensive rice system in China. Paper presented at the 15th International Plant Nutrition Colloquium, 15-19 Sep 2005, Beijing, China.

Pontius RG Jr., Boersman W, Castella JC, Clarke K, de Nijs T, Dietzel C, Fotsing E, Goldstein N, Kok K, Koomen E, Lippitt C, McConnell W, Pijanowski B, Pithadia S, Sood AM, Sweeney S, Trung TN, Verburg P, Zenhqiang D. 2005. Cross-case comparison for several prominent land change models. Paper presented at the 6th Open Meeting of the Human Dimensions of Global Environmental Change Research Community, 9-13 Oct 2005, University of Bonn, Bonn, Germany.

Preap V, Jahn GC, Hin K, Siheng N. 2005. Fish and rice management system to enable agricultural diversification. Paper presented at the 5th Asia-Pacific Congress of Entomology, 18-21 Oct 2005, Jeju, Korea.

Ramos M. 2005. PhilAgriNet: Philippine Agricultural Libraries and Information Services Network. Paper presented at the Agricultural Librarians Association of the Philippines' 33rd Anniversary Conference, 10 Jun 2005, UP Los Baños, Laguna, Philippines.

Ramos M, Saul S, Castro R. 2005. PhilAgriNet: linking Philippine agricultural knowledge with scientists worldwide. Paper presented at the 11th IAALD World Congress/2005 USAIN Biennial Conference, 15-18 May 2005, Lexington, Kentucky.

Sackville Hamilton NR. 2005. Introduction to the International Treaty on Plant Genetic Resources for Food and Agriculture, the standard Material Transfer Agreement, and the Global Crop Diversity Trust. Paper presented at the Symposium on Understanding of ITPGRFA and Trends of Research on Plant Genetic Resources, 16-18 Jun 2005, Jeju, Korea.

Samson MI, Laureles EV, Larazo WM, Gines HC, Buresh RJ. 2005. Benefits of real-time N fertilizer management during four years in two long-term experiments. Paper presented at the Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines, 2-6 May 2005, Cagayan de Oro City, Philippines.

Singh RK, Gregorio GB, Mackill DJ, Javier E. 2005. Networking Asia and Africa to validate improved rice germplasm for salinity tolerance: a livelihood enhancement to farmers. Paper presented at the INGER Technical Advisory Committee Meeting, 1-2 Oct 2005, Bangkok, Thailand.

Singh RK, Mishra B, Ismail AM, Gregorio GB. 2005. Breeding rice for salt-affected areas of India. Paper presented at the 4th Annual Meeting of the CURE Steering Committee, 24-27 May, 2005, Lombok Island, Indonesia.

Sivaprasad B, Ladha JK. 2005. Long-term sustainability of rice-wheat cropping system in Indo-Gangetic Plains. Paper presented at the Workshop on Direct Seeded Rice and Weed Management in the Irrigated Rice-Wheat System of the Indo-Gangetic Plains, 1-2 Feb 2005, G.B. Pant University of Agriculture and Technology, Pantnagar, India.

Tang Q, Castilla NP, Buresh R, Peng SB. 2005. Effect of nitrogen management in irrigated rice on sheath blight. Paper presented at the 9th International Workshop on Plant Disease Epidemiology, 11-15 Apr 2005, Landerneau, France.

Telebanco-Yanoria MJ, Fukuta Y, Araki E, Ebron LA, Kobayashi N. 2005. Graphical genotypes of near-isogenic lines for blast resistance with Indica-type CO 39 genetic background in rice (*Oryza sativa* L.). Paper presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Tuong TP, Fanslow G, Hoanh CT, Phong ND, An LT, Hien NX. 2005. Land-use and salinity management effects on water quality in Ca Mau Peninsula, Vietnam. Paper presented at the conference on the Environment and Livelihoods in Coastal Zones: Managing Agriculture-Fishery-Aquaculture Conflicts, 28 Feb-3 Mar 2005, Bac Lieu, Vietnam.

Tuong TP, Phong ND. 2005. Integrated resource management for sustainable livelihood in coastal zones: a large-scale impact research in the Mekong River Delta, Vietnam. Paper presented at the international workshop on Scaling-up Case Studies in Agriculture, 16-18 Aug 2005, Bangkok, Thailand.

Vera Cruz C, Carrillo G, Webb K, Oña I, Begum S, Goodwin P, Wu J, Bin L, Sugiyama N, Jianfa B, Leach J, Leung H. 2005. Sources of genes for crop improvement by biotechnology. Paper presented at the symposium on Contribution of Plant Pathology to Biotechnology during the 2005 American Phytopathological Society Meeting, 2 Aug 2005, Austin, Texas, USA.

Virk PS. 2005. IRRI activities and plans. Paper presented at the HarvestPlus Rice Crop Meeting, 24-25 Nov 2005, IRRI, Los Baños, Philippines.

Virk PS. 2005. Progress in backcrossing activities. Paper presented at the Golden Rice Network Meeting, 15-16 Nov 2005, IRRI, Los Baños, Philippines.

Virk PS. 2005. Screening for micronutrients in rice. Paper presented at the 2005 Annual Meeting of HarvestPlus China, 16-17 Sep 2005, Beijing, China.

Virk PS. 2005. Update on biofortification efforts to combat micronutrient deficiency in rice. Paper presented at the forum gizi mikro Indonesia, 2 Jun 2005, Bogor, Indonesia.

Virk PS. 2005.Criteria for event selection. Paper presented at the Golden Rice Network Meeting, 15-16 Nov 2005, IRRI, Los Baños, Philippines.

Virk PS, Blummel M. 2005. IRRI's research on crop-livestock systems. Paper presented at the APAARI-ANRDC-ICARDA-ICRISAT joint CLAN Steering Committee Meeting, 3-5 Nov 2005, Nueva Ecija, Philippines.

Virk PS, Hossain A. 2005. Processing and sample preparation. Paper presented at the HarvestPlus Rice Crop Meeting, 24-25 Nov 2005, IRRI, Los Baños, Philippines.

Xu K, Fukao T, Xu X, Vergara GV, Nas M, Singh N, Bailey-Serres J, Ronald P, Heuer S,Ismail A, Mackill DJ. 2005. Rice ERF transcription factor-like genes are involved in submergence tolerance. Paper presented at the 5th International Rice Genetics Symposium, 19-23 Nov 2005, EDSA Shangri-La, Manila, Philippines.

Newsletters

Abedin ZM. 2005. Successful technology adoption needs support from both farmers and governments. Rice Today 4(2): 38.

Barry G. 2005. What's new in golden rice? Highlights (The ATSE Crawford Fund) Oct: 8-9.
Barry G. 2005. Ups and downs: private-sector investment in rice research. Rice Today 4 (1):38.
Hamilton NRS, McNally KL. 2005. Unlocking the genetic vault. Rice Today 4(2):32-33.
Heong KL, Chen YH, Johnson DE, Jahn GC, Hossain M, Hamilton RS. 2005. Debate over a GM rice trial in China. Lett. Sci. 310 (5746): 231-233.
Hossain M. 2005. Do lower rice prices help the poor? Rice Today 4(1): 37.
Hossain M. 2005. Does rice research reduce poverty in Asia? Rice Today 4(2): 37.

Others

Abbasi FM, Carpena AL, Brar DS. 2005. Molecular cytogenetics of wide crosses in *Oryza*. International Rice Genetics Symposium, Manila, Philippines. (abstr.)
Alberto MCR, Larazo WM, Laureles EV, Pasuquin JMCA, Buresh. 2005. Long-term effects of water regimes, straw management, and fertilizer inputs on fertility of an intensively cultivated rice soil. Paper presented at the Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines. (Philipp. J. Crop Sci. (suppl.):43.)
Angeles OR, Cabiles DMS, Johnson SE, Brar DS, Buresh RJ. 2005. Faster straw decomposition of a brittle stem mutant of rice: implications for residue management. Annual Meeting of the American Society of Agronomy, Salt Lake City, USA. (abstr.)
Brar DS. 2005. Advances in alien introgression in rice. Plant and Animal Genome XIII, San Diego, USA. p 59. (invited paper)
Brar DS, Hue NT, Abbasi F, Aggarwal RK. 2005. Homoeologous pairing and alien introgression in rice. International Rice Genetics Symposium, Manila, Philippines. (abstr.)
Brar DS, Ramos J, Bui Chi Buu, Hue NT, Abbasi F, Ram T, Vera Cruz C, Chen Y, Hirabayashi H, Tambalo D, Madrigal A, Sapin J, Jena KK, Khush GS. 2005. Genetic enhancement for tolerance for biotic and abiotic stresses through introgression of genes from wild species into rice. International Rice Genetics Symposium, Manila, Philippines. (abstr.)
Buresh RJ. 2005. Data collection and management including use of IRRISTAT mixed model analysis. Training for staff of Land Use Division, Myanmar Agriculture Service, 29 Sep-1 Oct 2005, Yangon, Myanmar.
Buresh RJ. 2005. Introduction to IRRI and the Irrigated Rice Research Consortium (IRRC). 17 May 2005, Yangon, Myanmar.
Buresh RJ. 2005. IRRI-China Planning Meeting, 11 Oct 2005, Hangzhou, China.
Buresh RJ. 2005. Planning for Irrigated Rice Research Consortium (IRRC) Steering Committee Meeting, 29 Aug 2005, Yangon, Myanmar.
Buresh RJ. 2005. Planning Workshop on Site-specific Nutrient Management for Rice-wheat Cropping Systems. Project Directorate for Cropping Systems Research, 24-25 May 2005, Modipuram, Meerut, India.
Buresh RJ. 2005. Productivity and Sustainability Workgroup–IRRC Phase III. Presentation at IRRI Planning Meeting, 26 Apr 2005, IRRI, Los Baños, Philippines.
Buresh RJ. 2005. RTOP achievements in Phase II and plans for Phase III. IRRC Phase III Inaugural Steering Committee Meeting, 30 Sep-1 Oct 2005, Yangon, Myanmar.
Buresh RJ. 2005. Site-specific nutrient management. In-country Training on SSNM and Component Technologies, 27-28 Sep 2005, CARTC, Hlegu, Myanmar.
Buresh RJ. 2005. Vietnam-IRRI Dialogue on Planning the Delivery of Site-specific Nutrient Management (SSNM) for Rice, 24 Oct 2005, Hanoi, Vietnam.
Buresh RJ. 2005. Workshop on Evaluation and Dissemination of SSNM in Central Vietnam, 28 Oct 2005. Hue, Vietnam.
Buresh RJ. 2005. Workshop on Site-specific Nutrient Management for Rice in Indonesia, 20-21 Jun 2005, Medan, North Sumatra, Indonesia.
Buresh RJ. 2005. Workshop on Site-specific Nutrient Management for Rice in Southern Vietnam, Institute of Agricultural Sciences of South Vietnam, 18-19 Feb 2005, Ho Chi Minh City, Vietnam.
Castella JC. 2005. Multimedia. Videos on participatory simulation for natural resource management and support to agricultural innovation in Vietnam. http://www.canal.ird.fr/canal.php?url=/sommaires/thema8_en.htm
Ebron LA, Fukuta Y, Araki E, Yanoria MJT, Santos RE, Kobayashi N, Yokoo M. 2005. Identification of two blast resistance genes *Pib* and *Pita* using DNA markers in IRRI-bred rice varieties. Philippine Phytopathological Society Conference.
Hamilton NRS, McNally KL. 2005. Unlocking the genetic vault. Geneflow. p 29.
Hue NT, Barrion AA, Mendioro M, Brar DS. 2005. Homoeologous chromosome pairing analysis in wide-cross derivatives of *Oryza* through genomic in situ hybridization. International Rice Genetics Symposium, Manila, Philippines. (abstr.)

IRRI–International Rice Research Institute. 2005. Terminal report of the IRRI-ADB Project: Sustaining Food Security in Asia through the Development of Hybrid Rice Technology. Los Baños (Philippines): IRRI. 113 p.

Ismail A. 2005. Improving productivity of salt-affected areas: what can we achieve through the Challenge Program on Water and Food Project #7? Invited lecture given at the workshop organized by the Cuu Long Delta Rice Research Institute (CLRRI) for farmers, extension personnel, and government authorities, 7 Mar 2005, CLRRI, Vietnam.

Ismail A. 2005. Physiology of submergence tolerance and prospects for breeding. Lecture given at the Rice Breeding Course, April 2005, IRRI Training Center.

Ismail A. 2005. Salt tolerance in rice: physiological aspects and relevance to breeding. Lecture given at the Rice Breeding Course, April 2005, IRRI Training Center.

Ismail A. 2005. Unfavorable rice environments: prospects and challenges. Invited lecture presented at the University of North Sumatra, 18 May 2005, Medan, Indonesia.

Janiya J, Johnson DE. 2005. Using a drum seeder to sow pregerminated seed. Los Baños (Philippines): International Rice Research Institute.

Johnson D. 2005. Common weeds of rice in Myanmar. Poster presented at a rice training course, September, Yangon, Myanmar.

Ladha JK. 2005. Efficiency of fertilizer N in cereal production: retrospect and prospects. Invited keynote speech given during the 16th Dr. S.P. Raychaudhuri Memorial Lecture, Punjab Agriculture University, 9 Sep 2005, Ludhiana, India.

Ladha JK. 2005. Productivity and sustainability of rice-wheat system. Invited keynote speech at National Agriculture Research Center, 15 Mar 2005, Islamabad, Pakistan.

Ladha JK. 2005. Workshop on Reducing Food Insecurity Associated with Natural Disasters in Asia and the Pacific, Food and Agriculture Organization of the United Nations, 27-28 Jan 2005, Regional Office for Asia and the Pacific, Bangkok, Thailand. Invited presentation on "Impact of global warming on rice yield."

McNally KL. 2005. Allele mining at the IRGC. Presented at CIRAD, 6 Oct 2005, Montpellier, France.

McNally KL. 2005. Allele mining the IRGC. Symposium on Rice Genetics and Genomics, 17-18 Oct 2005, Academia Sinica, Taipei, Taiwan.

Paris T. 2005. Gender issues in agricultural extension. Presented at the training course for agricultural extension workers, 25 Aug 2005, PhilRice and IRRI.

Paris T. 2005. The impact of labor outmigration on rice household economy and gender roles. Presented in RUSSICK, Curtin University, 9 Sep 2005, University of Western Australia.

Piegu B, Roulin A, Guyot R, Brar DS, Panaud O. 2005. Role of transposable elements in the recent expansion of *Oryza australiensis* genome. International Rice Genetics Symposium, Manila, Philippines. (abstr.)

Ramos M, Ali KM. 2005. Maximizing library resources through consortial subscriptions: the case of the CGIARLIS Consortium. IAALD Q. Bull. L(1/2):5-9.

Saito K, Linquist B, Atlin GN, Phanthaboon K, Shiraiwa T, Horie T. 2005. Response of traditional and improved upland rice cultivars to N and P fertilizer in northern Laos. Field Crops Res. (online 11 Aug 2005)

Sana EA, Hernandez J, Chen Y, Brar DS. 2005. Mapping of QTLs for brown planthopper resistance introgressed from *Oryza minuta* into rice. International Rice Genetics Symposium, Manila, Philippines. (abstr.)

Santos REM, Ebron LA, Yanoria JM, Imbe T, Kato H, Araki E, Uga Y, Kobayashi S, Fukuta Y, Kobayashi N. 2005. Characterization of near-isogenic lines with indica-type rice IR64 genetic background by using DNA markers. International Rice Genetics Symposium, Manila, Philippines. (abstr.)

Sheehy JE. 2005. Building, testing and using a very simple rice model. Lecture presentation for a seminar series, via distance education, "Plant organization and crop simulation modeling: integrating interdisciplinary perspectives," for the University of Nebraska-Lincoln students (agronomy and distance education, Fall 2005 semester).

Shim J, Mendioro MS, Panaud O, Brar DS. 2005. Development of *Oryza minuta* specific clones using representational difference analysis (RDA) for high-throughput analysis of alien introgression in rice. International Rice Genetics Symposium, Manila, Philippines. (abstr.)

Shoji K, Kawamura T, Horio H, Nakayama K, Kobayashi N. 2005. Variability of micro-elevation, yield, and protein content within a transplanted paddy field. Precision Agric. 6: 73-86.

Shoji K, Kobayashi N. 2005. Micro-elevation and yield response in paddy fields. 1st Asian Conference on Precision Agriculture, Aug 2005, Toyohashi, Japan.

Invited seminars

Jackson MT. 2005. Rice research and the millennium development goals. Seminar presented at the University of Birmingham, 6 Jul 2005.

Padolina WG. 2005. HRD models in international science agencies. Invited paper presented at the Science Education Institute Planning Workshop, 27 Jan 2005, SEAMEO-INNOTECH, Diliman, Quezon City.

Sheehy JE. 2005. Rice climate relations and climate. A short course on agroclimatology, PAGASA, Diliman, Quezon City.

Sheehy JE. 2005. Rice, gaseous pollutants and the impact of climate change. First Workshop on Asian Brown Clouds (ABC): Impact Assessment Program. UNEP, Bangkok, Thailand.

Speeches

Sheehy JE. 2005. The changing rice environment. Scientific presentation for the CGIAR: setting research agenda for climate change, 10-14 Oct 2005, Nairobi, Kenya.

Sheehy JE. 2005. Climate change: preparing for the worst. Scientific presentation for the Board of Trustees Meeting, 30 Mar-1 Apr 2005, IRRI, Los Baños, Laguna.

Sheehy JE. 2005. Climate change and rice yield. Scientific presentation for the representatives of the Foreign Correspondents Association of the Philippines (FOCAP) and National Media Practitioners on the Agriculture Bear, Board Room, 18 Oct 2005, IRRI, Los Baños, Laguna.

Sheehy JE. 2005. Will climate change bring famine or feast? A rice story. Invited scientific presentation at the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), University of the Philippines Los Baños, 10-14 Oct 2005, Laguna.

Rice research seminars

Hybrid rice in the United States. Dr. Fangming Xie, candidate for hybrid rice breeder.

What's new in Golden Rice? Dr. G. Barry.

What's natural about natural resource management? Dr. R. Buresh.

Intensive agro-ecosystems: advancing the IRRI-CIMMYT alliance. Dr. R. Ortiz, director, Intensive Agro-Ecosystems, CIMMYT.

IRRI, Asia, and nontraditional fund raising. Mr. D. Macintosh.

Looking for a needle in the haystack: the *pup1* story. Dr. M. Wissuwa.

Progress despite hurdles: the story of hybrid rice outside China. Dr. S.S. Virmani.

From the IRRI farm to the rice fields of Asia. Dr. M. Bell.

Charting IRRI's future: why, who, and so what? Dr. R.S. Zeigler.

Fast-tracking technology adoption for impact: the power of community action. Dr. Z. Abedin.

The people's choice: alternative options and their politico-economic implications. Dr. S. Monsod, School of Economics, University of the Philippines.

Quality assurance: champagne performance on a beer budget. Dr. E. Paski, QA consultant from the British Columbia Institute of Technology, Burnaby BC, Canada.

Progress in breeding for drought tolerance. Dr. G. Atlin.

Life inside grasses: nitrogen-fixing endophytic bacteria in rice. Dr. B. Reinhold-Hurek, professor at Bremen, University of Germany.

Scaling up communication of resource management to farmers. Dr. K.L. Heong.

Rica and water: the livelihood of Asia. A chapter of the comprehensive assessment of water management in agriculture. Dr. B. Bouman.

Multiple approaches to attaining sustainable development. Prof. J. Furtado.

Rice and food security in sub-Saharan Africa: an intercenter collaboration. Dr. T. Berhe, SG2000 regional director, Sasakawa Africa Association.

Effective deployment of technologies through integrated crop management. Dr. V. Balasubramanian.

Engineering—putting science into practice. Dr. M. Gummert.

Enhancing crop performance: the challenge of integrating crop establishment strategies with effective plant traits. Dr. T. Lafarge.

The continuing nitrogen enigma. Dr. J.K. Ladha.

Climate change and N management—impact on rice quality. Dr. M. Fitzgerald.

Rice sheath blight: progress and challenges. Dr. N. Castilla.

Division seminars

Crop, Soil, and Water Sciences

New approaches for assessing the impacts of climate change on annual crops. Dr. T. Wheeler, Department of Agriculture, The University of Reading, UK.

Productivity and research use efficiency of rice as affected by crop establishment and nitrogen management. Dr. M. Akkas Ali.

Faster straw decomposition using a brittle mutant of IR68: implications for residue management. Mr. D. Cabiles and Ms. O. Angeles.

Plant vacuolar Na/H antiporters; their role in ion homeostasis and intravesicular trafficking. Dr. E. Blumwald, Department of Pomology, University of California Davis, USA.

Microbial biomass and their diversity in relation to paddy soil fertility and Iron materials and methane emission from paddy soil fertility. Prof. K. Inubushi, Chiba University, Japan, and Dr. Y. Furukawa, National Agricultural Research Center for Tohoku Region,National Agricultural Research Organization.

Assessment of environmental loads for enhancing water quality of watersheds. Dr. Lee Kyeong-Bo, Honam Agricultural Research Institute, NICS, Rural Development Administration, Korea.

How do rice yield and water requirement respond to water-saving technologies?: a modeling approach. Dr. Liping Feng.

Using remote sensing and GIS to map irrigated rice fields and to estimate rice growth in Dang-jin, Korea and Physiological alterations of young rice plants under osmotic stress. Dr. Hong Suk-Young, Department of Agricultural Environment, National Institute of Agricultural Science and Technology, Rural Development Administration (RDA), Korea, and Dr. Kwon Taek-Ryoun, National Institute of Agricultural Biotechnology, RDA, Korea.

Entomology and Plant Pathology

Induced resistance in insect pest management. Mr. R. Karban.

Anatomy of RTSV resistance: a case study with Utri Merah. Dr. Il-Ryong Choi.

Potato leafhopper and its injury: the initiation of hopperburn in legumes. Mr. W. Lamp.

Basic and applied studies on viruses and virus expression vectors in plants. Dr. R.S. Nelson.

The kaleidoscopic path to Laos. Dr. G. Jahn.

Plant Breeding, Genetics, and Biotechnology

Improving grain quality of rice: ultrasructure of physiochemical properties of specialty rice varieties. Kyung-Soo Kim, Rural Development Administration, Korea.

A chromosomal segment for P-deficiency-induced root elongation and its effects on iron toxicity. H. Ikehashi and A. Shimizu, College of Bioresource, Nihon University, Japan.

Transposable elements and genome evolution in *Oryza*. Dr. O. Panaud, University of Perpignan, France.

Stable isotopes in human nutrition, their relevance in rice research. Dr. T. Preston, Scottish University, Scotland.

How to get research findings published in SCIENCE. G. Riddihough, SCIENCE editor, Molecular Genetics.

TILLING the field, application of SNPs in breeding. Dr. K. McNally.

Stress response pathway in rice: regulatory mechanisms. B. delos Reyes, Department of Biological Sciences, University of Maine, USA.

Biosafety systems: environmental risk assessment and management. H. Quemada, Western Michigan University, and K. Hokanson, University of Minnesota, USA.

Marker-assisted backcrossing for submergence tolerance in rice: progress and potential. Ms. R. Maghirang-Rodriguez.

QTL mapping and marker-assisted breeding: basic concepts and perspectives from the Australian molecular marker program. Dr. B. Collard.

Effect of genetic background on introgression and QTL expression in rice. Dr. Jianlong Xu.

Comparative analysis of grain filling in transgenic/nontransgenic rice and C4 cereals: implications in rice improvement. Dr. K. Sellapan.

Oryza map alignment: construction of BAC libraries of wild species and their use in genomics research. R. Wing, Arizona Genomics Institute, University of Arizona, USA.

Developing Ac-Ds transposon lines for functional genomics in rice. Gi-Hwan Yi, NICS, Rural Development Administration, Korea.

Irrigated rice breeding program's activities. Mr. A.A. Evangelista.

Upland rice improvement in northern Laos. K. Saito, Kyoto University, Japan.

Social Sciences

Getting to know the SSD shareportal site. Ms. S. Macatangay and Mr. P. Aladin.

Staff Changes in 2005

January

Dr. Nobuya Kobayashi joined as scientist, plant breeding, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Rakesh K. Singh joined as international research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Sigrid Heuer joined as scientist, molecular biology, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Tomas Masajo joined as consultant, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Peter Mitchell joined as consultant, Crop, Soil, and Water Sciences Division, and left after completion of his assignment in the same month.

Mr. John Leslie Maclean joined as consultant, Office of the Director for Program Planning and Coordination.

Dr. Chitra Raghavan joined as postdoctoral fellow, Entomology and Plant Pathology Division.

Dr. Bertrand Collard joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Shahbaz Mushtaq joined as consultant, Social Sciences Division.

Dr. Ramasamy Rajendran, postdoctoral fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Mr. Girish Chandel, consultant, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Dr. Jakir Hossain, consultant, Genetic Resources Center, left after completion of his assignment.

Dr. Bong-Choon Lee, visiting research fellow, Entomology and Plant Pathology Division, left after completion of his assignment.

February

Dr. Bruce Linquist, senior scientist, upland agronomist, IRRI-Lao PDR Project, resigned.

Mr. Kim-Ki Young joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Shailaja Hittalmani joined as visiting scientist, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Yolanda Garcia joined as consultant, Social Sciences Division.

Mr. Kyung-Ho Ma joined as collaborative research fellow, Genetic Resources Center.

Mr. Greg Fanslow joined as consultant, Entomology and Plant Pathology Division.

Dr. Byung-Ohg joined as visiting research fellow, Genetic Resources Center.

Dr. Tom Mew joined as consultant, Entomology and Plant Pathology Division.

Mr. John Leslie Maclean, consultant, Office of the Director for Program Planning and Coordination, left after completion of his assignment.

Dr. Jae-Hwan Roh, visiting research fellow, Entomology and Plant Pathology Division, left after completion of his assignment.

Dr. Bhuban Barah, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Mr. Phil Gibson, consultant, International Programs Management Office, left after completion of his assignment.

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

March

Dr. Deborah J. Templeton joined as scientist, social science/economics, Social Sciences Division.

Dr. Robert S. Zeigler joined as director general.

Dr. Gyung-Mee Gim joined as visiting research fellow, Social Sciences Division, left after completion of her assignment in the same month.

Mr. Jianming Zeng joined as collaborative research fellow, Crop, Soil, and Water Sciences Division.

Mr. Mayank Rai, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Ms. Jin-Young Lee joined as collaborative research fellow, Social Sciences Division.

Mr. Geert Claessens joined as consultant, International Programs Management Office.

Dr. Aparna Das joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Yoshimichi Fukuta joined as consultant, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Len Wade joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Jianlong Xu joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Jae-Hwan Roh rejoined as visiting research fellow, Entomology and Plant Pathology Division.

Dr. Tom Preston joined as consultant, Crop, Soil, and Water Sciences Division, and left after completion of his assignment in the same month.

Dr. Byung-Ohg Ahn, visiting research fellow, Genetic Resources Center, left after completion of his assignment.

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

Mr. Kyung-Ho Ma, collaborative research fellow, Genetic Resources Center, left after completion of his assignment.

Dr. Shailaja Hittalmani, visiting scientist, Plant Breeding, Genetics, and Biotechnology Division, left after completion of her assignment.

April

Dr. Renee Lafitte, physiologist and consultant, Crop, Soil, and Water Sciences Division, resigned.

Dr. Swapan K. Datta, senior scientist, plant biotechnology, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Dr. Karabi Datta, senior scientist, plant biotechnology, Plant Breeding, Genetics, and Biotechnology Division, left after completion of her assignment.

Mr. Jan Orsini joined as consultant, International Programs Management Office.

Mr. Tim Overett joined as consultant, Visitors and Information Services.

Dr. Ferdousi Naher joined as consultant, Social Sciences Division, and left after completion of her assignment in the same month.

Dr. Edilberto Redoña joined as consultant, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Dr. Mirza Islam joined as collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Mr. Jonathan Niones joined as collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Martin Mortimer joined as consultant, Crop, Soil, and Water Sciences Division, and left after completion of his assignment in the same month.

Dr. Philippe Hervé joined as consultant, Intellectual Property Management Unit, and left after completion of his assignment in the same month.

Mr. Kim-Ki Young, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

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

Dr. Humnath Bhandari, postdoctoral fellow, Social Sciences Division, left after completion of his assignment.

Dr. Sarah Johnson, postdoctoral fellow, Crop, Soil, and Water Sciences Division, resigned.

Dr. Ravindra Babu, visiting research fellow, Biometrics and Bioinformatics Unit, left after completion of his assignment.

Ms. Josyline Javelosa, visiting research fellow, Social Sciences Division, left after completion of her assignment.

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

Dr. Jae-Hwan Roh, visiting research fellow, Entomology and Plant Pathology Division, left after completion of his assignment.

May

Dr. Sarah Johnson rejoined as international research fellow, Crop, Soil, and Water Sciences Division.

Dr. Philippe Hervé joined as scientist, molecular biology, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Kumi Yasunobu joined as IRS seconded from JIRCAS, Social Sciences Division.

Ms. Danielle Marechal joined as consultant, Communication and Publications Services.

Ms. Alma Redillas-Dolot joined as consultant, Office of the Director for Program Planning and Coordination.

Ms. Marlar Oo joined as consultant, Social Sciences Division, and left after completion of her assignment in the same month.

Dr. Kyeong-Bo Lee joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Dr. Xuemei Ji joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. B.C. Viraktamath joined as consultant, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Dr. Ann Braun joined as consultant, Entomology and Plant Pathology Division.

Dr. Ilyas Ahmed joined as consultant, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Dr. You-Chun Song, collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Mr. Jianming Zeng, collaborative research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Ms. Jin-Young Lee, collaborative research fellow, Social Sciences Division, left after completion of her assignment.

Mr. Jonathan Niones, collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Mr. Adam Barclay, consultant, Visitors and Information Services, left after completion of his assignment.

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

June

Mr. Adam Barclay rejoined as international research fellow, Communication and Publications Services.

Dr. Matthias Wissuwa, international research fellow, left after completion of his assignment, Crop, Soil, and Water Sciences Division.

Dr. M. Zainul Abedin, international research fellow, Social Sciences Division, resigned.

Dr. Eufemio Rasco joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Barbara Reinhold-Hurek joined as collaborative research scientist, Plant Breeding, Genetics, and Biotechnology Division.

Ms. Yoke Sau Cheng Metz joined as consultant, International Programs Management Office/Training Center.

Dr. Peter Mitchell rejoined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Kyeong-Bo Lee, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Dr. Yolanda Garcia, consultant, Social Sciences Division, left after completion of her assignment.

Dr. Chirravuri Neeraja, postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of her assignment.

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

Mr. Tim Overett, consultant, Visitors and Information Services, left after completion of his assignment; rejoined as consultant, Office of Administration and Human Resources.

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

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

July

Dr. Fangming Xie joined as senior scientist, hybrid rice breeder, Plant Breeding, Genetics, and Biotechnology Division.

Dr. Christine Kreye joined as international research fellow, Crop, Soil, and Water Sciences Division.

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

Dr. Humnath Bhandari joined as visiting research fellow, Social Sciences Division.

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

Dr. Do-Yeon Kwak joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

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

Mr. Tim Overett, consultant, Office of Administration and Human Resources, left after completion of his assignment.

August

Dr. Grant Singleton joined as coordinator of the Irrigated Rice Research Consortium, Entomology and Plant Pathology Division.

Mr. Martin Senger joined as consultant, Biometrics and Bioinformatics Unit.

Dr. Georgina Vergara joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Mark Bell joined as consultant, International Programs Management Office.

Dr. Gurgen Hagmann joined as consultant, Office of the Director for Program Planning and Coordination, and left after completion of his assignment in the same month.

Dr. Yuka Sasaki joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Mr. John Leslie Maclean rejoined as consultant, Office of the Director for Program Planning and Coordination, and left after completion of his assignment in the same month.

Dr. Woon-Goo Ha joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Mr. Robert Woodward joined as consultant, Office of Administration and Human Resources.

Mr. Robert Hill joined as consultant, Visitors and Information Services, and left after completion of his assignment in the same month.

Dr. Do-Yeon Kwak, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

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

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

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

Ms. Shaohong Zhang, visiting research fellow, Entomology and Plant Pathology Division, left after completion of her assignment.

Dr. Ann Braun, consultant, Entomology and Plant Pathology Division, left after completion of her assignment.

Dr. Md Abdul Ghani, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

September

Dr. Xiaochun Lu joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Prof. W.H. Jaim joined as consultant, Social Sciences Division.

Dr. Michael J. Thomson joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Ngo The Dan joined as consultant, International Programs Management Office.

Prof. Jose Furtado joined as consultant, Entomology and Plant Pathology Division.

Dr. Charmian Sackville Hamilton joined as consultant, Crop, Soil, and Water Sciences Division, and left after completion of her assignment in the same month.

Dr. Liping Feng, postdoctoral fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Mr. Robert Woodward, consultant, Office of Administration and Human Resources, left after completion of his assignment.

Dr. Woon-Goo Ha, visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, left after completion of his assignment.

Ms. Samjhana Shrestha, consultant, International Programs Management Office, left after completion of her assignment; rejoined as consultant, Plant Breeding, Genetics, and Biotechnology Division.

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

October

Dr. Ferdousi Naher rejoined as consultant, Social Sciences Division.

Dr. Chan-Won Park joined as visiting research fellow, Entomology and Plant Pathology Division, and left after completion of his assignment in the same month.

Ms. Hendrika Van Laar joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Endang Septiningsih joined as postdoctoral fellow, Plant Breeding, Genetics, and Biotechnology Division.

Mr. John Leslie MacLean rejoined as consultant, Office of the Director for Program Planning and Coordination.

Dr. Gi-Hwan Yi joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Dr. Jin-Il Choung joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division.

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

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

Dr. Barbara Reinhold-Hurek, collaborative research scientist, Plant Breeding, Genetics, and Biotechnology Division, left after completion of her assignment.

Prof. Jose Furtado, consultant, Entomology and Plant Pathology Division, left after completion of his assignment.

November

Dr. Robert J. Hijmans joined as GIS specialist, Social Sciences Division.

Dr. Suk-Young Hong joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Dr. Taek-Ryoun Kwon joined as visiting research fellow, Plant Breeding, Genetics, and Biotechnology Division, and left after completion of his assignment in the same month.

Ms. Alma Redillas-Dolot, consultant, Office of the Director for Program Planning and Coordination, and left after completion of her assignment; rejoined as consultant, Information Technology Services.

Dr. Satish Kedia joined as visiting research fellow, Social Sciences Division, and left after completion of his assignment in the same month.

Mr. Doh-Won Yun joined as visiting research fellow, Entomology and Plant Pathology Division.

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

Dr. Surapong Sarkarung joined as consultant, Crop, Soil, and Water Sciences Division, and left after completion of his assignment in the same month.

Ms. Yoon-Ji Choi joined as collaborative research fellow, Social Sciences Division, and left after completion of her assignment in the same month.

Mr. Robert Hill rejoined as consultant, Visitors and Information Services, and left after completion of his assignment in the same month.

Mr. Jong-Cheol Ko joined as collaborative research fellow, Plant Breeding, Genetics, and Biotechnology Division.

Mr. Chu Gia Thuy joined as consultant, Entomology and Plant Pathology Division.

Dr. Ferdousi Naher, consultant, Social Sciences Division, left after completion of her assignment.

Ms. Samjhana Shrestha, consultant, Plant Breeding, Genetics, and Biotechnology Division left after completion of her assignment.

December

Dr. Nobuhiko Fuwa, international research fellow, left after completion of his assignment.

Dr. Young-Chang Cho joined as visiting research fellow, Entomology and Plant Pathology Division.

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

Ms. Hendrika Van Laar, consultant, Crop, Soil, and Water Sciences Division, left after completion of her assignment.

Mr. Chu Gia Thuy, consultant, Entomology and Plant Pathology Division, left after completion of his assignment.

Dr. Nigar Nargis joined as consultant, Social Sciences Division, and left after completion of her assignment in the same month.

Dr. Mun-Sik Shin joined as visiting research fellow, Entomology and Plant Pathology Division, and left after completion of his assignment in the same month.

Prof. W.H. Jaim, consultant, Social Sciences Division, left after completion of his assignment.

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

Dr. Jatinder Kaur, consultant, Genetic Resources Center, left after completion of her assignment.

Research support services

ANALYTICAL SERVICE LABORATORIES

The Analytical Service Laboratories (ASL) continued to provide analytical and analysis-related services to IRRI research programs. It also provides liaison-related services to projects involving use of radionuclide.

Analytical services

ASL completed 51,568 routine analyses for plant, soil, water, and other samples. Plant samples account for 75% of the completed analyses with N, Fe, and Zn determinations being the most requested (ASL Table 1). About 75% of the total samples received came from the Crop, Soil, and Water Sciences Division (CSWS); the rest came from Plant Breeding, Genetics, and Biotechnology Division (PBGB), Grain Quality and Nutrition Research Center (GQNRC), Entomology and Plant Pathology Division (EPPD), International Programs Management Office (IPMO), Training Center (TC), Social Sciences Division (SSD), Experiment Station (ES), Agricultural Engineering Unit (AEU), and external clients (ASL Table 2).

ASL Table 1. Analyses completed in 2005.

Analysis	ASL Section		Total	Percent
	PSL[a]	MSL[b]		
Plant	30,148	8,515	38,663	75
Soil	5,884	971	6,855	13
Water	6,050	0	6,050	12
Total	42,082	9,486	51,568	100

[a]PSL=Plant and Soil Laboratory. [b]Mass Spectrometry Laboratory.

ASL Table 2. Profile of samples and analyses completed in 2005, by OU.

OU	Samples (no.)	Percent	Analyses (no.)	Percent
CSWS	14,065	73.98	33,327	64.63
PBGB	3,469	18.25	10,045	19.48
GQNRC	549	2.89	5,346	10.37
EPPD	297	1.56	467	0.91
IPMO	100	0.53	200	0.39
TC	48	0.25	368	0.71
SSD	20	0.11	440	0.85
ES	6	0.03	12	0.02
AEU	5	0.03	8	0.02
External[a]	453	2.4	1,355	2.6
Total	19,012	100.0	51,568	100.0

[a]Clients from UPLB, ICRAF, and PHILSURIN.

Laboratory information management system

One of the recommendations made by the Center-commissioned External Review Panel during its May 2004 review of ASL is the installation of a laboratory information management system (LIMS) to enhance the capacity of the Plant and Soil Laboratory. The LIMS system will be key to the efficient functioning of ASL as it will expedite client interactions with the laboratory, increase client access to information, and improve turnaround time for processing of samples. It

currently takes approximately 2.5 person-days to verify the data quality of one 60-sample set from the ICP; the LIMS system is expected to decrease this data-processing time to a few minutes. A contract with UPLB-FI for an "enhanced ASL LIMS development package" beginning 10 Jan 2005 will provide the following services:

1. Develop a system to automate the capture of sample analysis from laboratory devices and to automate the analysis of experimental data and error reporting, given existing applications already in place;
2. Reimplement a web application that allows researchers to request for analytical services; and
3. Implement all recommendations made for the current ASL LIMS based on the evaluation earlier made by ASL.

The memorandum of agreement (MOA) specifies that the ASL LIMS software must be finished, tested, and accepted by September 2005. However, due to computational complexities and unforeseen requirements, some of the items included in the MOA were not accomplished. The following are pending:

- Machine integration modules for the different ASL analytical machines (ICP, AAS, elemental analyzer, IRMS, autoanalyzers)
- Minor application utilities for data management, some LIMS administration tool components
- Training
- ICIS integration

The development of the rest of the machine integration modules was deferred to give full concentration on integrating ICP, which is, by far, the most complex of the ASL machines. The ICP machine, which is the workhorse of the ASL and which can process the most number of analyses, will be the basis for integrating the other machines to the ASL LIMS. This will speed up the process of developing modules for the other machines. The ICP Device Integration Module transfers and converts raw data from ICP to the MySQL database for analysis and retrieval of data. It includes a facility where a technician may input the necessary data such as methods and calibration and reference standards needed for the computations and validation. Graphs are also provided to help in validating results.

The ASL staff, along with the LIMS development team, decided to prioritize and focus on ASL's critical requirements first and develop the software according to these requirements. The ICIS integration component of the project was put on hold so the team can concentrate on finishing the ICP module. This module and its interfaces will allow ASL-LIMS data to be integrated to the ICIS.

Progress has been made on the following:

- The online client request system is responsible for dealing with the user's account and request information. Clients can create an account to register an experiment and submit their requests (for analysis, facilities, and services) to ASL using the system. Clients will have to wait for the manager's approval before submitting the samples to the laboratory.
- The ASL assistant manager is the one who approves requests. She gets a notification of the request from the system through email. A technician checks if the data on the submitted sample information form match the actual samples sent. An administrator controls access to the system and a researcher acts as quality assurance officer who checks the validity of results before releasing these to the client.
- Testing and verification on the ICP integration module. A decision is yet to be made whether to treat results of automated computation as correct; a comparison with off-line computation results by laboratory technicians will be made.
- An interface for an all-device integration module, which is roughly based on the ICP integration module, is still being developed and will require more testing and improvement. The upload result interface is yet to be developed.
- The web site component of the project is now ready for testing. However, the problem of the database system suddenly becoming disconnected when the application is not being used for some time is assumed to be a database-server configuration problem. The immediate solution for now, if the system has been inactive for 2 d or more, is to restart the server every morning or every 2 d. A long-term solution is yet to be determined.

The contract was extended for another 3 mo (Oct–Dec 2005) to develop the remaining modules without changing the original contract price ($4,000). (It was agreed that the remaining contract price of $3,000 will be paid upon acceptance of the project as a whole.)

User training and consultation will be done after the development of the aforementioned software components. A 1-yr software warranty from the date of completion of the project is guaranteed.

New method for plant analysis

A new di-acid plant tissue digestion method for high-sample throughput using a block digestor was developed at ASL. This method, using HNO_3-$HClO_4$ mixtures, digests samples in the IRRI ASL-designed prototype digestor and can effectively

digest macro-and microelements in plant tissues. Digests were analyzed by inductively coupled plasma (ICP) spectrometry for Na, Mg, Al, P, S, K, Ca, Mn, Fe, Cu, Zn, and Mo. This method was developed specifically for plant and grain analysis when Fe and Al are of particular interest. Analysis of NIST apple leaves SRM 1515, peach leaves SRM 1547, and rice flour SRM 1568a gave good recoveries for the 12 elements analyzed. This method was also found proficient in analyzing samples from the Wageningen Evaluating Program for Analytical Laboratories-International Plant Exchange (WEPAL-IPE) proficiency testing for plant analysis. A manuscript is being prepared for the publication of this method in *Communications in Soil Science and Plant Analysis*.

Radioisotope Laboratory

Ms. Lilia R. Molina was designated as IRRI's acting radiological health and safety officer (RHSO) on 27 Jan 2005 by the Philippine Nuclear Research Institute (PNRI). Projects assisted through the use of radioisotope laboratory facilities and liaison services of the PNRI were

- Southern blot and hygromycin phosphotransferase assay of transgenic rice plants
- Analysis of gene expression in response to rice tungro virus infection in rice plants
- 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
- Analysis of wild crosses

Training

All ASL staff participated in two major training courses held at IRRI: 1) Isotope Ratio Mass Spectrometry (14-22 Mar 2005) by Dr. Tom Preston, University of Glasgow; and 2) Quality Assurance (QA) (18-29 Jul 2005) by Dr. Edgar Paski, British Columbia Institute of Technology.

Dr. Preston gave a series of lectures with demonstration and practical sessions on elemental analyzer and mass spectrometer and covered the following topics:

- Principles of mass spectrometry, especially when combined with GC, EA, and LC
- Method source and analyzer options for environmental, forensic, food, natural product, and biological analysis
- Sampling and cleanup for chromatography-mass spectrometry
- Isotope dilution, isotope ratio MS
- Quantitative methods
- Management, maintenance, and troubleshooting of equipment
- Costing analyses, economic operation of the system, and planning equipment replacement

A 10-d QA training program by Dr. Paski provided an in-depth coverage of the ISO 17025, the international standard for quality for organizations involved in testing and calibration-related activities. Special sessions on quality management for management and administration personnel provided details on concepts as well as hands-on problem-solving on quality issues. Sessions for research and technical personnel were devoted to important technical aspects of quality management as well as in-depth treatment of important topics such as calibration, sampling, reference materials, method validation, and measurement uncertainty. Special topics on occupational health and safety, managing hazardous chemicals and their disposal, and seismic hazard control in laboratories were also discussed.

Resource person

Dr. Sarah Johnson was selected as resource person of ASL from 1 May 2005 to 30 Apr 2008. Her time allocation for assistance to ASL is 25%. She will provide strategic support for streamlining routine analyses, determining the needs of the institute for routine analysis, preparing an inventory and rationalization of equipment, and planning for operations of the user lab portion of ASL.

BIOMETRICS AND BIOINFORMATICS UNIT

The Biometrics and Bioinformatics Unit (BBU) provides support to IRRI's research programs in the areas of biometrics, data management, computational biology, and bioinformatics through consultation service, collaborative research, and training.

Biometrics consultation

One hundred statistical consultations were carried out by BBU statistics staff in 2005 and several papers were reviewed for the *International Rice Research Notes* and international refereed journals.

Organizational unit	Clients (no.)
EPPD	19
CSWS	20
PBGB	11
GRC/CPS/SSD	6
Others	16
Total	72

Statistical software

The unit was involved in the training for NARES breeders, including special sections on design and analysis of variety evaluation trials and information management in pedigree breeding programs.

Two papers were prepared, one on using reference lines for managing and understanding genetic by environment interactions in rainfed lowland trials and another on quantitative trait locus by environment interaction in rainfed environments. These papers should be completed in 2006.

Research continued on statistical methods for the incorporation of pedigree information into the analysis of varietal evaluation trials. One paper was prepared and submitted to *Crop Science* in collaboration with University of Madras and the CIMMYT biometrics unit.

Biometrics training and workshops

Extensive training programs were conducted by BBU: five in-house courses with the use of four different software: IRRISTAT, ICIS, R, and SAS with a total of 100 participants; two short courses (79 participants) and five in-country courses to introduce IRRISTAT to other researchers and to promote good statistical practice with IRRISTAT (Cambodia, Bhutan, Vietnam, Philippines, and Mexico).

Course/workshop	Date	Participants (no.)
In-house training		
Introduction to the R Statistics Computing Environment	7-10 Feb	15
Introduction to the ICIS	28 Feb-4 Mar	20
Basic Experimental Design and Data Analysis Using IRRISTAT	25-29 Jul	25
Analysis of Mixed Models Using IRRISTAT	22-24 Aug	18
Introduction to the SAS System for Windows	7-11 Nov	22
Participation in other short-term courses/workshops		
Planning Rice Breeding for Impact	7-18 Feb	21
Advances in Marker-assisted Selection Workshop	21-24 Feb	58
In-country training/workshop		
Basic Experimental Design and Data Analysis Using IRRISTAT		
CARDI, Phnom Penh, Cambodia	4-8 Apr	14
Applied Statistics in Agriculture		
CIMMYT, El Batan, Mexico	29 Aug-9 Sep	20
Training on Statistics		
RNR-RC, Bhutan	3-12 Oct	23
Basic Experimental Design and Data Analysis Using IRRISTAT		
CLRRU, Can Tho, Vietnam	10-14 Oct	30
Basic Method of Statistical Analysis		
PhilRice, Nueva Ecija, Philippines	20 Oct	35

Statistical software

We have completed the development of REML software for IRRISTAT, prepared training materials, and released software and training documents. An extensive testing of REML software was conducted during January and February and updates were defined during the year, which should be carried out by the contract programmer in early 2006.

Generation Challenge Program (GCP)

- Collaborative meetings have been held to plan and execute software development and data.
- Collaboration on the design of data models and laboratory information management systems for GCP data has been facilitated by subprogram teams across 16 partners working with e-mail and collaboration software.

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

Product development

- Development of the Genetic Resources Information Management Module of ICIS is progressing well and conversion from IRGCIS should be complete in 2006.

NARES collaboration

- There were new releases of ICIS software and IRIS databases during 2005. Assistance was provided to ICIS implementations on sorghum, barley, lesquerella, and wheat. IP tracking was implemented for rice at IRRI.
- A strategy for the improvement of quality of existing GCP databases was developed in collaboration with nine teams from different institutes working on development of an integrated information platform for the GCP.
- Technical support on the deployment and use of ICIS has been given to NARES partners in India, Thailand, Philippines, and China.
- The ICIS international development team met once in Netherlands in February and then in Perth in October. ARI partners, Nunza, GBA, and UQ VIDA have worked with ICARDA and IRRI to develop and improve ICIS applications.
- IRRI worked with Australian rice breeders (at Yanco), barley breeders at ICARDA and in the UK, and wheat breeders in Australia to capture large volumes of historical data.

Bioinformatics

- Bioinformatics support of activities for the International Rice Functional Genomics Consortium (IRFGC) was enhanced by the addition of a new full-time NRS support for IRFGC web site development.

- GCP activities dominated bioinformatics activities over the year, with IRRI bioinformatics leadership in the development of scientific models for data, bioinformatics networking standards and continued software development of the GCP next-generation crop information platform spanning genetic resources, genomics, and crop improvement.
- The GCP bioinformatics networking technologies are also being applied to the development of the MARDI pilot project of the Global Crop Diversity Trust and to the development of a rice mutant information network of the IRFGC.
- The Perlegen Single Nucleotide Polymorphism project got under way with heavy preparatory bioinformatics analysis of the latest public genomic sequences, executed on IRRI's high-performance bioinformatics computing cluster.
- IRRI's bioinformatics specialist presented a report to CORRA in Bali in September about rice bioinformatics.
- IRRI's bioinformatics specialist hosted the discussion meeting portion of the 2nd Rice Annotation Project (RAP2; www.irri.org/rap2) as a satellite meeting of the Rice Genetics 5 Symposium.

Collaboration systems

As part of a GCP project, web-based collaborative systems were commissioned to support software development and textual content development. These systems are now being used by the following projects and groups:

- The Wiki system (http://cropwiki.irri.org) for collaborative textual content development is used by the GCP, the ICIS development community, various locus/trait focused groups (*pup1*, *sub1*, *SHZ2*, drought), and for bilateral institutional collaboration (IRRI–CIMMYT, IRRI Grain Quality Lab–University of Sydney, IRRI BBU–Grain Biotech Australia).
- The collaborative software development system (http://cropforge.org) hosts 49 projects related to the development of software mainly from the GCP and the ICIS community. Other projects hosted include IRRISTAT (IRRI), DIVA (CIP), and MGIS (INIBAP). A request from the European Genetic Resources community indicates an interest to use this system more widely.

Open source/open content licensing

To support broader participation in the creation and wider use and sharing of information products, open-source and open-content licensing were initiated. Initially, the open-source General Public License was selected and approved for the ICIS software. Currently, the open-content Creative Commons License is being investigated for releasing the content of the ICISWiki collaboration website. The above licenses provide a mechanism for the formalization of the global public good status of information products.

COMMUNICATION AND PUBLICATIONS SERVICES

Publications and publishing

Through CPS, IRRI produced 10 titles in 2005, including six scientific books, two issues of *Rice Today* (plus a 1,000-copy reprint of the first issue), which has gone back to becoming a quarterly in 2006, and the *Annual Report of the Director General 2004-05*. Also produced were two issues of the *International Rice Research Notes (IRRN)*, which kicked off its 30th anniversary celebration with the second issue. There are currently 30 titles in the production queue for 2006 and beyond.

In the area of copublishing with other agencies, the Japan International Research Center for Agricultural Sciences (JIRCAS) and IRRI published the proceedings of the scientific meeting of the November 2004 World Rice Research Conference (WRRC), *Rice is life: scientific perspectives for the 21st century*, on CD only. The CD also contains recent issues of the *IRRN* and *Rice Today*. We see this type of proceedings publishing as the wave of the future. For example, the proceedings of the Fifth International Rice Genetics Symposium, held in November 2005, will also be produced on CD in 2006 along with the four previous symposia proceedings, which will provide a handy one-location repository for a wealth of information on rice genetics. The papers in the WRRC proceedings are also available at www.irri.org/publications/wrrc/index.htm for free downloading.

In 2005-06, IRRI forged and/or is continuing to negotiate a number of copublishing arrangements for the following scientific titles:

- *Innovations in pro-poor agricultural extension: lessons from Bangladesh* (with CABI, to be printed in July 2006)
- A Chinese version of *Breeding rice for drought-prone environments* (with the Shanghai Agrobiological Gene Center, to be printed in April 2006)
- *Why the Philippines imports rice* (with PhilRice to be printed in March 2006)
- *Sharing rice for peace and prosperity in the Greater Mekong Subregion* (with Sid Harta Publishers in Australia, to be printed in April 2006). This title follows the same style and format as *The burning of the rice*, by Don Puckridge, and will serve as a second installment of a popularly written book series on IRRI's impact.

- *Rice: a practical guide to nutrient management* (with the Potash & Phosphate Institute/Potash & Phosphate Institute of Canada and Indonesian Center for Food Crops Research for a Bahasa Indonesia version. Discussions are also under way for Chinese, Hindi, and Bangla versions of this popular title with appropriate local publishers.

IRRI on the Web

On the Web in 2005, CPS introduced *Rice News Worldwide* (http://ricenews.irri.org), a daily RSS-compatible update of rice news available from numerous sources on the Web, and added links to CPS-produced videos on IRRI's new briefing for visitors, *Rice science for a better world*, and a program on Theme 1 of the Challenge Program for Water and Food, *A time of change* (both available at www.irri.org/video.asp) and the *Welcome to IRRI* recruitment video (www.irri.org/jobs/index.asp).

CPS staff also worked very closely with the scientific staff to 1) set up GreenRice.Net (www.greenrice.net) and get it online in time for the World Environment Day on 3 Jun 2005; 2) establish a new Web site promoting site-specific nutrient management (www.irri.org/irrc/ssnm/index.htm); 3) produce both hard-copy and digital versions of *RIPPLE (Rice Research for Intensified Production and Prosperity in Lowland Ecosystems)*, a new quarterly newsletter of the Irrigated Rice Research Consortium available online at www.irri.org/irrc; and 4) place online additional features about the impact of IRRI's research at www.irri.org/media/impact/index.asp.

CPS designed and continued to update the information for the November 2005 International Rice Genetics Symposium (www.irri.org/rg5). In a similar manner, we already have online preliminary information on a new Web site for the 2006 International Rice Congress (www.irri.org/irc2006/index.htm). We are working very closely with the Indian coordinators on this important meeting set for 9-13 Oct 2006.

Photo bank and photography

In 2005, an additional 1,061 educators, students, photographers, graphic designers, and others registered online to view and sometimes obtain the images available in the IRRI rice photo bank (http://rice-photos.irri.org), which contains more than 5,000 rice-related images, including landscapes, people, events, markets, laboratories, pests, and diseases. To date, 3,352 persons worldwide have registered to gain access to the photo bank. Registrants have come from 94 countries, the top 10 being United States (536), India (462), Philippines (386), China (210), Japan (104), Australia (87), Thailand, (93), Malaysia (90), Germany (80), and Brazil (76). CPS accommodated approximately 100 requests for downloading digital images from external clients in 2005. A second generation of the photo bank was delayed in 2005 due to a change in development of technical applications but is scheduled to go online later in 2006 with an open architecture system that will provide a wider array of images and a more user-friendly downloading process.

To supplement the photography needs of the Institute and to help avoid unnecessary additional purchases of new cameras by OUs, CPS makes available for checkout by IRRI staff members three digital single-lens reflex (DSLR) cameras (Nikon D70). In 2005, these cameras were checked out 39 times by staff. CPS periodically provides relevant basic and advanced digital camera short courses. In 2005, the CPS photography staff provided basic digital camera training for two IRRI staff members.

Communications support

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

In 2005-06, the OU's print shop produced 852,520 impressions of various materials, not including IRRI books, which were outsourced to printers in Manila, and an additional 66,678 laser-generated color impressions. On 1 Mar 2006, the IRRI print shop was closed permanently to make way for a new digital copy center 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.

Approximately 5,800 new digital photographs were produced. For the first time ever, no traditional original slides were produced, compared with a peak production of 67,000 in 1992, indicating a complete switch over to digital images used in PowerPoint for this type of presentation.

Fifteen video programs were produced and 104 shorter clips were provided for the *Bulletin* (IRRI's weekly electronic newsletter for staff, BOT, and alumni; http://bulletin.irri.cgiar.org) and PowerPoint presentations.

Graphic artists produced 73 illustrations, laid out 2,446 pages for publications, and prepared and printed 117 posters.

IRRI editors worked on more than 605 pages appearing in refereed journal articles, 1,454 pages appearing in IRRI's scientific books, plus 112 pages for the *International Rice Research Notes*, and more than 700 pages of additional conference papers, abstracts, proposals, and others.

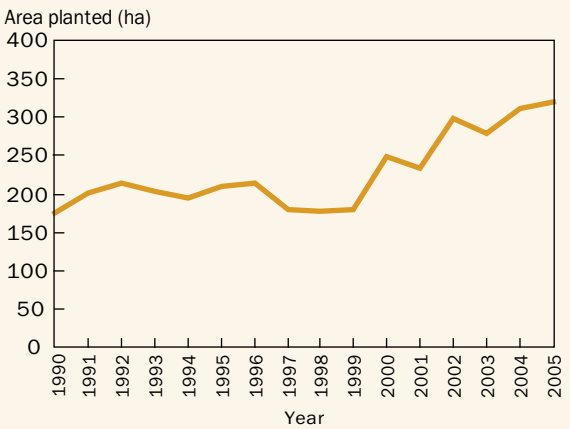
EXPERIMENT STATION

The Experiment Station (ES) Field Operations Unit provided support services to 145 field experiments. The Controlled Plant Growth Facilities and Grounds Unit (CGFG), on the other hand, supported a total of 56 experiments in the Phytotron and CL4 transgenic greenhouse facilities and 84 experiments in the glasshouses and screenhouses. A total of 11,062 maintenance and service requests were served during the year.

Land use

Land use in 2005 totaled 319.42 hectares. Overall, annual land utilization increased by about 49% compared with the 10-year average (1992–2002). PBGB remained the biggest user of the farm, using some 137.60 hectares. This included the 1-hectare transgenic field-testing facility approved by the National Committee on Biosafety of the Philippines, which began full operation during the 2005 wet season. Under PBGB, collaboration with the large-scale Korean Seed Multiplication Project (KSMP) expanded during the same season. This increased the KSMP land allocation from an average of 3 hectares per year to 15 hectares. ES, the second biggest user, planted a total of 134.83 hectares for the rice production and seed increase activities of the unit, which also included more than 2 hectares for seed production of cover crops. To support the seedling requirements of various field experiments, the ES also established and maintained 14.36 hectares of nursery beds, 10.36 hectares and 4.0 hectares of which were maintained using the dry-bed and wet-bed method, respectively.

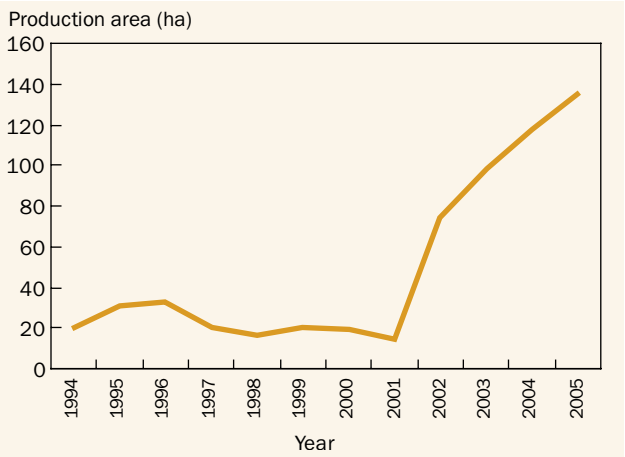
Division	Dry season (ha)	Wet season (ha)	Total
PBGB	78.32	59.28	137.60
ES	53.86	80.97	134.83
CSWS	13.40	7.94	21.34
EPPD	11.13	3.35	14.48
TC	3.79	5.63	9.42
GRC	1.25	0.50	1.75
Total	161.75	157.67	319.42



Land use at ES (1990-2005).

Crop production operations

The ES seed increase and rice production operations in 2005 reflected a 14% increase in cropped area compared with the 2004 cropping of 117 hectares. Over the past 10 years, ES-managed crop production areas have actually increased by more than 300%, from an average of about 22 hectares per year to the new crop production target of at least 90 hectares of rice crop per year. Sixty-three percent of the rice crop was established mainly by direct seeding through manual broadcasting of pregerminated seeds, drum seeding on wet fields, and seed drilling on 'dry-prepared' areas. Manual and mechanical transplanting methods were used on the other 37%, particularly in the deep plots and during wet periods when weather and field conditions did not allow direct seeding. The seedling nursery requirements for these were served using some 400 square meters of concrete space used as modified *dapog* nurseries at the back of the ES administration building.



ES crop production hectarage (1994-2005).

ES harvested 429 tons of paddy from ES-managed production plots. The highest yield was 6 tons per hectare from blocks 1002 to 1005, which were planted to NSCI 122. Another 124 tons of mixed varieties were harvested from materials turned over by researchers and from border rows. Harvesting was mainly done with the use of mechanical combine harvesters.

Crop protection services

In line with its equipment update program for 2005, the ES Crop Protection Unit acquired 15 new knapsack sprayers, 2 new units of power sprayer pump and tank trailer assembly, 1 new tractor-mounted boom sprayer, and 2 new ES-designed and -fabricated handheld roller sprayers. These equipment units were designed to increase efficiency of chemical applications, reduce chemical exposure of the applicators, and increase environmental safety of operations.

Manual weeding has consistently been the single most costly, labor-intensive crop protection operation at the farm over the years, and use of herbicides has remained the cheapest and most cost-effective method of weed control. While most weed control efforts were sustained using manual labor in most experimental plots, sublethal doses of nonselective herbicides were applied to effectively control weeds on fallow areas, levees, and perimeter fences to help save on labor costs. Mechanized herbicide applications at the farm using the four-wheeled drive mudmaster not only helped save on labor costs but also increased the effectiveness and efficiency of applications. Most importantly, it increased the margin of safety of such operations, both for the operator and the environment.

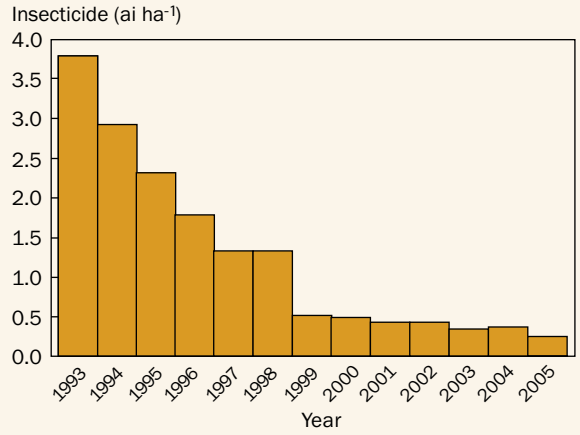
Manual collection of snails and snail eggs was routinely done on greenhouse areas, rice fields, and canals to help reduce snail populations to more manageable levels and help reduce chemical use. Control of other pests such as birds and rats also focused on nonchemical means such as bird trapping, bird net installations on 3.89 hectares of experimental plots, and manual bird boy services for bird control toward the harvest period, as well as trap barrier systems, burrow destruction, flame throwing, and sanitation and hygiene for rat control.

Rat traps yielded 1,568 live catch during the year. Rat control services provided in 2005 include the installation of some 288 baiting stations, active barrier fencing on 64 hectares of experimental plots, and installation of 916 live traps. These values reflected some 15% reduction in the use of rat control devices as compared with the 2004 installations, an indication of how effective the integrated rat control measures were practiced at the farm. These measures included a community trap barrier strategy, active management of fallow areas, closed seasons, and maintenance of general cleanliness in the farm.

Fertilizer and insecticide use

A total of 115 tons of fertilizers were used in the farm in various forms: ammonium sulfate, complete, muriate of potash, solophos, urea, zinc oxide, and zinc sulfate. Compared with the previous year, an 8% increase in fertilizer use was noted and mainly attributed to a significant increase in total area planted.

Insecticide use, on the other hand, continued to decline and is being maintained at the lowest level possible as integrated pest management (IPM) has remained the standard practice in the IRRI farm. For instance, with the use of resistant varieties, zero-insecticide application was maintained on all ES production plots. Insecticide applications at the farm have now been limited to those required by researchers in their experiments. Compared with the 2004 level, reduction in insecticide active ingredient use per hectare in 2005 was about 9%.



Insecticide use at ES (1993-2005).

Irrigation and drainage services

Irrigation water was supplied through portable irrigation pipes equipped with overhead sprinklers in Blocks B, D, the 833 series, the 900 series, the UD, UJ, UI, UP, UO, UQ, UW, UX, UR, UL, UM, UN, UMN, UV, UW, and UN/UV/UX dry beds. Twenty units of drainage outlets at the old, new lowland, and upland areas were developed and constructed. Fifteen irrigation risers, eight concrete boxes, and three gate valves at the lowland, upland, and the old area were repaired. Flat hose irrigation systems were set up to meet special irrigation requirements in Blocks D and the 400 series. To improve the reliability of irrigation water supply in the UT reservoir, 500 meters of PVC source pipe was installed to connect the reservoir to the UW pump. One hundred meters of PVC pipes were also similarly installed to connect the pump in block UZ to the block UX reservoir. Continuous maintenance operations to ensure a reliable water supply in all reservoirs included the extraction and installation of submersible pumps on demand. The Irrigation and Drainage Services team also operated on staggered schedules during peak periods to provide reliable services even during weekends and holidays. Maintenance and cleaning of perimeter fences were also done.

Land development and civil works

Land development operations were done on about 10.45 hectares during the year. Blocks UI3 to UI4 (where forage crops used to be grown) were converted from upland to lowland fields, while reworking was done in blocks UG, UL, UK2-UK3, UV2, and B38-40. Civil works included road rehabilitation and development work in the lowland areas, particularly the roads between the 500 and 600 series, those between the 700 and 800 series, and in the greenhouse area in Block A. Routine civil maintenance work 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 involved the regular maintenance of some 44 kilometers of farm road network through surface scraping, backfilling, patching, and compaction. As part of the continuing wall construction project in the unprotected zone, another 100 meters of concrete wall was put up along the perimeter areas in block 1000. Another 100 meters of wire fences were repaired in blocks F to K and in the 200 to 700 series.

Equipment fabrication, repair, and maintenance services

The ES Mechanical Shop provided repair, fabrication, and maintenance services for tractors, farm equipment, implements, machineries, and irrigation facilities. There were 1,324 requests for repair and maintenance of light and heavy equipment and farm implements from the different units and research divisions. Defective and malfunctioning vertical motors and submersible pumps in blocks C26, UW, the 2000 series, the 100 series, F and UT were extracted and repaired with minimum downtime. Fifty units of threshers and 32 units of dryers were also repaired and maintained. Two units of roller sprayers designed for effective weed control on levees and perimeter areas were fabricated and are now being used by trained pesticide applicators. Two seeders attached to steel-wheeled tractors were modified to incorporate laser-guided systems that facilitate mechanized direct seeding operations under wet conditions. Routine maintenance and repair services were also provided to the Rice Mill Unit.

Postharvest services and rice mill operations

Postharvest support services provided by ES included threshing, cleaning, drying, and storage, among others. The oven dryers and flatbed dryers being maintained by the station accommodated majority of the drying requirements of researchers for plant samples and harvested grains. A new recirculating dryer was acquired to replace the old dryer in the upland crop processing complex. A new silo was also put up to meet storage requirements for grains that are harvested and handled in bulk in the upland farm.

From 541 tons of dried (at 14% moisture) rice paddy intended for milling in 2005, the Rice Mill Operations Unit produced 342 tons of milled rice. About 2 tons were issued to fulfill various requests from different organizational units of milled rice, while 22 tons were sold to the highest bidder through sealed public bidding organized by the Materials Management (MM) unit. The rest of the milled rice was issued to the MM unit to cover the monthly rice entitlement of the nationally recruited staff (NRS). The Rice Mill output for 2005 was able to meet more than 8 months' supply of milled rice for all IRRI NRS.

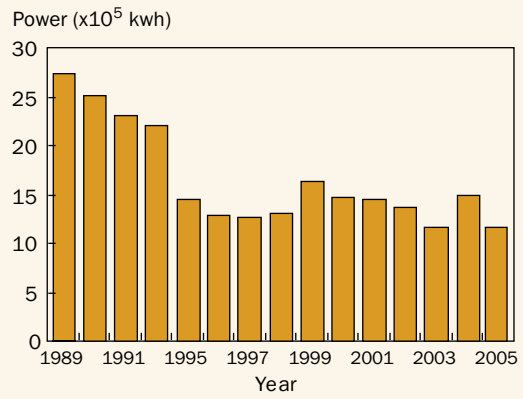
The byproducts of the milling operations totaled 13.4 tons of broken rice, 51.1 tons of rice bran, and some 15 tons of rice hulls. Broken rice was also sold through a bidding process, whereas rice hulls were sold to regular buyers who use hulls for insulation, animal bedding, landscaping, and composting. Some rice hulls were also used in two AE and CSWS experiments. All the rice bran, on the other hand, were set aside and used as fish feed in the fish production project of the ES.

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 135 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. Considering the volume of materials being processed on a day-to-day basis and occasions of equipment breakdown, an increasing need to augment and/or upgrade the old autoclave unit was noted. 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 25,287 gallons of RO grade water for their experiments. Improvements done in 2005 for the Phytotron cooling system included the replacement of two old chillers with new units. Repair work involved the replacement of worn-out parts of indoor growth chambers and outdoor growth cabinets and the magnetic contactors, circuit breakers, fan blades, and condenser fan motors of the CL4 greenhouse bays. Repainting and refurbishment were done on the chilled water tank, the hot water tank, and the Phytotron building.

Over the years, various cost-cutting techniques have led to more than 50% reduction in power consumption at the Phytotron, equivalent to some US$36,000 savings in electricity at current power rates. Phytotron power consump-

tion in 2005 was lower by 20% than in the previous year. This was made possible through conscious efforts to save on electricity to bring back and maintain power consumption to 2003 levels and reduce energy costs further. Sustained energy-saving practices included the use of solar energy in the environment control system, efficient programming and running of the cooling and heating systems, and the harvesting of rainwater for use in irrigation and maintenance at the Phytotron in place of processed water plus a number of simple and conscientious routines such as turning off unnecessary lights and unused electrical appliances and the use of energy-efficient bulbs.



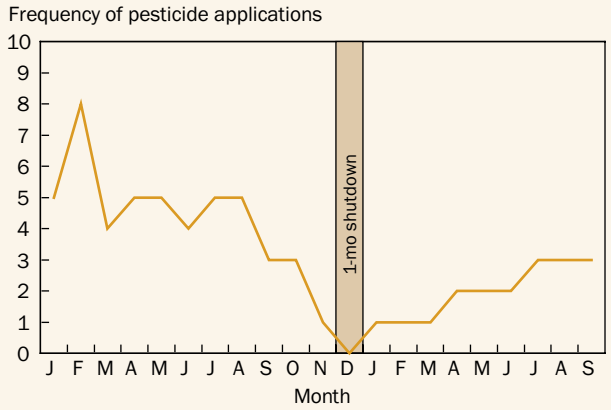
Phytotron energy use from 1989 to 2005.

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 281 maintenance requests, provision of 1,850 assorted pots, and delivery of 710 tons 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-month greenhouse shutdown operations in clusters B and N facilitated unhampered annual preventive maintenance operations in the greenhouses. More importantly, it helped reduce pesticide applications through the provision of a long break in the crop, pest, and disease cycles inside these facilities. Shutdown operations included general cleanup, surface wash down, and repair of roofing and all support structures.

Refurbishment of the BG05 mist room was completed with the installation of polycarbonate roofing, two new air-cooling units, portable misters, and a backup air-conditioning unit.



Pesticide use reduction in plant growth facilities.

Roof replacements and repainting were completed in the wash shed and soil bin facilities of BW-01, BW-02, MB-03, and the pot storage area. Two new concrete benches and a new wash shed facility were constructed adjacent to BG-07 to augment increased requirements for insect rearing, testing, and plant material processing and washing in EPPD. Industrial heavy-duty screen mesh was installed in AS01-C to replace the worn-out cladding. New heavy-duty nylon cords were installed in the US and AS01 screenhouses, replacing rusted and worn-out GI wires to reduce screen wear and tear and hence prolong the life span of screen claddings. Repair work was also done on window screens in Cluster B and N headhouses. The support structures of some 42 greenhouse benches were also repaired and worn-out linings were replaced. Screen repair and replacements were also done on the sidings of glasshouses AG02, NG01, NG03, NG04, NG05, and BG03 Annex.

Grounds services

The Grounds Services Unit served 271 requests for landscape maintenance and development 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 the various staff housing units of the institute. Areas that were improved and landscaped in 2005 included the frontage of the ISLB, SH01 and SH-04, frontage of Apartment #3 at the ISH, MSS Hall lobby, Tabon Gate IRRI Marker site, CL-4 area, and the R.P. Cantrell Building. In a formal tree planting ceremony, a fire tree was planted in front

of Chandler Hall in memory of Dr. Robert Havener, former IRRI interim director general. At least 10 other fire trees were also planted in various locations at the research center. 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.

The Grounds Unit also managed the fish production project in the farm reservoirs. Low-cost maintenance operations included periodic pond cleanup, weekly harvesting, and regular feeding of the fish with rice bran from the rice mill. Some 1,386 kilograms of fresh fish were harvested and sold to IRRI staff.

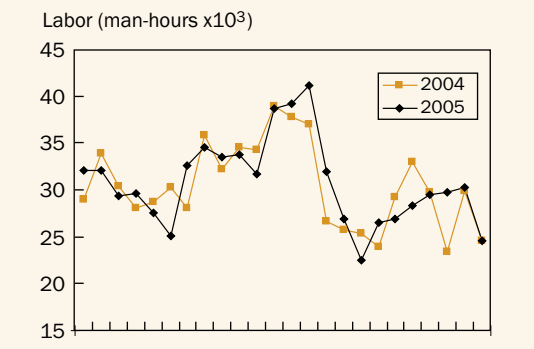
New equipment acquisitions for the year included one vacuum/blower machine, three brush cutters, two push mowers, one riding mower, assorted tools and gadgets, a 40-ft aluminum ladder, and a water dispenser unit. Fifty worn-out trash bins were also replaced with new units during the year. Ceiling repair works were also initiated in the fertilizer and equipment shed at the staff housing.

Kabesilya labor services

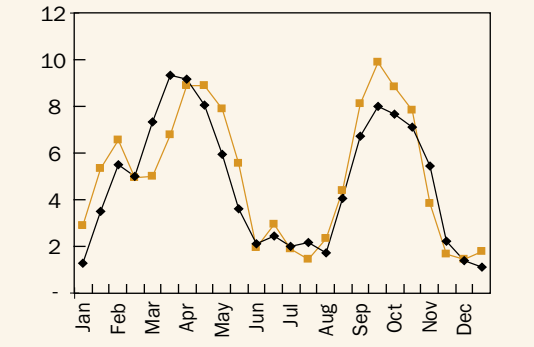
Performance monitoring of *kabesilya* services was continuously implemented by the ES Administrative Unit. A summary of performance data taken from kabesilya job completion feedback forms revealed very high annual total acceptability values of 99.8% for bird-scaring services and 99.5% for other contractual labor services in 2005. Except for an isolated case of poor performance, feedback ratings given by endusers ranged from good to excellent.

Man-hour utilization of kabesilya services rendered by two service providers as requested by the various research divisions and support units totaled 753,671 man-hours in 2005. This represented a 3% increase in utilization compared with the previous year's total of 730,305 man-hours.

Manual bird-scaring services, on the other hand, went down by 7% from 121,108 man-hours in 2004 to 112,852 man-hours this year. Although utilization levels for kabesilya labor services were generally maintained at almost similar levels in the previous year and use of bird-scaring services was lower in 2005 than in 2004, the annual cost for kabesilya labor and bird-scaring services went up by more than 11% as wage rates for the kabesilya workers went up twice, following two regional wage orders issued by the National Wage Board in May and in September of 2005.



Utilization of kabesilya labor service.



Utilization of kabesilya bird-scaring service.

Partnership activities and other support services

In coordination with the Community Relations 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. Communication linkages and close coordination with UPLB were also maintained by the station through the IRRI-UPLB Management Committee regular meetings and personal communication between UPLB and ES staff. Other support activities provided by ES in 2005 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 TC. ES staff also participated as facilitators and trainors in three training course offerings of the TC and provided planning and logistical support to the conduct of the 2005 Rice Genetics Symposium field demonstration and tours.

Environmental management system implementation

In line with the goals and objectives of the IRRI Environmental Agenda, the first draft of the ES Environmental Management System (EMS) was developed in August 2005. The EMS, designed to conform to international standards (ISO14001), is envisioned to serve as a management tool to ensure that ES activities at the research center are conducted in an environ-

ment-friendly way. With the work plan endorsed by the IRRI Environmental Council, formal implementation of the EMS began in December 2005 through a seminar workshop attended by all ES staff. The seminar workshop introduced the concepts of EMS and ISO14001 certification to the staff. The first draft of the ES Environmental Policy Statement was also presented and discussed. The importance of full cooperation and support of all ES staff in the EMS implementation was emphasized. Through the attendees' active participation, various environmental aspects of ES operations were identified. Group presentations during the workshop discussed the potential impact to the environment of ES activities. Suggestions on how positive impacts to the environment can be enhanced and how negative impacts can be avoided or minimized were given. In 2006, the outputs of this workshop shall be summarized, analyzed, and evaluated by an EMS team. This will be used as basis in the prioritization and design of environmental management programs that will help mitigate potential environmental impacts of the station's operations.

Staffing trends

The number of permanently employed farm personnel has drastically been reduced by more than 65% since 1991, from a total of 230. ES currently maintains 77 regular staff in its administration, field operation, and CGFG units and three project staff in the rice mill. To ensure continuity and sustainability in its operations, the restructuring and farm administration strategies employed included changes in a number of protocols and procedures, manpower pooling and realignment, job rotation, staff training, mechanization, modernization, and outsourcing, among others. Despite significant reductions in its workforce over the years, the Unit was able to meet new challenges and even absorb additional responsibilities as it continuously satisfies changing researcher requirements.

LIBRARY AND DOCUMENTATION SERVICE

The IRRI Library and Documentation Service (LDS) strives to live up to its status as the world's most comprehensive repository of published and unpublished technical rice literature coming from all over the world. As IRRI pursues its mission of uplifting the life of rice farmers and consumers in the developing countries, the LDS stands in the background and supports its scientific staff as well as scientists worldwide to achieve excellence by promptly linking them to up-to-date rice information sources. Its 24-hour web presence and maximum utilization of digital tools enable it to disseminate rice information and render services promptly via links to global sources and from its own collections. As in the past, the clients consisted of walk-in users (IRRI staff, students, and faculty from neighboring and remote universities and schools, general public), and scientists working in 49 countries all over the world.

The Library's Web site (http://ricelib.irri.org)

The home page, which is open 24 hours a day, serves as the main portal to search and retrieve print and electronic information resources, which are either physically present or are remotely accessible through the WWW. The IRRI Library's web presence is evidenced by 2,580,000 hits generated with a simple Google search. In 2005, there were 90,858 visitors to the site, with an average of 7,571 per month. This shows an increase of more than 3,000 per month over the previous year.

To further enhance its usefulness and functionality, the site was redesigned with less color and simpler graphics. Searching can now be done instantly as the main page is opened. More links were added to relevant web sites and documents.

Growth of the collection

A modest growth in monographic collection was achieved. But rice literature acquisition received a major boost when all librarians teamed up to procure rice articles as soon as they are announced by alerting services. The total number of rice reprints (mostly with pdf counterparts) received was 2,033. Of these, 1,697 were received, free of charge, from authors or from partner libraries and institutions. The average rate for pay-per-view access is about US$30. Hence, at this rate, the procurement of free documents translates to savings of approximately US$50,910. The collection development statistics for all types of materials are given in LDS Table 1.

LDS Table 1. Collection development in 2005.

Publication type	Added in 2005	Total collection
Monographs (books and pamphlets)	1,122	75,158
Rice reprints	625	25,504
PDF	1,408	1,456
Journals (print & electronic)	33 print	
	309 electronic	1,509 active titles
Rice theses	156	4,470
Online databases	2 (4 existing) (with paid licenses)	61 (includes free sources from the WWW)
Electronic links created		
OPAC	273	2,106
Rice database	282	2,200
Total monograph collection	3,162	137,913

Approximately 90% of the total collection budget was spent on subscriptions to electronic journals. For many titles, electronic-only subscriptions were paid on account of budget limitations. The LDS paid for subscription to 178 journal titles, of which 160 are in electronic format. This figure is much lower than the previous year's subscriptions due to the increasing costs of journals and budget constraints. Forty-one electronic journals were obtained through the CGIAR Libraries and Information Services Consortium (CGIARLISC). Membership in the CGIARLISC increased access to e-journals. Though IRRI has 41 paid consortial titles, IRRI staff have access to 114.

Two major additions to electronic online databases is *The Essential Electronic Agricultural Library (TEEAL)* and the *Web of Science (WOS)*. The acquisition of TEEAL eliminated the need for archival preservation of more than 100 print journals, whose contents might perish with time. TEEAL is now fully installed in IRRI's local area network. WOS (http://portal.isiknowledge.com/portal.cgi?DestApp=WOS&Func=Frame), although very expensive, is a vital tool that has long been awaited by IRRI scientists. It enables the creation of subject alerts and the evaluation of peer-reviewed publications through citation analysis. With this subscription, eight simultaneous users can search all subjects covered by *Current Contents Connect* and the various citation indexes: *Arts and the Humanities Citation Index, Science Citation Index,* and *Social Sciences Citation Index*.

The library subscribed to other vital databases: the *Library of Congress Classification Web* (http://classification-web.net/Menu/index.html), an online resource, integrating the various cataloging tools used by the LDS daily; the *Crop Protection Directory; the Crop Protection Compendium* (www.cabicompendium.org/cpc/home.asp), which are both highly specialized information sources; and CABDirect (www.cabdirect.org/), which covers all fields of agriculture. Eleven technical paper alerts were sent to scientific staff per week. These databases complement the 50 plus free online databases linked to the Library's web site.

Electronic links to full-text documents continued to be added to the online catalog and the rice database. Created were 273 links on the OPAC and 282 on the rice database. The OPAC now carries 2,106 links, while the rice database has 2,200. This will continue to grow as users prefer instant desktop access to full-text sources.

LDS services

The LDS staff tried to reduce the turnaround time between receipt of a query or request and delivery of answers or documents. The services took the form of current awareness, literature searches, reference services, document delivery, interlibrary loans, training of librarians, and binding. LDS Table 2 shows the extent of information services rendered by the LDS staff for the year.

CGIAR Center scientists and librarians are major recipients of documents from the IRRI LDS. IRRI continued to be the biggest provider of documents to CGIAR Center libraries (LDS Table 3). All the 500 documents were delivered, free of charge, as per consortium agreement. In return, IRRI received 30 documents from CGIAR Center libraries.

The number of countries that availed of LDS services increased from 41 in 2004 to 49 in 2005 (LDS Table 4).

Library projects

In addition to routine tasks, the LDS staff ventured into projects that would boost its information service capability. Archival preservation is put into focus so that access to information will be sustained for many years. Most of the projects, especially the databases, are continuing.

A project for searching and downloading freely available pdf of technical rice articles and dissertation on the WWW was launched in April. Downloaded during the 8-month period were 773 rice articles, books and conference proceedings, and dissertations.

Collaboration within and outside IRRI

The LDS worked in close partnership with other IRRI units and with local and foreign institutions to maximize its resources. The Rice Thesaurus Project and the Database of IRRI Digital Collections were done jointly with CPS. The ongoing digitization of rice newspaper clippings is a joint effort with VIS.

Outside the Institute, various collaborators lent support to the IRRI Library:

- Exchange partners. The LDS has exchange relations with more than 600 local and foreign libraries. Some local libraries that supplied documents requested by the Library are the Thomas Jefferson Information Center, the libraries of the University of the Philippines Los Baños, the University of the Philippines School of Economics at Diliman, the De La Salle University, and the Ateneo de Manila University. On the foreign front, support was received from some CGIAR libraries; the IRRI outreach offices in Korea, Bangladesh, and China; the National Agricultural Library in Maryland; the National Library of Australia; FAO; and the Delhi Libraries Network (DELNET). Many foreign authors gave pdf copies of their papers, free of charge.

LDS Table 2. Services rendered by LDS in 2005.

Service	Number delivered in 2005	Description
Current awareness		
Alerts	573	Search profiles were designed and alerts were set up for IRRI scientists, upon request, so that they may promptly be informed of new articles in their area of interest.
Announcements	53	Information on free journal issues, new publications by IRRI staff, new books of general interest, newly acquired theses, vital reference sources, useful Web sites, and Table of Contents alerts were published in the weekly electronic *IRRI Bulletin* and in the Public Announcements folder.
List of forthcoming relevant conferences	125 +	Regular feature of the Library's Web site and is updated daily
List of new acquisitions	12	Published on the LDS Web site
Reference & circulation		
Reference questions answered	521	Queries received from walk-in and remote clients
Book loans processed	12,690	Covers checkouts and renewals
Interlibrary loans	66–lent 36–borrowed	Only UPLB and PhilRice Libraries are entitled to interlibrary loans
Requests for literature search	177	Still being done in spite of available online databases
Document delivery		
Documents delivered to IRRI staff	505	Strong preference for pdf format evident
Documents delivered to CGIAR libraries	500	LDS still the top provider in the CGIAR system
Documents delivered to other organizations	332	
Bindery		
Monographs bound	253	Includes job orders from other units
Journals bound	725	
Other bindery products	309	Princeton files, boxes, folders, etc.
Training		
Orientations/briefings	285	
Hands-on instruction on how to use library databases	37	
Hands-on instruction on using EndNote or ProCite or WebAGRIS	5	
On-the-job training for librarians	1	One library science student from Germany started his 4-month training in November.
Cataloging for other units	205	
Procurement of books and journals for other units in IRRI	280	
Countries that availed of LDS services	49	An increase of 8 countries over the past year

- CGIAR. The LDS was a key player in the development of the CGIAR virtual library, as it contributed a compilation of various catalogs and online databases of the 15 CGIAR centers and intercenter initiatives. Coordination of the joint journal subscription of the CGIARLISC was another major contribution of IRRI.
- Agricultural Networks Information Center (AGNIC). IRRI was granted full membership by this network in December. This will give more exposure to IRRI's knowledge resources while availing of electronic resources contributed by other members.
- Local library beneficiaries. Withdrawn and duplicate monographs and journals were distributed to the following libraries: the Municipal Library of Sto. Tomas, Batangas; the Center for International Environmental Law (CIEL) Philippines; University of Peradeniya, Sri Lanka; the University of Southern Mindanao; and some units in UPLB.

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.

LDS Table 3. Electronic document delivery to CGIAR Centers in 2005.

Center	Articles delivered (no.)
CIAT	1
CIFOR	26
CIMMYT	60
CIP	83
ICARDA	8
ICRAF	39
ICRISAT	185
IFPRI	32
IITA	7
ILRI	8
ISNAR	
IWMI	12
WARDA	24
WorldFish	15
Total	500

LDS Table 4. Information services rendered, by country, 2005.

Country	Literature search requests (no.)	Documents delivered (no.)	Country	Literature search requests (no.)	Documents delivered (no.)	Country	Literature search requests (no.)	Documents delivered (no.)
Australia	1	53	India	37	688	Philippines	30	324
Austria		1	Indonesia	1	95	Russia		5
Bangladesh	3	4	Iran	2	32	Singapore		18
Belarus		7	Italy		5	Sri Lanka		48
Benin		1	Ivory Coast	1	64	Switzerland		10
Bhutan		2	Japan		8	Syria		16
Brazil	1		Kenya		77	Taiwan		2
Cambodia		1	Korea		10	Thailand	1	4
Cameroon	1	2	Lao PDR		3	Togo		4
Canada		5	Malawi		2	UK		13
China	2	24	Malaysia		42	Uruguay		1
Colombia	2	39	Mexico		150	USA	3	103
Costa Rica		1	Myanmar	1	16	Vietnam	2	
Egypt		75	Nepal	1	33	IRRI staff (local)	2	505
Ethiopia		18	Netherlands		2			
France		5	Nigeria		13	Total	94	2,702
Germany		3	Pakistan	3	38			
Ghana		4	Peru		126			

LDS Table 5. Projects pursued in 2005.

Project title	Entries added in 2005 (remarks)	Total
International Directory of Rice Workers	683	1,753
Rice Patent Database	180	1,340
Searching of free rice articles/monographs from the WWW	773	773 (added to pdf archives)
PDF archives	1,456	1,456
Rice thesaurus (jointly with CPS)	1,638 terms	1,638 terms
Database of IRRI digital collections (jointly with CPS)	3,307	3,307
Citation analysis of IRRI scientists' literature output from 1998 to 2003	Full paper is now available	
Digitization of rice in the news and IRRI in news clippings	Outsourced, started in November 2005	
Rice in the news & IRRI in the news database	1,066	14,413
New publications by IRRI staff (e-list posted on the Library's Web site)	261	261

VISITORS AND INFORMATION SERVICES

The Institute welcomed and hosted some 63,723 visitors (VIS Table 1) as compared with last year's 50,581 with an increase of 13,142 visitors. This included distinguished visitors comprising 1,205 government officials, 2 ambassadors, and 15 ministers, together with various members of the diplomatic community and representatives of various donor and international organizations, including ADB, FAO, GTZ, USA, and the European Union.

Three new sets of activity books for three student categories (preschool, elementary, and high school) were also conceptualized and produced for the 36,590 students who visited the Institute last year. The materials aimed 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.

The Visitors Office also handled 345 workshops and seminars, including the Fifth International Rice Genetics Symposium held at EDSA Shangri-La and its Open Day at IRRI, which attracted more than 400 participants. The Office also welcomed some 2,244 farmers on two farmers' day events that aimed to educate and raise awareness about recent technologies and research at IRRI.

Workshops, conferences, and meetings

During the year, IRRI hosted or cohosted 39 regional and international conferences, workshops, and symposia (VIS Table 2). The regional and international workshops were participated in by more than 2,134 representative delegates from 59 countries.

Riceworld and facilities

In 2005, the Riceworld Museum and Learning Center staff successfully mounted 11 exhibitions with varied themes, including biotechnology, population and employment, production, environment, culture and art, and general knowledge on rice.

Exhibitions included the following:

As participant

Angat Laguna, Sta Cruz, May
Ecop, Manila, May
Biotechnology and Human Genome, Senate Manila, May
ASEAN S&T, Indonesia, August
SOM-AMAF, Tagaytay, September
Bañamos, UPLB, September

As organizer

ADB Hybrid Rice, Manila, June
LBSCFI Anniversary, Los Baños, July
Rice Genetics, Manila, November

As collaborator/resource

Museo Negrense, Bacolod, September

Special museum exhibit

Anthony Nañola Art exhibit, Riceworld, August

Improvements in the museum's permanent displays included the addition of Korean, Japanese, Vietnamese, Cambodian, and Lao-donated artifacts. Fiberglass display covers were also fabricated to prevent damage to items in the rice products section. The Training Center section introduced an initial version of a cube picture puzzle exhibit to engage guests. A Graindell mural in the Asia Room was also added, along with a life-size caricature painting of a farmer with a youngster on a carabao for photo opportunities.

IRRI facilities were able to host a total of 27 non-IRRI events composed of school, corporate, and organization functions. Almost all preschools and Montessori in the Los Baños area held their recognition rites here at IRRI. Chandler Hall Auditorium was the venue for one voice and three piano recitals in 2005.

Community projects

The Community Relations Office (CRO) coordinated the distribution of more than 300 computers to all elementary and secondary public schools in Los Baños and Bay. Through a memorandum of agreement initiated by the CRO, all secondary public schools have agreed to provide free computer training courses to out-of-school youth as recommended by the Institute.

The CRO also organized 9 local public consultations for the field testing of the *Xa21* gene against bacterial blight. These public consultations included seminars given to UPLB science students and a presentation and dialogue with the faculty and students of the UPLB College of Agriculture.

Meanwhile, through arrangements made by the CRO, IRRI was well represented in all community activities like the Bañamos, UPLB Foot Parade, and the launching of the iron-rich rice in Laguna, among others. IRRI's local presence is also felt down to the barangay level through CRO's continuous coordination with municipal and barangay officials concerning donations, participation in local activities, and accommodating other requests. The CRO acted on more than 40 requests for donation of used equipment and materials and all sorts of assistance from the Institute.

Moreover, five high-impact local community projects have been implemented through partnership with the private sector: seminar on beauty and cosmetology with Splash Foundation, seminar on alternative films at UPLB with MOWELFUND, seminar on writing reports on agriculture in Filipino with the *Komisyon sa Wikang Filipino*, seminar on entrepreneurship with LEAP, and seminar on rice and vegetable farming with the Tan Yan Kee Foundation.

The CRO also maintained close coordination with the local women leaders through the IRRI-assisted women's organization, *Sulo ng Pamayanan*. The CRO assisted the members of the said organization in the conduct of seminars on lamaze and childbirth in several barangays in Los Baños and Bay.

Meanwhile, to effectively convey information on IRRI's mission and its activities, the CRO worked with the *Komisyon sa Wikang Filipino* for the translation of IRRI's information materials as well as the IRRI video. The said information materials were distributed during the conduct of community activities.

Media

VIS arranged programs for visits, interviews, and filming of research activities in 2005, capped by the successful sequencing of the rice genome and the 5th Rice Genetics Symposium, which made headlines and attracted international and Philippine media organizations.

Foreign media included Agence France Presse, Reuters, Associated Press, *Prothom Alo* (Bangladesh newspaper), Agence Capa Television (French), Discovery News, Voice of America, *Nation* (Bangkok newspaper), *New York Times*, German National Public Television, *China Daily*, Foreign Correspondents Club (Japan), Creation TV (Japan-based TV service broadcast on Internet), TravelAsia (cable channel), Thalassa (French TV magazine), *Science & Vie Junior* (French magazine), *Nature, Science, Nature Biotechnology*, and Mediterranean Diet (Spanish television).

National media included the Philippine Agricultural Journalists, Inc., Philippine News Agency, *Manila Bulletin, Philippine Daily Inquirer, The Philippine Star, The Manila Times, Malaya, People's Tonight, Remate, People's Journal, Tribune, Abante/Abante Tonite*, television channels ABS-CBN 2, NBN 4, GMA 7, RPN 9, and IBC 13, radio stations DZMM and DWIZ, and regional newspapers *The Barangay, The Network News, Ang Dyaryo Natin, The Monday Mail,* and *LB Times*.

VIS Table 1. IRRI visitors, by group, in 2005.

Group type	Philippines	Asia	Africa	Australasia	Europe	Latin America	North America	USA	Total
Students	36,399	160		1	8		2	20	36,590
Conference participants	17,512								17,512
Nongovernment organizations	297	47			5				349
Donors		7			5			1	13
Government officials	1,089	107			9				1,205
Farmers	2,078	166							2,244
Faculty members/parents	2,361	46			5		5		2,417
Scientists, university staff	339	200		6	21		15	39	620
Private sector	777	306		1	10	1	7	12	1,114
UN agencies, CGIAR, TAC, etc.	43	6				1	2	1	53
Diplomatic corps		3				1		2	6
Media	1	33							34
Religious groups	162	179						2	343
Tourists	20	275	1	8	16	2	22	61	405
Others	709	62			5	7	3	32	818
Total	61,787	1,597	1	16	84	12	56	170	63,723

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.)
24-26 Jan	International Workshop on Innovations in Communication for Rural Extension	Vietnam	81	15
2-5 Feb	Annual Review and Planning Meeting on Accelerating Technology Adoption to Improve Rural Livelihoods in the Rainfed Eastern Gangetic Plains	Bangladesh	62	9
21-24 Feb	Advances in Marker-assisted Selection Workshop	IRRI	62	11
28 Feb-4 Mar	Joint Planning Meeting for CURE Drought Ecosystems	IRRI	31	4
1-3 Mar	International Conference on Effective Land-Water Interface Management for Solving Agriculture-Fishery-Aquaculture Conflicts in Coastal Zones	Vietnam	51	17
5-7 Apr	BOT Program Committee Meeting	IRRI	20	13
11-12 Apr	Workshop and Project Meeting on Development of Integrated Rice Cultivation System under Water-saving Condition	IRRI	20	2
18 Apr	Inaugural Meeting of the IRRI Environmental Council	IRRI	15	1
18-20 Apr	Managing Rice Landscapes in Marginal Uplands for Household Food Security and Environmental Sustainability	IRRI	24	5
20-23 Apr	First 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	Bangladesh	62	10
26-27 Apr	Workshop on Impact of Labor Out-migration on Rice Household Economy with Emphasis on Gender Issues	IRRI	28	8
9-11 May	International Workshop on Research Prioritization on Genetic Diversification to Sustain Rice Productivity	IRRI	62	9
10-20 May	Generation Challenge Program Workshop	IRRI	34	13

17-18 May	First Planning Workshop on Revitalizing Marginal Lands: Discovery of Genes for Tolerance for Saline and Phosphorus-deficient Soils to Enhance and Sustain Productivity	IRRI	35	7
24-27 May	Fourth Annual Meeting of the CURE Steering Committee	Indonesia	75	11
6-8 Jun	Regional Workshop for the Development and Dissemination of Hybrid Rice Technology	Philippines	56	15
6-10 Jun	Water, Rice, and Livelihoods–A Comprehensive Assessment Writers' Workshop	IRRI	15	11
13-16 Jun	Combined Workshop of the Standing Panel on Impact Assessment (SPIA) of the CGIAR and the 6th Meeting of the CGIAR Task Force on Integrated Natural Resource Management	IRRI	37	21
22 Jun	ICAR-IRRI Collaborative Workplan Meeting	India	39	2
5 Jul	Environmental Forum Planning Session	IRRI	24	1
8-10 Aug	Strategic Planning Exercise–External Consultation Workshop	IRRI	25	13
25 Aug	Environmental Forum Plenary Session	Philippines	45	1
9-11 Sep	9th Annual Meeting of the Council for Partnerships on Rice Research in Asia	Indonesia	29	17
14-16 Sep	BOT Program Committee Meeting	Indonesia	20	13
26 Sep-2 Oct-	Intellectual Property Rights Training Workshop and INGER Technical Advisory Committee Meeting	Thailand	37	18
4-6 Oct	Workshop on Integrating Environmental Issues into Sustainable Rice Farming and Rural Development	IRRI	32	1
10-12 Oct	China-IRRI Collaborative Workplan Meeting	China	114	2
14 Oct	Environmental Forum 2nd Plenary Session	IRRI	21	1
27-28 Oct	Research Needs Assessment Workshop for Southeast Asia	IRRI	22	16
3-4 Nov	Developing a System of Temperate and Tropical Aerobic Rice in Asia Workshop	IRRI	14	1
9 Nov	Program 3 Scientific Meeting	IRRI	30	1
16-17 Nov	Golden Rice Network Meeting	IRRI	22	12
18-19 Nov	Second Rice Annotation Project Workshop	Philippines	52	12
19-23 Nov	5th International Rice Genetics Symposium and 3rd International Rice Functional Genomics Symposium	Philippines	736	40
24-25 Nov	HarvestPlus Rice Crop Meeting	IRRI	46	16
5-7 Dec	Inception and Planning Meeting of the Challenge Program on Water and Food Project	Thailand	19	5
6-8 Dec	Environmental Radio Soap Opera for Rural Vietnam Drama Scriptwriting Workshop	Vietnam	26	2
12-13 Dec	External Review of Research Program on Upland Rice	IRRI	10	6
Total				2,134

VIS issued 18 press releases during the year:

- Major new research alliance formed to fight poverty (19 Jan)
- Help on the way for tsunami-battered rice farmers (28 Jan)
- Respected plant pathologist named as new director general (3 Feb)
- Three new board members appointed (18 Feb)
- Restore agriculture first, "Smart Aid" can help developing countries recover faster from natural disasters and conflicts (4 Mar)

- Crying time (7 Mar)
- Bhutanese farmers play games with scientists (29 Mar)
- Asian drought triggers surge in poverty – but help is on the way (23 May)
- New alliance takes shape (17 Jun)
- Research offers drought-devastated rice farmers a chance to fight back (1 Sep)
- Rice-producing nations stress importance of developing new crop varieties (12 Sep)
- China focuses on improved rice quality and nutrition (20 Oct)
- Perlegen Sciences and International Rice Research Institute to collaborate on rice DNA variation study (16 Nov)
- An exciting new era in rice research (20 Nov)
- Study finds that nutritionally enhanced rice reduces iron deficiency (1 Dec)
- Finalized rice genome sequence makes waves in agricultural research (9 Dec)
- Open-source biotechnology alliance for rice research (13 Dec)
- Some good news for the world's poor (19 Dec)

Three issues of *Rice Today* were published and distributed to more than 2,167 subscribers in more than 98 countries; four online *IRRI Hotline* issues were released to 2,439 recipients; and 11 issues of the monthly *Sandiwa* (in-house publication) were published.

INFORMATION TECHNOLOGY SERVICES

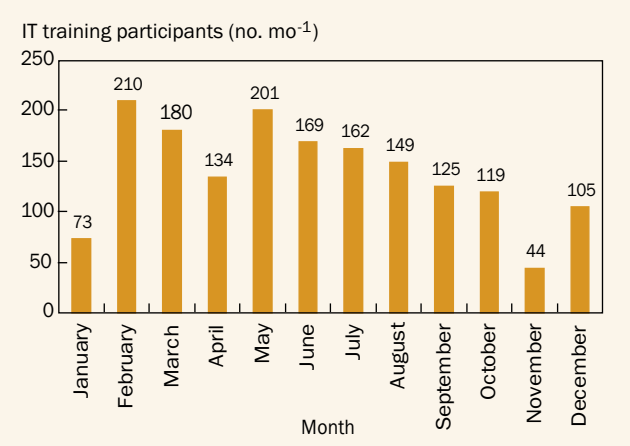
The year 2005 saw the completion of the second phase of IRRI's switch from purchasing computers as capital items to a rental arrangement via a "seat management" arrangement with Hewlett Packard (HP). Two hundred additional computers were added to the arrangement. In all, 902 computers were included in subscription-based services by the end of 2005. As planned, network storage expanded in line with the additional numbers of computers without any tendering or other time-consuming activities. The success of IRRI's seat management implementation, the first in Southeast Asia, was recognized externally with invitations to present on the topic (IRRI IT head Paul O'Nolan did so at an IQPC conference in Singapore in September and at a CIO Summit in Brisbane in December) and media interest: Paul O'Nolan was interviewed on the subject in December 2005 by *CIO Asia* magazine. IRRI's relationship with HP deepened with the decision in 2005 to replace 55 Xerox photocopiers with 27 HP multifunction network printers/copiers. The new devices provide improved copying and printing services, support full chargeback for all use, and will enable a reduction in the number of printers used at IRRI. As a result of the growing relationship with HP, IRRI, and its sister centers in Asia in the CGIAR were granted access to HP Direct, a direct sales channel of HP normally requiring an annual business volume in excess of $1M. IWMI later acknowledged that benefits included faster, simpler procurement and lower prices (19% savings on laptops, 4% on desktops).

Two IRRI IT staff completed the foundation course in IT Infrastructure Library (ITIL) methods. ITIL is a growing best practice movement focused on improvements in IT Service Management. Paul O'Nolan was later certified by the IT Service Management Foundation (first in the CGIAR).

In 1995, IRRI became the second organization in the Philippines with a permanent Internet connection. History repeated itself 10 years in 2005, as IRRI became the second organization in the Philippines with an Access Grid node. The Access Grid is a powerful, open-source-based technology for multipoint video conferencing. It has been pioneered in the CGIAR by IRRI. IRRI IT head, Paul O'Nolan, leads a World Bank-funded project to link up a handful of centers to Internet2, APAN, and similar networks during 2006.

The Institute's IT systems were hardened in November as an outcome of an IT security training workshop organized by IRRI for CGIAR centers in the region. The workshop was undertaken as part of a World Bank-funded project to improve IT security and business continuity in the CGIAR. The project, led by IRRI, is being undertaken in partnership with SGV & Co., the Manila-based firm of auditors.

2005 was a good year for improved access to information in IRRI. With help from IT Services, more than 50 organizational units implemented Microsoft Sharepoint (document management) sites with full text search capability. In addition, IT Services implemented an Intranet dashboard to integrate various administrative workflows and commissioned a work order system for IRRI's Physical Plant Services.



Other notable events in 2005 included a doubling of IRRI's Internet bandwidth (from 2x1 Mb to 2x2 Mb), the extension of the campus phone system to the Forestry apartments, the first implementation of SSL VPN technology for secure remote access to network resources by staff, and a substantial increase in the number of people getting IT training at IRRI (see graph on bottom of previous page).

SEED HEALTH UNIT

Phytosanitary certification

The Seed Health Unit (SHU) issued 394 phytosanitary certificates covering 33,506 seedlots (921.34 kg) and sent to 52 countries worldwide (SHU Table 1). By region, East Asia received 89 rice seed shipments (13,645 seedlots); Europe, 37 shipments (659 seedlots); Latin America, 7 shipments (295 seedlots); North America, 30 shipments (485 seedlots); Oceania, 7 shipments (286 seedlots); South Asia, 78 shipments (5,604 seedlots); Southeast Asia, 117 shipments (10,927 seedlots); sub-Sahara Africa, 11 shipments (421 seedlots); West Africa, 5 shipments (161 seedlots); and West Asia and North Africa, 13 shipments (1,023 seedlots).

The rice seed export originated from different organizational units (OUs): International Network for Genetic Evaluation of Rice (INGER), 34 shipments (1,359 seedlots); Crop, Soil, and Water Sciences Division (CSWS), 10 shipments (710 seedlots); Entomology and Plant Pathology Division (EPPD), 15 shipments (1,770 seedlots); Genetic Resources Center (GRC), 144 shipments (7,914 seedlots); Grain Quality and Nutrition Research Center (GQNRC), 1 shipment (17 seedlots); and Plant Breeding, Genetics, and Biotechnology Division (PBGB), 190 shipments (21,736 seedlots).

The different fungi detected with corresponding detection level and affected seedlots are shown in SHU Table 2. Routine seed health testing of 784 nontreated, outgoing seedlots showed that *Trichoconis padwickii* affected 99.36% of the seedlots; followed by *Curvularia* spp., 98.21%; *Sarocladium oryzae*, 81.89%; *Phoma* spp., 73.09%; *Nigrospora* spp., 67.09%; *Fusarium moniliforme*, 48.47%; *Bipolaris oryzae*, 34.82%; *Microdochium oryzae*, 14.67%; *Aphelenchoides besseyi*, 9.57%; *Tilletia barclayana*, 4.72%; and *Pyricularia oryzae*, 0.38 %. 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. All outgoing seeds were fumigated with phosphine.

Sixty phytosanitary certificates were also issued to INGER for their nursery seed distribution covering 29,647 seedlots (708.74 kg) and sent to 30 countries worldwide. By region, East Asia received 19 shipments (3,722 seedlots); Europe, 1 shipment (116 seedlots); Latin America, 6 shipments (3,463 seedlots); South Asia, 11 shipments (14,740 seedlots); Southeast Asia, 18 shipments (5,813 seedlots); sub-Sahara Africa, 1 shipment (84 seedlots); and West Asia and North Africa, 4 shipments (1,709 seedlots).

Post-entry clearance

Thirty-five incoming seed shipments (7,707 seedlots weighing 143.92 kg) from 19 countries were also processed for post-entry clearance (SHU Table 3). The highest number of shipment, seedlot, and total weight originated from Southeast Asia, with nine shipments covering 4,307 seedlots that weigh 56.98 kg. The consignees of these seed shipments are the OUs: PBGB received 14 shipments (6,014 seedlots); INGER got 12 shipments (214 seedlots); EPPD, 4 (71 seedlots); GRC, 3 (219 seedlots); Intellectual Property Management Unit (IPMU); 1 (2 seedlots); and GQNRC, 1 (1,187 seedlots).

SHU Table 4 shows the results of post-entry examination on 1,338 seedlots. Only 0.30% of the seedlots visually inspected had seeds with soil, whereas 2.54% were damaged by insects, mainly by *Sitophilus granarius* (0.15%). Contamination with weed seeds was 1.57%, mainly *Ischaemum rugosum* (0.82%) and *Echinochloa* spp. (0.52%). Seed health tests showed *that Curvularia* spp. affected 95.24% of the seedlots, followed by *T. padwickii* (93.12%), *S. oryzae* (80.42%), *Phoma* spp. (76.72%), *Nigrospora* spp. (75.13%), *B. oryzae* (68.25%), *M. oryzae* (64.55%), *F. moniliforme* (49.21%), *T. barclayana* (19.76%), *A. besseyi* (9.52%), and *P. oryzae* (3.17%) (SHU Table 5). The prescribed ASEAN standard treatments were applied to all incoming seeds.

Crop inspection

Post-entry and preexport crop health inspections were conducted on GRC, EPPD, PBGB, and TC multiplication plots and post-entry quarantine areas during dry and wet seasons. For post-entry, crop health inspections were conducted on 1,982 entries during dry season and 3,820 entries during wet season. SHU Table 6 shows the different diseases observed with corresponding percent prevalence. The most prevalent disease observed during dry and wet seasons was rice tungro (21.00% and 8.82%, respectively). Preexport crop health inspection was also conducted on 6,693 entries during dry season and 2,883 entries during wet season. The most prevalent disease during the dry and wet seasons was sclerotium seedling blight (16.60% and 13.42%, respectively).

Advance testing for GRC seeds

A total of 5,323 GRC seedlots for long-term storage were processed for seed health status. The different fungi detected with corresponding detection level and number of affected seedlots are shown in SHU Table 7. Routine seed health testing of 5,270 nontreated seedlots revealed that *Curvularia* spp. affected 99.98% of the seedlots, followed by *Phoma* spp., 95.71%; *Nigrospora* spp., 94.06%; *T. padwickii*, 92.18%; *S. oryzae*, 82.90%; *F. moniliforme*, 43.38%; *B. oryzae*, 36.03%; *A. besseyi*, 3.66%; *M. oryzae*, 3.53%; *P. oryzae*, 0.78%; and *T. barclayana*, 0.11%.

Nonseed biological materials and soil samples

The SHU as the gatekeeper for IRRI rice seeds was also designated as the sole entry and exit point for all incoming and outgoing nonseed biological materials (NSBMs) and soil samples (DG Memo No. 2005-025 circulated 15 Aug 2005). In this memorandum, NSBMs were qualified and the guidelines for distribution/exchange of these materials were included. The term includes the following: nonseed plant parts, tissue/cell cultures of rice plants, plasmids, azolla and other biofertilizer materials, insects, pure culture of fungi, bacteria, nematodes, and other phytopathogenic materials associated with rice, DNA samples, anti-serum (except commercially available anti-sera), and enzymes (except commercially available enzymes). All exchanges of NSBMs and soil samples are now coursed through the SHU. This is to reinforce the internal control over the exchange of NSBM and soil samples. Furthermore, this ensures better compliance with legal and contractual requirements and facilitates easier monitoring and safekeeping of transaction records. It is imperative that IRRI knows precisely the intellectual property (IP) status of all germplasm going in and out of the Institute. In line with this, additional requirements for seed export and import to enable seed and IP tracking (DG Memo No. 2005-008) were implemented. The new requirements have increased efficiency and clarity of germplasm exchange in tracking the IP status of any line at any time for any IP constraints on any progenitor, which might have occurred through the current line. Moreover, this helped in tracking immediately the seed movement within the Institute and in integrating the characterization and evaluation data for lines from different screens and studies.

The opening of the GQNRC in 2004 resulted in an increase in distribution and exchange of rice grains (polished/dehulled/milled/powdered/ground) for destructive analysis and testing. Hence, for more efficient distribution/exchange of rice grains for these purposes, additional guidelines were made and implemented (DG Memo No. 2005-031).

Through SHU, 16 shipments were processed for phytosanitary certification covering 2,843 samples and sent to 8 countries worldwide (SHU Table 8). By region, East Asia received 5 shipments covering 73 samples; Europe, 3 shipments covering 11 samples; Latin America, received 1 shipment covering 1,221 samples; North America received 5 shipments, 50 samples; South Asia, 1 shipment, 1,486 samples; and Southeast Asia, 1 shipment, 2 samples. SHU Table 9 shows the nature and total number of NSBMs exported by IRRI during 2005. The highest number of exported NSBMs was ground rice straw (1,486 samples), followed by DNA samples (1, 301 samples). These materials came from CSWS, 4 samples; EPPD, 73 samples; GRC, 1,234 samples; and PBGB, 2,843 samples.

Eleven shipments (823 samples) coming from four regions were also processed for post-entry clearance (SHU Table 10). The highest number of shipments originated from Europe (7 shipments), while the highest number of samples originated from South Asia (450 samples). The highest number of incoming materials was rice leaf powder with 450 samples, followed by ground straw grain with 312 samples. The recipients of these incoming materials were CSWS with 9 shipments covering 768 samples; EPPD with 1 shipment covering 1 sample; and INGER with 1 shipment covering 54 samples.

Workshops, training courses, and visitors

The SHU also participated in various training/workshops coordinated by the Training Center. The Rice Production Course (1st offering) had 25 participants from 6 countries and 6 participants from IRRI; the 2nd offering had 21 participants. Other visitors included eight delegates from the China National Rice Research Institute headed by Dr. Shenxiang Tang, China INGER national coordinator; 43 Agronomy 170 (Fundamentals of Seed Technology) students from UP Los Baños (UPLB); 20 Seed Pathology and Entomology students and two professors from Central Luzon State University; 19 Agronomy 150 (Methods of Plant Breeding) students from UPLB; 12 Plant Pathology 121 (Postharvest Pathology) students from UPLB; 20 participants, two resource persons from the International Seed Testing Association (ISTA), and three National Seed Quality Control Service staff attending the ISTA-Asia Pacific Seed Association (APSA) Workshop; and 10 Vietnamese officials (in coordination with the Philippine Seed Industry and APSA).

SHU Table 1. Distribution of rice seed exported by IRRI in 2005.

Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)
East Asia (6)			
Japan	16	1,473	5.858
Korea N	4	429	7.837
Korea S	16	7,466	158.073
Mongolia	1	147	1.000
PROC	47	3,402	31.286
Taiwan	5	728	10.497
Subtotal	89	13,645	214.551
Europe (13)			
Austria	2	14	1.029
Belgium	3	13	.118
France	9	109	1.733
Germany	6	177	4.253
Italy	1	5	.069
Netherlands	2	2	30.100
Norway	1	3	2.000
Portugal	1	2	.060
Russia	1	22	.550
Spain	3	64	1.314
Sweden	2	19	.260
Switzerland	1	2	.065
United Kingdom	5	227	.668
Subtotal	37	659	42.219
Latin America (5)			
Brazil	2	141	10.791
Chile	1	25	.325
Colombia	2	36	.371
Ecuador	1	90	1.300
Mexico	1	3	.038
Subtotal	7	295	12.825
North America (2)			
Canada	2	18	3.000
USA	28	467	16.112
Subtotal	30	485	19.112
Oceania (1)			
Australia	7	286	1.671
Subtotal	7	286	1.671
South Asia (6)			
Bangladesh	12	689	19.095
Bhutan	1	32	.290
India	55	4,659	114.480
Nepal	2	29	.525
Pakistan	5	128	2.245
Sri Lanka	3	67	3.000
Subtotal	78	5,604	139.635
Southeast Asia (8)			
East Timor	2	20	39.600
Indonesia	6	177	15.379
Laos	2	105	4.070
Malaysia	4	87	13.694
Myanmar	3	91	2.788
Philippines	80	9,103	348.656
Thailand	6	321	9.306
Vietnam	14	1,023	13.989
Subtotal	117	10,927	447.482
Sub-Sahara Africa (8)			
Burundi	1	119	1.200
Congo	1	7	.380
Ethiopia	3	84	3.360
Gambia	1	54	.868
Kenya	1	103	2.100
Rep of Guinea	2	13	.240
Senegal	1	32	1.600
South Africa	1	9	.400
Subtotal	11	421	10.148
West Africa (1)			
Benin	5	161	3.925
Subtotal	5	161	3.925
West Asia and North Africa (2)			
Egypt	6	725	24.104
Iran	7	298	5.667
Subtotal	13	1,023	29.771
Grand total	394	33,506	921.339

SHU Table 2. Routine seed health test results for untreated outgoing seeds received by SHU for certification in 2005.

Pathogen	Affected seedlots[a] (%)	Detection level (%)	Mean (%)
Trichoconis padwickii	99.36	1 – 80	24.01
Curvularia spp.	98.21	1 – 59	17.84
Sarocladium oryzae	81.89	1 – 68	6.12
Microdochium oryzae	14.67	1 – 8	1.21
Fusarium moniliforme	48.47	1 – 57	3.12
Bipolaris oryzae	34.82	1 – 3	1.12
Phoma spp.	73.09	1 – 36	3.61
Pyricularia oryzae	.38	1 – 4	2.33
Nigrospora spp.	67.09	1 – 44	5.88
Tilletia barclayana	4.72	1 – 71	7.57
Aphelenchoides besseyi[b]	9.57	1 – 43	4.16

[a]Based on 200 seeds seedlot^{-1} drawn for testing (n=784). [b]Actual nematode count using sedimentation test.

SHU Table 4. Quarantine objects intercepted in incoming rice shipments in 2005.

	Infested seedlots (no.)	Percentage[a]
Weed-contaminated	21	1.57
Weeds		
Echinochloa spp.	7	0.52
Ischaemum rugosum	11	0.82
Insect-damaged	34	2.54
Insects		
Sitophilus granarius	2	0.15
Seeds with soil	4	0.30

[a]Based on 1,338 seedlots visually inspected.
Seeds, by category (general quality)
Category 1 ---------- 0
Category 2 ---------- 11

SHU Table 5. Routine seed health test results received by SHU for post-entry clearance in 2005.

Pathogen	Affected seedlots (%)	Detection level (%)	Mean (%)
Trichoconis padwickii	93.12	1 – 76	19.60
Curvularia spp.	95.24	1 – 32	10.19
Sarocladium oryzae	80.42	1 – 36	7.54
Microdochium oryzae	64.55	1 – 15	2.44
Fusarium moniliforme	49.21	1 – 6	1.49
Bipolaris oryzae	68.25	1 – 98	14.36
Phoma spp.	76.72	1 – 14	3.08
Pyricularia oryzae	3.17	1 – 1	1.00
Nigrospora spp.	75.13	1 – 38	7.46
Tilletia barclayana	19.76	1 – 39	5.62
Aphelenchoides besseyi[a]	9.52	1 – 25	5.17

[a]Actual nematode count based on 200 seeds seedlot^{-1} (n=189).

SHU Table 3. Origin and number of seedlots of imported rice seeds in 2005.

Region/country	Total shipments (no.)	Total seedlots (no.)	Total weight (kg)
East Asia (3)			
Japan	1	5	5.200
Korea S	4	1,395	11.305
PROC	2	183	2.170
Subtotal	7	1,583	18.675
Europe (1)			
Portugal	1	6	.100
Subtotal	1	6	.100
Latin America (2)			
Colombia	2	1,295	12.300
Ecuador	1	6	1.000
Subtotal	3	1,301	13.300
North America (1)			
USA	4	10	1.749
Subtotal	4	10	1.749
Oceania (1)			
Australia	1	1	.096
Subtotal	1	1	.096
South Asia (1)			
Bangladesh	3	110	43.384
Subtotal	3	110	43.384
Southeast Asia (5)			
Indonesia	2	21	11.600
Laos	3	68	15.300
Philippines	1	4	6.000
Thailand	1	4,201	21.000
Vietnam	2	13	3.078
Subtotal	9	4,307	56.978
Sub-Sahara Africa (2)			
Gambia	1	7	.575
Senegal	1	107	5.000
Subtotal	2	114	5.575
West Africa (1)			
Benin	2	111	2.391
Subtotal	2	111	2.391
West Asia and North Africa (2)			
Egypt	2	154	.679
Turkey	1	10	.988
Subtotal	3	164	1.667
Grand total	35	7,707	143.915

SHU Table 6. Diseases observed on incoming and outgoing entries planted at GRC, EPPD, PBGB, and TC seed multiplication plots and post-entry quarantine areas, 2005 dry and wet seasons.

Disease	Incoming				Outgoing			
	Dry season entries	%	Wet season entries	%	Dry season entries	%	Wet season entries	%
Entries without diseases	1,539	78.00	2,989	78.25	5,362	80.11	1,292	44.81
Bacterial leaf streak	0	0	139	3.64	22	0.33	113	3.92
Bacterial stripe	0	0	0	0	0	0	3	0.10
Leaf scald	0	0	16	0.42	9	0.13	49	1.70
Rice tungro	421	21.00	337	8.82	110	1.64	295	10.23
Yellow dwarf	4	0.20	0	0	3	0.04	0	0
Sheath rot	18	0.91	16	0.42	71	1.06	114	3.95
Sheath blight	0	0	1	0.03	0	0	166	5.76
Narrow brown leaf spot	0	0	0	0	0	0	9	0.31
Bakanae	0	0	0	0	5	0.07	0	0
False smut	0	0	137	3.59	0	0	35	1.21
Sclerotium seedling blight	0	0	5	0.13	1,111	16.60	387	13.42
Blast	0	0	7	0.18	1	0.01	332	11.52
Total	1,982		3,820		6,693		2,883	

[a]Diseases observed on plants originating from incoming seeds were not of an introduced nature.

SHU Table 7. Routine seed health test results for untreated GRC seeds for long-term storage in 2005.

Pathogen	Affected seedlots[a] (%)	Detection level (%)	Mean (%)
Trichoconis padwickii	92.18	1 – 78	9.37
Curvularia spp.	99.98	1 – 79	15.49
Sarocladium oryzae	82.90	1 – 51	4.00
Microdochium oryzae	3.53	1 – 3	1.02
Fusarium moniliforme	43.38	1 – 12	1.29
Bipolaris oryzae	36.03	1 – 4	1.14
Phoma spp.	95.71	1 – 60	4.26
Pyricularia oryzae	0.78	1 – 9	1.68
Nigrospora spp.	94.06	1 – 72	7.23
Tilletia barclayana	0.11	1 – 1	1.00
Aphelenchoides besseyi[b]	3.66	1 – 50	4.04

[a]Based on 200 seeds seedlot^{-1} could be drawn for testing (n=5,270). [b]Actual nematode count using sedimentation test.

SHU Table 8. Distribution of nonseed biological materials exported by IRRI in 2005.

Region/country	Total shipments (no.)	Total samples (no.)
East Asia (2)		
Japan	4	45
Korea South	1	28
Subtotal	5	73
Europe (2)		
France	1	3
Germany	2	8
Subtotal	3	11
Latin America (1)		
Brazil	1	1,221
Subtotal	1	1,221
North America (1)		
USA	5	50
Subtotal	5	50
South Asia (1)		
India	1	1,486
Subtotal	1	1,486
Southeast Asia (1)		
Philippines	1	2
Subtotal	1	2
Grand total	16	2,843

SHU Table 9. Description and number of samples of nonseed biological materials exported by IRRI in 2005.

Nature of materials	Total shipments (no.)	Total samples (no.)
Antisera	1	2
DNA samples	8	1,301
RNA samples	3	34
Ground rice, straw	1	1,486
Leaf samples	2	16
Rice husks	1	4
Total	16	2,843

SHU Table 10. Origin and number of samples of imported nonseed biological materials in 2005.

Region/country	Total shipments (no.)	Total samples (no.)
Europe (2)		
Germany	1	1
Netherlands	6	12
Subtotal	7	13
South Asia (1)		
Bangladesh	1	450
Subtotal	1	450
Southeast Asia (1)		
Laos	3	360
Subtotal	3	360
Grand total	11	823

GRAIN QUALITY AND NUTRITION RESEARCH CENTER

Grain quality evaluation services

For many years, a Rice Quality Laboratory has existed at the Institute, meeting the needs of plant breeders using established routine grain quality methodologies. Now, under the leadership of Dr. Melissa Fitzgerald, the grain quality evaluation service has been integrated into the newly established Grain Quality and Nutrition Research Center (GQNRC). Here, new equipment and cutting-edge technologies are being incorporated into established methodologies to help breeders develop rice varieties that are high-yielding, disease- and pest-resistant, tolerant of problem soils, and have superior grain quality and high nutritional value.

The Center was formally opened in December 2004. During the first year of quality evaluation services under GQNRC, new methods and equipment were installed and calibrated against established methods. These are the new equipment used for analysis of compositional parameters and for visual inspection of appearance:

- *Infratec™ 1241 whole grain analyzer (near-infrared transmittance technique)*
  This instrument can measure essential compositional parameters such as amylose, protein, oil, and moisture simultaneously in seconds. However, the method is indirect. Accuracy thus depends on the robustness of the calibration and the accuracy of the reference method used. Apparent amylose content is considered the most important quality trait examined during variety development; hence, primarily, application models for amylose evaluation in milled and brown rice were developed. Grain samples were loaded in a standard sample cell in the sample transport module. But the limited number of grains submitted by breeders for evaluation often times necessitated the use of a smaller size cell. The application models developed for amylose were therefore specific for the type of cells used to scan the samples and the type of rice (milled or brown).

  Calibration was performed using the established "iodine method" for apparent amylose content (Juliano 1971) as the reference method.

  Future work is geared toward updating the calibration with a wider range of samples to ensure broad acceptability and to network and promote the use of this fast technique in other breeding programs.
- *Cervitec™ 1625 grain inspector (digital image analysis)*
  This automated high-speed grain image inspection system evaluates physical qualities such as chalkiness and kernel dimensions (length, width, area) as well as head rice and damaged kernels. The system includes two cameras that record images of each kernel while the kernels are being separated and transported by a rotating disk. Image analysis is also an indirect method and the system is factory precalibrated based on the artificial neural network technique. In 2005, this new technique was evaluated and the staff worked jointly with the instrument manufacturer to improve the design of the rotating disk to ensure its applicability for a wider range of rice physical qualities (indica as well as japonica).

Other new equipment are used for evaluation of premium qualities such as cooking characteristics and aroma:

- *Rapid visco analyzer (RVA) (viscogram profile)*
  The RVA is used to produce a viscogram profile or a measure of the changes in viscosity of a slurry of rice flour as the cooking temperature changes. A firm viscogram indicates rice that will have a firmer cooked texture and better stability after cooking than a variety with intermediate or soft viscogram profile.

  In 2005, the viscogram profiles of the top 10% of breeders' lines measured with high head rice yield were evaluated.
- *5890 gas chromatograph with flame ionization detector (fragrance evaluation)*
  This year, a gas chromatograph acquired from the former User Lab of ASL was installed and used to quantify the amount of 2-acetyl-1-pyrroline (2-AP), the principal volatile component of fragrant rice. About 200 recombinant inbred lines from a parent Basmati submitted from EPPD were analyzed for aromatic traits.

Despite the transition period and with limited staff, GQNRC continued to provide quality evaluation services to breeders using established methods. A total of 78,000 analyses were performed on grain samples from PBGB. There was a 60% increase in number of analyses requested this year as compared with 2004 where only 48,000 total analyses were performed. The increase is also due to additional grain samples submitted for quality evaluation by other units like GRC and the Korean and salinity breeding programs.

Of the total analyses, 65% were done on breeders' lines (collected from the pedigree nursery, advanced observation yield trials, replicated yield trials, hybridization block, and the Bulu observation nursery). About 35% of grains evaluated were from the other programs (Aerobic, Salinity, Korean, GRC, and INGER).

Degree and postdegree training in 2005

Group training courses conducted in 2005.

Course title	Participants (no.)	Duration
Regular courses		
Modular Public Speaking and Presentation Skills Course	21	Nov 2004- Nov 2005
Planning Rice Breeding for Impact	23	7-18 Feb
Advances in Marker-aided Selection (Workshop)	58	21-24 Feb
English for Conversation	12	28 Feb - 11 Mar
Introduction to the International Crop Information System (ICIS)	18	28 Feb - 4 Mar
Introduction to the R Statistical Computing Environment	16	7-11 Mar
Two-Week Rice Production Training Course (1st offering)	29	7-18 Mar
English 1 Course	18	5 Jul - 11 Aug
Basic Experimental Designs and Data Analysis using IRRISTAT for Windows	24	25-29 Jul
Mixed Model Analysis using IRRISTAT	17	22-26 Aug
Two-Week Rice Production Training Course (2nd offering)	21	19-30 Sep
Leadership Course for Asian Women in Agriculture R&D and Extension	26	7-19 Nov
Introduction to the SAS System for Windows	22	7-11 Nov
IRRI-CIP UPWARD Training Course on Application of Participatory Approaches to Agricultural Research and Extension	30	21 Nov - 2 Dec
Special courses		
Project Management Workshop	40	28 Feb
SNP Discovery through (Eco) Tilling (Workshop)	20	28 Feb - 3 Mar
One-Week Study Tour for SFFP Officers, Bangladesh	10	28 Feb - 4 Mar
Two-Week Study Tour for SAIP Officers, Bangladesh	9	21 Mar - 1 Apr
IRRI-CIMMYT Scientific Writing Course	10	18-21 Jul
Quality Assurance Training	113	18-29 Jul
Rice Production Training Cum Scientific Visit for SAIP Officers, Bangladesh	10	14 Nov - 2 Dec
PhilRAA Alumni Workshop	29	7-11 Nov
IRRI-PhilRice Capacity Building/Accelerating Impact	25	24-26 Aug
AC-Sec Workshop	10	
Total	611	

Scholars on board in 2005, by country.

Country		By type	
Africa			
Ghana	1	**Summary**	
Ethiopia	1		
Rwanda	1	**Type I - PhD & MS scholars, thesis research at IRRI**	
Asia		PhD	35
Bangladesh	12	MS	20
Cambodia	1		
China	11	**Type II - PhD & MS scholars, coursework and thesis research at IRRI**	
India	6	PhD	17
Indonesia	4	MS	7
Iran	4		
Japan	3	**Type III - OJT/Nondegree, Interns**	
Korea	4	OJT/nondegree	5
Lao PDR	2	Interns	24
Myanmar	7		
Philippines	38	**Total**	**108**
Sri Lanka	1		
Thailand	1		
Vietnam	4		
Europe			
Australia	2		
Netherlands	1		
Germany	1		
Italy	1		
North America			
U.S.A.	1		
Canada	1		
TOTAL	108		

Scholars, by country and type who completed their training in 2005.

Country		By type	
Africa			
Ghana	1	**Summary**	
Asia		**Type I - PhD & MS scholars, thesis research at IRRI**	
Bangladesh	3	PhD	21
China	12	MS	14
India	12		
Indonesia	1	**Type II - PhD & MS scholars, coursework and thesis research at IRRI**	
Iran	1	PhD	0
Japan	1	MS	1
Korea	2		
Lao-PDR	2	**Type III - OJT/nondegree**	
Malaysia	1	OJT/nondegree & Interns	38
Myanmar	2		
Nepal	1	**Total**	**74**
Philippines	19		
Vietnam	5		
Europe			
Netherlands	1		
France	1		
Australia	1		
Germany	5		
North America			
United States	3		
Total	74		

Weather summary

Annual rainfall for year 2005 was 1,681 mm for the IRRI dryland (upland) site and 1,648 mm for the wetland (lowland) site. These values were 392 mm lower than the long-term average rainfall for the upland site and 355 mm lower for the lowland site. Los Baños experienced more than twice as much rainfall in December and less rainfall in May, June, and July this year, compared with the long-term amount. The wettest day at IRRI occurred on 15 Sep, with more than 88 mm rainfall per day. The longest recorded continuous wet spell was 10 d at the upland site (12–21 Dec) and 11 d at the lowland site (12–22 Dec). The longest continuous dry spell was 16 d (21 Jan–5 Feb) at the upland site and 20 d (12 Feb–3 Mar) at the lowland site.

Mean monthly solar radiation reached a peak in April (more than 20 MJ m^{-2} d^{-1}) and gradually declined to 9.6 MJ m^{-2} d^{-1} in December. Solar radiation was relatively low during the second decade of December. The highest recorded cumulated solar radiation (25.6 MJ m^{-2} d^{-1}) occurred on 17 May. The average duration of bright sunshine was about 6.4 h d^{-1} in June and declined to low values of 2.8 h d^{-1} in December. The longest record of sunshine at Los Baños was on 14 May with 12.9 h of bright sunshine.

Maximum temperature reached its highest monthly mean value in May (35.4 °C at the upland site and 34.2 °C at the lowland site); it then gradually dropped to its lowest monthly mean value in December (28.2 °C at the upland site and 28.0 °C at the lowland site). Except for March, April, and December, the recorded averages of maximum temperature for 2005 were higher than the long-term average. The hottest day in Los Baños was on 17 May with 37.8 °C of recorded maximum temperature at the upland site and 36.0 °C in the lowland site. The distribution of minimum temperatures was more stable than the distribution of the maximum temperatures. The coldest day for 2005 was on 29 Jan with 17.5 °C in the upland site and 19.6 °C in the lowland site.

Mean early morning relative humidity ranged from 78 to 90% in the upland site and 80–89% in the lowland site. Midday vapor pressure deficit was consistently higher in the upland site than in the lowland site.

Daily mean windspeed, measured at 2-m height was 1.5 m s^{-1} in the upland site and 1.3 m s^{-1} in the lowland site. Windspeed was generally low (<1.9 m s^{-1}), except during the passage of tropical disturbances. Maximum 24-h average windspeed was 3.8 m s^{-1} at the upland site on 21 Sep.

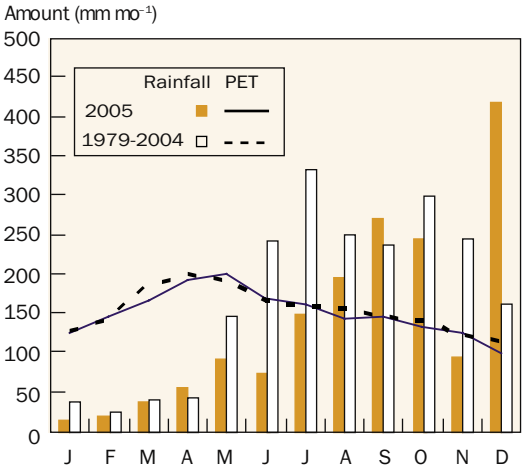
Because of a slightly higher air temperature, lower amount of rainfall, and higher vapor pressure deficit at midday, free water evaporation at the upland site was slightly higher than at the lowland site. Open-pan evaporation totals were 1,791 mm at the upland site and 1,630 mm at the lowland site. These values were 50 mm lower than the long-term evaporation total at the upland and lowland sites.

Seventeen disturbances passed through the Philippines' area of responsibility. Three of these disturbances were super typhoons: Feria (15–19 Jul), Jolina (2–4 Sep), and Maring (29 Sep–2 Oct).

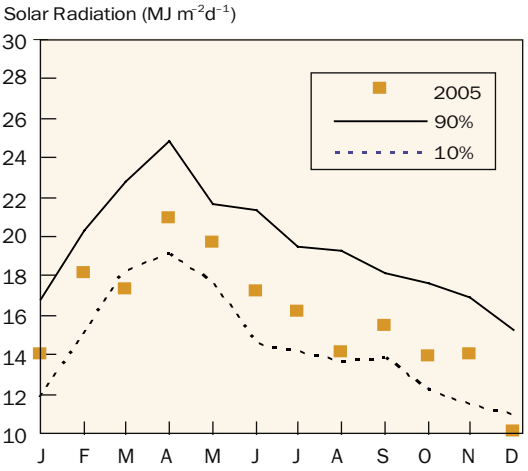
WS Table 1. Monthly weather data for IRRI and cooperating weather stations in the Philippines, 2005.

Site			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total or daily average
							Rainfall (mm mo^{-1})								
IRRI, dryland site	(14°13′ N, 121°15′ E)		14	21	40	56	92	74	151	197	272	246	97	420	1681
IRRI, wetland site	(14°11′ N, 121°15′ E)		17	17	54	58	51	86	112	180	323	240	122	388	1648
Dapdap, Paniqui, Tarlac	(15°37′ N, 120°44′ E)		0	0	3	54	92	191	128	155	412	1035			
PhilRice, Muñoz, Nueva Ecija	(15°45′ N, 120°56′ E)		0	0	18	2	106	256	95	335	190	400	1403		
Siniloan, Laguna	(14°29′ N, 121°30′ E)		102	74	144	74	107	182	371	319	573	553	2499		
MMSU, Batac, Ilocos Norte	(18°03′ N, 120°32′ E)		0	0	0	0	70	309	182	561					
WESVIARC, Iloilo	(10°46′ N, 122°35′ E)		6	1	36	23	187	273	371	507	248	150	76	198	2075
							Solar radiation (MJ m^{-2} d^{-1})								
IRRI, dryland site			14.0	18.1	17.3	20.9	19.7	17.2	16.2	14.1	15.5	13.9	14.0	10.1	15.9
IRRI, wetland site			13.5	17.7	16.8	20.5	19.3	16.7	15.8	13.7	15.1	13.4	13.5	9.6	15.5
Dapdap, Paniqui, Tarlac			17.1	19.3	19.8	20.3	19.2	16.4	16.0	13.9	15.1	17.5			
PhilRice, Muñoz, Nueva Ecija			20.7	22.2	25.1	26.1	25.5	22.2	21.6	18.9	17.3	19.3	21.9		
Siniloan, Laguna			19.3	20.7	21.4	24.3	24.0	19.9	19.3	17.4	17.8	16.7	20.1		
MMSU, Batac, Ilocos Norte			m	m	21.0	23.3	23.3	18.8	20.0	21.3					
WESVIARC, Iloilo			m	m	m	m	m	m	m	m	m	m	m	m	m
							Relative humidity (%)								
IRRI, dryland site			85	83	82	79	78	85	84	88	88	90	88	88	85
IRRI, wetland site			88	86	86	82	80	85	85	88	87	88	88	89	86
Dapdap, Paniqui, Tarlac			87	86	80	76	82	89	88	91	91		86		
PhilRice, Muñoz, Nueva Ecija			82	84	84	78	83	91	89	93	94	91	87		
Siniloan, Laguna			92	90	90	86	86	88	89	92	92	91	90		
MMSU, Batac, Ilocos Norte			75	75	78	78	77	84	83		79				
WESVIARC, Iloilo			86	85	83	83	87	89	92	92	91	92	93	93	89
							Temperature (°C)								
IRRI, dryland site		Max	29.2	31.4	31.3	33.5	35.4	33.8	32.6	31.6	31.4	31.2	31.0	28.2	31.7
		Min	21.8	22.2	22.9	23.7	24.9	24.9	24.5	24.3	24.1	24.1	24.1	23.5	23.8
IRRI, wetland site		Max	28.2	30.0	29.9	32.3	34.2	32.8	31.9	31.2	31.2	30.8	30.6	28.0	30.9
		Min	22.0	22.3	22.9	23.5	25.0	25.2	25.0	24.7	24.5	24.4	24.3	23.6	24.0
Dapdap, Paniqui, Tarlac		Max	31.5	33.2	34.1	36.5	37.1	33.9	33.5	32.4	32.4	33.8			
		Min	19.3	19.7	21.0	23.1	24.7	24.7	24.5	24.2	24.1	22.8			
PhilRice, Muñoz, Nueva Ecija		Max	30.3	30.8	32.1	35.5	36.5	33.7	32.6	31.6	32.0	32.7	32.8		
		Min	21.1	21.5	21.8	23.2	24.6	24.6	25.0	24.6	23.7	23.5	23.4		
Siniloan, Laguna		Max	25.8	27.1	27.1	29.5	32.6	30.9	29.8	29.5	29.2	28.3	29.0		
		Min	20.0	20.9	21.2	22.1	23.1	23.2	23.0	22.6	22.7	22.6	22.1		
MMSU, Batac, Ilocos Norte		Max	31.0	31.7	32.9	34.0	34.8	33.2	33.4	32.4	32.9				
		Min	15.5	19.1	22.2	25.6	27.4	25.7	26.1	24.1	23.2				
WESVIARC, Iloilo		Max	30.7	32.4	32.7	33.8	34.6	32.6	31.4	31.3	31.5	31.9	31.9	30.4	32.1
		Min	22.1	22.7	23.0	23.6	24.1	24.1	23.7	23.4	23.2	23.4	23.5	23.1	23.3
							Windspeed (m s^{-1})								
IRRI, dryland site			1.6	1.7	1.8	1.6	1.5	1.5	1.4	1.5	1.4	1.1	1.3	1.6	1.5
IRRI, wetland site			1.5	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.0	1.2	1.7	1.3
Dapdap, Paniqui, Tarlac			0.8	1.0	1.4	1.1	0.8	0.8	0.7	0.6	0.6	0.9			
PhilRice, Muñoz, Nueva Ecija			2.4	1.9	1.9	1.4	1.1	1.1	1.5	1.0	0.7	1.0	1.4		
Siniloan, Laguna			3.5	3.3	3.8	2.9	1.1	0.6	0.9	0.5	0.7	1.7	1.9		
MMSU, Batac, Ilocos Norte			0.3	0.3	0.4	0.4	0.5	0.3	0.3	0.4					
WESVIARC, Iloilo			1.7	1.8	2.0	1.7	1.0	0.9	1.0	1.0	0.9	0.8	1.0	1.6	1.3
							Evaporation (mm mo^{-1})								
IRRI, dryland site			123	157	179	218	221	170	144	132	131	116	111	90	1791
IRRI, wetland site			113	142	153	191	198	155	136	127	127	103	106	80	1630
Dapdap, Paniqui, Tarlac			142	158	200	205	211	136	131	110	128		1420		
PhilRice, Muñoz, Nueva Ecija			157	136	185	185	203	172	173	121	162	135	1628		
Siniloan, Laguna			182	176	214	199	204	138	163	145	141	115	1677		
MMSU, Batac, Ilocos Norte			131	147	172	197	207	170	164	1187					
WESVIARC, Iloilo			132	184	202	197	186	154	144	147	145	148	119	118	1876

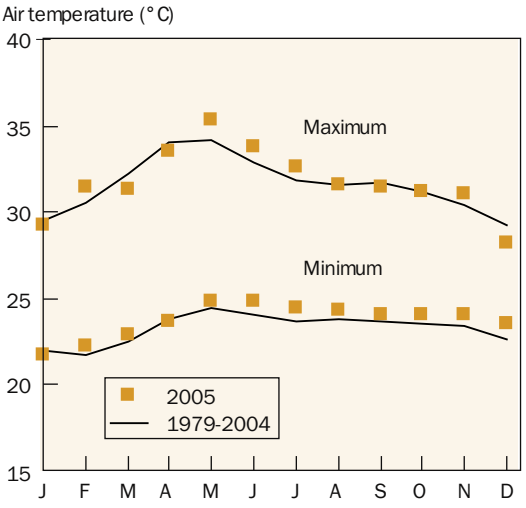
[a]MMSU = Mariano Marcos State University. [b]WESVIARC = Western Visayas Integrated Agricultural Research Center. [c]m = missing data.



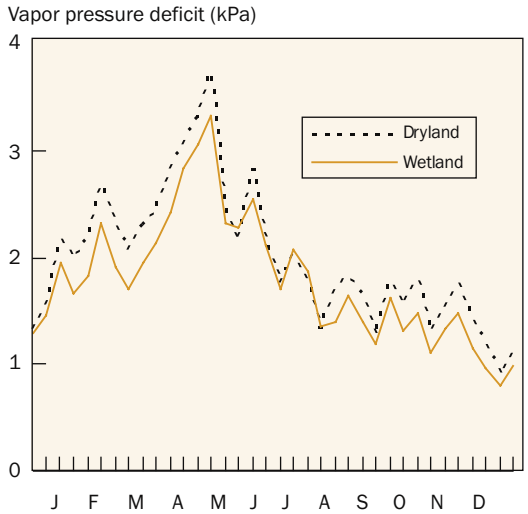
1. Rainfall and potential evapotranspiration patterns at Los Baños. IRRI, 2005.



2. Mean monthly solar radiation with 10 and 90% probability of occurrence. IRRI, 2005.



3. Maximum and minimum air temperature at the dryland site. IRRI, 1979-2005.



4. Midday vapor pressure deficit at the dryland and wetland sites. IRRI, 2005.

Board of Trustees (as of 1 March 2006)

Dr. Keijiro Otsuka (Chair)
Director
FASID Graduate Program
Professor, National Graduate Institute for Policy Studies
GRIPS/FASID Joint Graduate Program
7-22-1 Roppongi, Minato-ku
106-8677 Tokyo, Japan
Tel: (81-3) 5413-6035
Fax: (81-3) 5413-0016
E-mail: otsuka@grips.ac.jp

Mr. Fazle Hasan Abed
Founder and Executive Director
Bangladesh Rural Advancement Committee
BRAC Centre
75 Mohakhali, Dhaka 1212, Bangladesh
Tel: (880-2) 882-4180
Fax: (880-2) 882-3542
E-mail: abed.fh@brac.net

Dr. Achmad Mudzakkir Fagi
Senior Researcher
Indonesian Agency for Agricultural Research and Development
Ministry of Agriculture
Jalan Ragunan 29, Pasarminggu
Jakarta Selatan 12540, Indonesia
Tel: (62-21) 780-5395; 780-6202
Fax: (62-21) 780-0644
E-mail: amfagi@cbn.net.id

Dr. Ralph Anthony Fischer
Program Adviser, South Asia
Australian Centre for International Agricultural Research (ACIAR)
GPO Box 1571, Canberra ACT 2601
Australia
Tel: 02 6217 0500
Fax: 02 6217 0501
E-mail: fischer@aciar.gov.au

Dr. Eun-Jong Lee
Former Administrator
Rural Development Administration
Jugong Apt. 216-1302, 861 Jowon-dong
Suwon, 440-716, Republic of Korea
Tel: (82-31) 268-7086
Fax: (82-31) 253-8969
E-mail: eunjong41@yahoo.co.kr

Prof. Ruth K. Oniang'o
Member of Parliament
Founder, Rural Outreach Program and
Editor-in-Chief, African Journal of Food, Agriculture, Nutrition and Development
Shelter Afrique Center, Kilimanjaro Ave.
Off Mara Road, Upperhill
P. O. Box 29086-00625
Nairobi, Kenya
Tel: +254-20-2737989
Fax: +254-20-2734039
E-mail: oniango@iconnect.co.ke

Hon. Domingo F. Panganiban (ex officio)

Secretary
Department of Agriculture
Elliptical Road, Diliman
1100 Quezon City, Philippines
Tel: (63-2) 920-4323; 920-4358
Fax: (63-2) 929-8183; 928-5140
E-mail: sec_agri@da.gov.ph

Dr. Ronald L. Phillips

Regents Professor and
McKnight Presidential Chair in Genomics
Director, Center of Microbial and Plant Genomics
Department of Agronomy and Plant Genomics and Plant Molecular Genetics Institute
University of Minnesota
1991 Upper Buford Circle
St. Paul, MN 55108
USA
Tel: +1 612-625-1213
Fax: +1 612-625-1268
E-mail: phill005@umn.edu

Dr. Mangalai Rai

DARE Secretary and
Director General
Indian Council for Agricultural Research
Krishi Bhavan, New Delhi 110 001
India
Tel: (91-11) 2338-2629; 2338-6711
Fax: (91-11) 2584-3301
E-mail: mrai@icar.delhi.nic.in

Dr. Emerlinda R. Roman (ex officio)

President
University of the Philippines
Diliman, Quezon City, Philippines
Tel: (63-2) 928-3014; 928-0110
Fax: (63-2) 920-6882
E-mail: emerlinda.roman@up.edu.ph

Dr. Elizabeth J. Woods

Executive Director R&D Strategy
Department of Primary Industries and Fisheries
Primary Industries Building
80 Ann St., Brisbane, QLD
Post: GPO Box 46, Brisbane, Q 4001
Australia
Tel: +61 (0) 7 3239 0511
E-mail: beth.woods@dpi.qld.gov.au

Dr. Robert S. Zeigler (ex officio)

Director General
International Rice Research Institute
DAPO Box 7777
Metro Manila, Philippines
Tel: (63-2) 580-5600; (63-49) 536-2701 to 05
Fax: (63-2) 580-5699; 761-2404; 761-2406
E-mail: r.zeigler@cgiar.org

Prof. Baowen Zhang

Deputy Minister
Ministry of Agriculture
No. 11 Nongzhanguan Nanli
Beijing 100026
People's Republic of China
Tel: (86-10) 64192338
Fax: (86-10) 5600-1869
E-mail: bwz46111@sohu.com; bgt338@agri.gov.cn

Personnel (as of 31 December 2005)

Administrative staff

Robert S. Zeigler, *PhD, director general*[4]
William G. Padolina, *PhD, deputy director general for partnerships*
Ren Wang, *PhD, deputy director general for research*
Kwame O. Akuffo-Akoto, *CCA, treasurer and director for finance*
Michael T. Jackson, *PhD, director for program planning and coordination*
Ian M. Wallace, *MLS, director for administration and human resources*
Gerard F. Barry, *PhD, coordinator, Golden Rice Network*

Office of Administration and Human Resources

Tim Overett, *consultant*[3]
Robert Woodward, *consultant*[3]

Office of the Director for Program Planning and Coordination

John Leslie Maclean, *consultant*[4]
Alma Redillas-Dolot, *consultant*[3]
Gurgen Hagmann, *PhD, consultant*[3]

Agricultural Engineering

Joseph F. Rickman, *MS, senior scientist and head*
Martin Gummert, *BS, international research fellow*
Ricardo M. Hernandez, *BS, assistant manager I*
Paterno C. Borlagdan, *MS, assistant scientist*
Elenita C. Suñaz, *BS, officer - administrative coordination*
Rodolfo A. Angco, *officer - CADD*
Eugenio P. Aquino, *BS, researcher*
Eduardo L. Secretario, *technician III - research*
Romulo N. Aquino, *technician II - research*[6]

Crop, Soil, and Water Sciences

To Phuc Tuong, *PhD, water management engineer and head*
Bas A.M. Bouman, *PhD, senior scientist, water science*
Francois Affholder, *PhD, senior scientist, agronomy, IRS seconded from CIRAD, based in Vietnam*
Roland J. Buresh, *PhD, senior scientist, soil science, and leader, Enhancing Productivity and Sustainability of Favorable Environments Program*
Stephan M. Haefele, *PhD, scientist, soil science/agronomy*
Yasukazu Hosen, *PhD, scientist, soil science*
Abdelbagi M. Ismail, *PhD, senior scientist, plant physiology*
David E. Johnson, *PhD, senior scientist, weed science*
Jagdish K. Ladha, *PhD, senior scientist, soil science; coordinator, Rice-Wheat Consortium; and IRRI representative for India*
Tanguy Lafarge, *PhD, IRS seconded from CIRAD*
Renee Lafitte, *PhD, senior scientist, physiology and consultant*[1]
Bruce Linquist, *PhD, senior scientist, upland research specialist, Lao PDR*
Shaobing Peng, *PhD, senior scientist, crop physiology*
John E. Sheehy, *PhD, senior scientist, crop ecology/crop modeling*
Sarah E. Johnson, *PhD, postdoctoral fellow1, international research fellow, soil science*[4]
Christine Kreye, *PhD, international research fellow, agronomy*[4]
Matthias Wissuwa, *PhD, international research fellow*
Muthurajan Raveendran, *PhD, visiting research fellow*
Guoan Lu, *PhD, visiting research fellow*[4]
Jingsheng Zheng, *PhD, postdoctoral fellow*
Xiaochun Lu, *PhD, postdoctoral fellow*[4]
Yuka Sasaki, *PhD, postdoctoral fellow*[4]
Michael J. Thomson, *PhD, postdoctoral fellow*[4]
Georgina Vergara, *PhD, postdoctoral fellow*[4]
Liping Feng, *PhD, postdoctoral fellow*[1]
Ramasamy Rajendran, *PhD, postdoctoral fellow*[1]

Kyeong-Bo Lee, *PhD, visiting research fellow*[3]
Hong-Kyu Park, *PhD, visiting research fellow*[3]
Jianming Zeng, *PhD, collaborative research fellow*[3]
Peter Mitchell, *PhD, consultant*[3]
Len Wade, *PhD, consultant*[3]
Tom Preston, *PhD, consultant*[3]
Martin Mortimer, *PhD, consultant*[3]
Edgar F. Paski, *PhD, consultant*[3]
Charmian Sackville Hamilton, *PhD, consultant*[3]
Hendrika van Laar, *PhD, consultant*[3]
Surapong Sarkarung, *PhD, consultant*[3]
Md Abdul Ghani, *PhD, consultant*[1]
Romeo M. Visperas, *MS, senior associate scientist*
Lilia R. Molina, *BS, assistant manager II - ASL*
Serafin T. Amarante, *MS, associate scientist*
Helen Grace S. Centeno, *MS, associate scientist*
Evangelina S. Ella, *MS, associate scientist*
Joel D. Janiya, *MS, associate scientist*
Ma. Rebecca C. Laza, *MS, associate scientist*[2]
Ofelia S. Namuco, *MS, associate scientist*
Agnes T. Padre, *MS, associate scientist*[5]
Rolando O. Torres, *MS, associate scientist*
Rubenito M. Lampayan, *PhD, associate scientist*
Mirasol F. Pampolino, *PhD, associate scientist*[5]
Ma. Theresa L. Tenorio, *BS, assistant manager I - program coordination*
Ruvicyn S. Bayot, *MS, assistant manager I - program coordination*
Anaida B. Ferrer, *BS, assistant scientist*
Teodoro R. Migo, *BS, assistant scientist*
Joel D. Siopongco, *BS, assistant scientist*
Ma. Carmelita R. Alberto, *MS, assistant scientist*
Olivyn R. Angeles, *MS, assistant scientist*[5]
Anita A. Boling, *MS, assistant scientist*
Romeo J. Cabangon, *MS, assistant scientist*
Ambrocio R. Castañeda, *MS, assistant scientist*
Ernesto G. Castillo, *MS, assistant scientist*
Nelzo C. Ereful, *MS, assistant scientist*[5]
Jack Deodato C. Jacob, *BS, assistant scientist*[4]
Eufrocino V. Laureles, *MS, assistant scientist*
Tamerlane Mark S. Nas, *MS, assistant scientist*[7]
Paquito P. Pablico, *MS, assistant scientist*
Estela M. Pasuquin, *MS, assistant scientist*
Reynaldo C. Rodriguez, *MS, assistant scientist*
Marianne I. Samson, *MS, assistant scientist*[5]
Marnol V. Santos, *BS, specialist - instrument*
Elisa M. Tabaquero, *BS, officer - administrative coordination*
Ruben G. Chavez, *officer - ASL*
Feliciano R. Fagela, Jr., *BS, officer - database administration*[1]
Rexie Jane D. Parreno, *MS, officer-project coordination*[4]
Crisanta S. Bueno, *MS, researcher*
Teodoro Q. Correa, Jr., *BS, researcher*[4]
Glenn D. Dimayuga, *BS, researcher*
James A. Egdane, *BS, researcher*
Venus H. Elec, *BS, researcher*[4]
Jaime E. Faronilo, *MS, researcher*
Gloria D. Gamat, *BS, researcher*
Wenceslao M. Larazo, *BS, researcher*[5]
Lizzida P. Llorca, *BS, researcher*
Abigail E. Mabilangan, *BS, researcher*
Maria Carmela A. Ong, *BS, researcher*
Zenaida P. Pascual, *BS, researcher*
Corazon E. Bambase, *BS, secretary III*
Emma A. Fabian, *BS, secretary III*[4]
Elena G. Genil, *BS, secretary III*[1]
Lourdes A. Herrero, *BS, secretary III*
Florencia G. Junsay, *BS, secretary III*
Salvie F. Marinas, *BS, secretary III*[4]
Eva Corazon P. Reyes, *BS, secretary II*[5]
Rosalie L. San Antonio, *BS, secretary III*
Lolita L. Adriano, *secretary III*
Jacinta I. Evangelista, *secretary III*
Maximo N. Alumaga, *BS, technician III - research*
Aniceto B. Boncajes, *BS, technician III - research*
Mary Ann E. Burac, *BS, technician III - research*
Rene B. Carandang, *BS, technician III - research*
Ferdinand G. Corcuera, *BS, technician III - research*
Pedro N. Gapas, *BS, technician III - research*
Edsel T. Moscoso, *BS, technician III - research*[5]
Maximo L. Pelagio, *BS, technician III - research*
Jorge L. Alvarez, *technician III - research*
Edgar O. Amoloza, *technician III - research*
Emiliano M. Barcial, *technician III - research*
Jesus S. Belen, *technician III - research*
Lucio N. Caramihan, *technician III - research*
Teodoro M. Delgado, *technician III - research*
Nilo G. Driz, *technician III - research*
Ricardo L. Eugenio, *technician III - research*
Leonardo R. Holongbayan, *technician III - research*
Donato V. Lanwang, *technician III - research*
Lamberto V. Licardo, *technician III - research*
Anicio P. Macahia, *technician III - research*
Rufino D. Manuel, *technician III - research*
Ramon B. Masajo, *technician III - research*
Onofre A. Mendoza, *technician III - research*
Victor R. Micosa, *technician III - research*
Jerone R. Onoya, *technician III - research*
Rene M. Panopio, *technician III - research*
Enrique M. Reyes, *technician III - research*
Jose G. Rosales, *technician III - research*
Briccio C. Salisi, *technician III - research*
Gaudencio A. Sulit, *technician III - research*
Eduardo V. Tandang, *technician III - research*
Rochelle E. Zantua, *BS, technician III - research*[4]
Emma D. Quicho, *BS, data encoder*[4]
Katharine C. Ng, *BS, data encoder*[4]
Ireneo M. Gibas, *BS, secretary II*
Melencio. J. Apostol, *BS, technician II - research*[8]
Siena B. Calibo, *BS, technician II - research*

Rowena Z. Noblejas, *BS, technician II - research*[5]
Anthony T. Pulpulaan, *BS, technician II - research*[5]
Manolo S. Balanial, *technician II - research*
Angel M. Bautista, *technician II - research*[5]
Ricardo S. Catangay, *technician II - research*
Arturo L. Crisostomo, *technician II - research*[5]
Cesario B. De Mesa, Jr, *technician II - research*
Macario W. Del Valle, *technician II - research*
Leodegario O. Dela Rosa, *technician II - research*
Edwin P. Dizon, *technician II - research*
Roland N. Dizon, *technician II - research*[5]
Feriano T. Javier, *technician II - research*[5]
Rogelio T. Lapastora, Jr., *technician II - research*[5]
Victor H. Lubigan, *technician II - research*
Luis L. Malabayabas, *technician II - research*
Enrique F. Monserrat, *technician II - research*
Carmelito S. Oca, *technician II - research,*[5]
Sonny C. Pantoja, *technician II - research*[5]
Guido M. Ramos, *technician II - research*
Ariston V. Reyes, *technician II - research*[5]
Lino B. Tatad, *technician II - research*
Nicanor L. Turingan, *technician II - research*
Efren J. Turla, *technician II - research*
Osmundo C. Bondad, *technician I - research*
Isidro M. Tolentino, *technician I - research*

Entomology and Plant Pathology

Ren Wang, *PhD, acting head*
Twng W. Mew, *PhD, head and principal scientist*[1]*, consultant*[4]
Kong Luen Heong, *PhD, senior scientist, entomology/IPM specialist and deputy head*
Yolanda H. Chen, *PhD, scientist, entomology*
Il-Ryong Choi, *Ph D, scientist, plant virology*
Hei Leung, *PhD, senior scientist, plant pathology*
Georges Michel Reversat, *PhD, IRS seconded from Institut de recherche pour le développement (IRD)*
Casiana M. Vera Cruz, *PhD, senior scientist, plant pathology*
Grant Singleton, *PhD, coordinator, Irrigated Rice Research Consortium*[4]
Jan Leach, *PhD, adjunct scientist*
Jae-Hwan Roh, *PhD, visiting research fellow*[3]
Chitra Raghavan, *PhD, postdoctoral fellow*[4]
Young-Chang Cho, *PhD, visiting research fellow*[4]
Doh-Won Yun, *PhD, visiting research fellow*[4]
Shaohong Zhang, *MS, visiting research fellow*[1]
Bong-Choon Lee, *PhD, visiting research fellow*[3]
Chan-Won Park, *PhD, visiting research fellow*[3]
Mun-Sik Shin, *PhD, visiting research fellow*[3]
Ann Braun, *PhD, consultant*[3]
Greg Fanslow, *consultant*[4]
Chu Gia Thuy, *consultant*[3]
Jose Furtado, *consultant*[3]
Pepito Q. Cabauatan, *PhD, senior associate scientist*
Ma. Liberty P. Almazan, *BS, associate scientist*
Marietta R. Baraoidan, *MS, associate scientist*
Alicia A. Bordeos, *MS, associate scientist*
Rogelio C. Cabunagan, *MS, associate scientist*
Isabelita P. Oña, *MS, associate scientist*
Nancy P. Castilla, *PhD, associate scientist*
Luzviminda C. Fernandez, *BS, assistant scientist*
Carmencita C. Bernal, *MS, assistant scientist*
Josie Lynn A. Catindig, *MS, assistant scientist*
Angelita M. Romena, *MS, assistant scientist*
Edgardo L. Coloquio, *BS, researcher*
Jedeliza B. Ferrater, *MS, researcher*[4]
Ma. Reina Suzette B. Madamba, *BS, researcher*
Enrico Francisco L. Mercado, *BS, researcher*[4]
Jocelyn B. Pacia, *BS, researcher*
Ma. Ymber V. Reveche, *BS, researcher*
Veritas Morena R. Salazar, *BS, researcher*
Sylvia C. Villareal, *BS, researcher*
Nonnie P. Bunyi, *BS, secretary III*
Crisanta G. Culala, *BS, secretary III*
Cecilia L. Salonga, *BS, secretary III*
Panfilo T. Domingo, Jr., *BS, technician III - research*
Epifania F. Garcia, *BS, technician III - research*
Wilfredo M. Lanip, *BS, technician III - research*
Sergio G. Velasco, *BS, technician III - research*
Leonido M. Angeles, *technician III - research*
Esquirion A. Baguioso, *technician III - research*
Florencio R. Balenson, *technician III - research*
Maximino G. Banasihan, Jr., *technician III - research*
Conrado P. Bandian, *technician III - research*
Modesto A. Calica, *technician III - research*
Benedicto H. Consignado, *technician III - research*
Mario R. Izon, *technician III - research*
Flavio A. Maghirang, *technician III - research*
Eufrocino M. Pizarra, *technician III - research*
Alexander G. Ramos, *technician III - research*
Pedro F. Reaño, *technician III - research*
Errol T. Rico, *technician III - research*
Elenita T. Silab, *technician III - research*
Danilo D. Vasquez, *technician III - research*
Rodante R. Abas, *technician II - research*
Ruben C. Abuyo, *technician II - research*
Romulo N. Aquino, *technician II - research*
Ernesto M. Camangon, *technician II - research*[5]
Deomedes M. Dizon, *technician II - research*
Leovino B. Matundan, *technician II - research*
Alberto I. Naredo, *technician II - research*
Reyuel C. Quintana, *technician II - research*
Juan B. Reyes, *technician II - research*
Noel S. Salac, *technician II - research*
Antonio M. Salamatin, *technician II - research*
Noel L. Sosa, *secretary I*

Plant Breeding, Genetics, and Biotechnology

Headquarters-based

David J. Mackill, *PhD, head and leader, Genetic Resources Conservation, Evaluation, and Gene Discovery*
Sant Singh Virmani, *PhD, principal scientist, plant breeding and deputy head;[1] consultant[4]*
Gary Atlin, *PhD, senior scientist, plant breeding*
John Bennett, *PhD, senior scientist, molecular biology*
Darshan S. Brar, *PhD, senior scientist, plant breeding*
Karabi Datta, *PhD, senior scientist, plant biotechnology[1]*
Swapan K. Datta, *PhD, senior scientist, plant biotechnology[1]*
Philippe Herve, *PhD, scientist, molecular biology[4]*
Sigrid Heuer, *PhD, scientist, molecular biology and consultant[4]*
Glenn B. Gregorio, *PhD, scientist, plant breeding, consultant[3]*
Hung-Goo Hwang, *PhD, senior scientist, IRS seconded from RDA*
Edwin L. Javier, *PhD, senior scientist, plant breeding and coordinator, INGER*
Ho-Yeong Kim, *PhD, senior scientist, IRS seconded from RDA-Korea[1]*
Kshirod Kumar Jena, *PhD, senior scientist, plant breeding and IRRI representative for Korea*
Nobuya Kobayashi, *PhD, scientist, plant breeding[4]*
Zhikang Li, *PhD, senior scientist, molecular geneticist and coordinator, International Network for Molecular Breeding*
Parminder S. Virk, *PhD, senior scientist, plant breeding*
Fangming Xie, *PhD, senior scientist, hybrid rice breeder[4]*
Gregory J. Howell, *PhD, international research fellow, plant physiology[4]*
Rakesh K. Singh, *PhD, international research fellow, plant breeding[4]*
Bertrand Collard, *PhD, postdoctoral fellow[4]*
Aparna Das, *PhD, postdoctoral fellow[4]*
Xuemei Ji, *PhD, postdoctoral fellow[4]*
Endang Septiningsih, *PhD, postdoctoral fellow[4]*
Boonrat Jongdee, *PhD, postdoctoral fellow[1]*
C.N. Neeraja, *PhD, postdoctoral fellow[1]*
Devendra Dwivedi, *PhD, postdoctoral fellow[1]*
Ramaiah Venuprasad, *PhD, postdoctoral fellow[1]*
Arvind Kumar, *PhD, postdoctoral fellow[1]*
Eufemio Rasco, *PhD, visiting research fellow[4]*
Jeom-Ho Lee, *PhD, visiting research fellow[4]*
Yongming Gao, *PhD, visiting research fellow[4]*
Yong-Hee Jeon, *PhD, visiting research fellow[4]*
Jin-Il Choung, *PhD, visiting research fellow[4]*
Kyu-Seong Lee, *PhD, visiting research fellow[4]*
O-Young Jeong, *PhD, visiting research fellow[4]*
Jianlong Xu, *PhD, visiting research fellow[3]*
Suk-Young Hong, *PhD, visiting research fellow[3]*
Taek-Ryoun Kwon, *PhD, visiting research fellow[3]*
Gi-Hwan Yi, *PhD, visiting research fellow[3]*
Woon-Goo Ha, *PhD, visiting research fellow[3]*
Do-Yeon Kwak, *PhD, visiting research fellow[3]*
Kim-Ki Yong, *PhD, visiting research fellow[3]*
Shailaja Hittalmani, *PhD, visiting scientist[3]*
Sellapan Krishnan, *PhD, visiting research fellow[1]*
Mayank Rai, *MS, visiting research fellow[1]*
Barbara Reinhold-Hurek, *PhD, collaborative research scientist[3]*
Jong-Cheol Ko, *PhD, collaborative research fellow[4]*
Mirza Islam, *PhD, collaborative research fellow[3]*
Jonathan Niones, *PhD, collaborative research fellow[3]*
You-Chun Song, *PhD, collaborative research fellow[1]*
Samjhana Shrestha, *PhD, consultant[3]*
Tomas Masajo, *PhD, consultant[3]*
Yoshimichi Fukuta, *PhD, consultant[3]*
Edilberto Redona, *PhD, consultant[3]*
B.C. Viraktamath, *PhD, consultant[3]*
Ilyas Ahmed, *PhD, consultant[3]*
Alma Sanchez, *PhD, consultant[1]*
Girish Chandel, *MS, consultant[1]*
Marichu A. Bernardo, *MS, manager*
Antonio A. Evangelista, *BS, associate scientist*
Alvaro M. Pamplona, *BS, associate scientist*
Ma. Concepcion U. Toledo, *BS, associate scientist*
Vitaliano L. Lopena, *MS, associate scientist*
Benito U. Romena, *MS, associate scientist*
Rodolfo S. Toledo, *MS, associate scientist*
Lina B. Torrizo, *MS, associate scientist*
Editha M. Abrigo, *BS, assistant scientist*
Carlos L. Casal, Jr., *BS, assistant scientist*
Julio Romeo T. Chavez, *BS, assistant scientist[5]*
Marcelino A. Laza, *BS, assistant scientist*
Rhulyx D. Mendoza, *BS, assistant scientist*
Rowena H. Oane, *BS, assistant scientist*
Reycel M. Rodriguez, *BS, assistant scientist*
Ellen T. Raiz, *MS, assistant scientist[2]*
Mary Jeanie T. Yanoria, *BS, assistant scientist[5]*
Dante L. Adorada, *MS, assistant scientist[5]*
Modesto M. Amante, *MS, assistant scientist*
Leodegario A. Ebron, *MS, assistant scientist[5]*
Rogelio D. Magbanua, *MS, assistant scientist[5]*
Norman P. Oliva, *MS, assistant scientist*
Jessica D. Rey, *MS, assistant scientist*
Ellen B. Tumimbang, *MS, assistant scientist[5]*
Grace Lee S. Capilit, *MS, specialist - database administration*
Elma N. Nicolas, *BS, officer - administrative coordination*
Franco G. Nazareno, *BS, officer - database administration[4]*
Edwin R. Abucay, *BS, researcher[3]*
Glenn Patrick M. Alejar, *BS, researcher[4]*
Leonard M. Gaspar, *BS, researcher[4]*
Mary Ann S. Inabangan, *BS, researcher[4]*
Joie M. Ramos, *BS, researcher*
Darlene L. Sanchez, *BS, researcher[5]*
Rizza Eve M. Santos, *BS, researcher[5]*
Dinah D. Tambalo, *BS, researcher*
Justina M. De Palma, *MS, researcher[5]*
Jose Kenneth C. Yap, *BS, researcher[4]*
Marlon A. Calibo, *BS, associate - stock inventory[5]*
Yolanda C. Aranguren, *BS, secretary III*
Minerva B. Bandian, *BS, secretary III*
Felicidad S. Danglay, *BS, secretary III*

Nelie M. Delos Reyes, *BS, secretary III*
Leonida P. Nazarea, *BS, secretary III*
Jose L. Angeles, *BS, technician III - research*
Ma. Emeru L. Bool, *BS, technician III - research*[5]
Socorro L. Carandang, *BS, technician III - research*
Rollin V. Deocampo, *BS, technician III - research*[5]
Norberto T. Quilloy, *BS, technician III - research*
Virgilio T. Ancheta, Jr., *technician III - research*
Danilo B. Balagtas, *technician III - research*
Danilo C. De Ocampo, *technician III - research*
Blesilda A. Enriquez, *technician III - research*
Leonardo S. Estenor, *technician III - research*
Angelito S. Francisco, *technician III - research*
Reynaldo (Abdullah) P. Garcia, *technician III - research*
Evelyn A. Liwanag, *technician III - research*[5]
Virgilio P. Magat, *technician III - research*
Eleazar O. Manalaysay, *technician III - research*[5]
Norberto T. Quilloy, *BS, technician III – research*[4]
Nestor D. Ramos, *technician III - research*
Ernesto C. Sumague, *technician III - research*
Lorelie S. Olivo, *BS, secretary II*[5]
Emily P. Alcantara, *secretary I*[5]
Michelle V. Racelis, *secretary II*[5]
Marilyn A. Rala, *secretary II*
Victor P. Banasihan, *BS, technician II - research*[5]
Ma. Gina L. Borja, *BS, technician II - research*[5]
Cheryl O. Dalid, *BS, technician II - research*[4]
Cenon L. Lanao, *BS, technician II - research*[9]
Tala MacLaren C. Fugen, *BS, technician II - research*[4]
Virginia M. Laluz, *BS, technician II - research*[5]
Ma. Concepsion F. Lotho, *BS, technician II - research*[7]
April Joy P. Madrigal, *BS, technician II - research*[5]
Lolita C. Mendoza, *BS, technician II - research*[5]
Florencia A. Montecillo, *BS, technician II - research*[5]
Emmanuel R. Adique, *technician II - research*[5]
Virgilio M. Angeles, *technician II - research*
Renel C. Aventurado, *technician II - research*[5]
Joselito M. Calibo, *technician II - research*[5]
Luisito L. Caracuel, *technician II - research*
Patricio M. Carandang, *technician II - research*[5]
Ronaldo L. Cornista, *technician II - research*
Reynaldo J. Dela Cueva, *technician II - research*
Mario A. Garcia, *technician II - research*
Oscar A. Gonzales, *technician II - research*
Francisco V. Gulay, *technician II - research*
Rommel V. Javier, *technician II - research*[5]
Nestor P. Leron, *technician II - research*
Noel P. Llanza, *technician II - research*[5]
Orlando T. Lucero, *technician II - research*
Joel T. Macabenta, *technician II - research*[5]
Carmela D. Malabanan, *technician II - research*[5]
Apolonio N. Mamiit, *technician II - research*[5]
Alejandro C. Manio, *technician II - research*
Marina C. Manzanilla, *technician II - research*[5]
Jose M. Marasigan, *technician II - research*
Josefina G. Mendoza, *technician II - research*
Arsenio R. Morales, *technician II - research*
Honorio M. Oboza, *technician II - research*
Daniel L. Pasuquin, *technician II - research*
Juanito M. Pasuquin, *technician II – research*[1]
Godofredo B. Perez, *technician II - research*[5]
Macario S. Perez, Sr., *technician II - research*
Renato T. Pizon, Sr., *technician II - research*
Juvy G. Reyes, *technician II - research*[5]
Allan P. Salabsabin, *BS, technician II - research*[4]
Eloisa B. Suiton, *technician II - research*[5]
Julito P. Talay, *technician II - research*
Irma R. Tamisin, *technician II - research*[5]
Allan P. Trinidad, *technician II - research*[5]
Cenon P. Alvarez, *technician I - research*[4,5]
Paul Benny P. Malabanan, *technician I - research*[4]
Rodante M. Nuevo, *technician I - research*[5]
Marcial C. Panting, *technician I – research*[4]
Janice A. Sapin, *technician I – research*
Evangeline A. Angeles, *attendant – seed inventory*[4]

Country-based

Thailand
Dome Harnpichitvitaya, *MS, assistant scientist II*[5]
Chaiporn Soising, *field technician*
Pramote Tanupant, *BS, field technician*

Social Sciences

Mahabub Hossain, *PhD, economist and head; leader, Improving Productivity and Livelihood for Fragile Environments Program*
Sushil Pandey, *PhD, senior scientist, agricultural economics and deputy head; leader, Strengthening Linkages Between Research and Development Program*
Robert J. Hijmans, *PhD, GIS specialist*[4]
Thelma R. Paris, *PhD, senior scientist, gender specialist*
Deborah J. Templeton, *PhD, scientist, social science/economics*[4]
Kumi Yasunobu, *PhD, IRS seconded from JIRCAS*[4]
Mohammed Zainul Abedin, *PhD, international research fellow*[1]
Nobuhiko Fuwa, *PhD, international research fellow*[1]
Humnath Bhandari, *PhD, postdoctoral fellow*[1]*; visiting research fellow*[4]
Gyung-Mee Gim, *PhD, visiting research fellow*[3]
Satish Kedia, *PhD, visiting research fellow*[3]
Stephen Zolvinski, *PhD, postdoctoral fellow*[1]
Josyline Javelosa, *MS, visiting research fellow*[1]
Jin-Young Lee, *collaborative research fellow*[3]
Yoon-Ji Choi, *collaborative research fellow*[3]
Shahbaz Mushtaq, *PhD, consultant*[4]
Yolanda Garcia, *PhD, consultant*[3]
Nigar Nargis, *PhD, consultant*[3]
W.H. Jaim, *consultant*[3]
Marlar Oo, *consultant*[3]

Ferdousi Naher, *PhD, consultant*[3]
Bhuban Barah, *PhD, visiting research fellow*[1]
Piedad F. Moya, *MS, senior associate scientist*
Fe B. Gascon, *BS, associate scientist*[5]
Arnel B. Rala, *BS, associate scientist*
Amelia S. Delos Reyes, *MS, associate scientist*[5]
Catalina P. Diaz, *MS, associate scientist*
Lolita L. Garcia, *MS, associate scientist*[5]
Zenaida M. Huelgas, *PhD, associate scientist*[4]
Imelda R. Molina, *MS, associate scientist*
Florencia G. Palis, *PhD, associate scientist*
Vina L. Alvarez, *MS, assistant manager I - program coordination*
Joyce S. Luis, *BS, assistant scientist*
Alice G. Laborte, *MS, assistant scientist*
Aileen V. Lapitan, *MS, assistant scientist*
Maria Lourdes E. Velasco, *MS, assistant scientist*
Sidky M. Macatangay, *BS, systems analyst/programmer*
Mirla D. Domingo, *BS, officer - administrative coordination*
Josephine H. Narciso, *BS, officer - database administration*
Ma. Romilee L. Bool, *BS, researcher*[5]
Ellanie R. Cabrera, *BS, researcher*[5]
Pio Adan A. Cenas, *BS, researcher*
Rica Joy B. Flor, *BS, researcher*[4]
Esther B. Marciano, *BS, researcher*
Aileen A. Maunahan, *BS, researcher*
Gerlie O. Toque, *BS, researcher*[4]
Ma. Shiela D. Valencia, *BS, researcher*
Lorena S. Villano, *BS, researcher*
Ma. Aleli Sharon D. Fajardo, *MS, researcher*[1]
Cornelia A. Garcia, *BS, associate - graphics*
Joel E. Reaño, *BS, associate - statistics*
Lydia B. Damian, *BS, secretary III*
Rosendo G. Gutierrez, *BS, secretary III*
Angelina A. Malabrigo, *BS, secretary III*
Teodora D. Malabanan, *BS, assistant - statistics*
Aladin B. Poblete, *BS, assistant - statistics*[4]
Frederick C. Lagasca, *assistant - statistics*
Anna Christine A. Doctolero, *BS, secretary II*
Jocelyn L. Go, *BS, secretary II*

Experiment Station

Arnold R. Manza, *MS, senior manager*
Tomas P. Clemeno, *BS, manager*
Bienvenido B. Manimtim, *BS, assistant manager I*
Roberto P. Escandor, *BS, officer*
Mario A. Mandilag, *senior officer*
Erlinda A. Oracion, *MS, officer - administrative coordination*
Roslen S. Anacleto, *MS, programmer*[4]
Sheila Sophia N. Roy, *BS, programmer*[1]
Rolando R. Pacion, *associate - stock inventory*
Virginia G. Aranda, *BS, secretary III*
Enrico A. Lucero, *secretary III*
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*
Abraham G. Dalid, *BS, technician III - research*
Jose D. Manuel, *BS, technician III - research*
Benedicto S. Alborida, *technician III - research*[5]
Jesse C. Banasihan, *technician III - research*
Sulpicio J. Malabanan, *technician III - research*
Nazario B. Timbol, *technician III - research*
Celso L. Varron, *technician III - research*
Romeo T. Llamas, *technician III - Welding*
Marcelino O. Magpantay, *research technician II*[1]
Cecilio L. Villamayor, *secretary II*
Delfin M. Ilagan, *technician II - equipment*
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. Bandoy, *technician II - research*
Policarpio S. Barbadillo, *technician II - research*
Rogelio V. Bargola, *technician II - research*
Daniel A. Barrion, *technician II – research*[10]
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*
Vicente E. Carandang, *technician II - research*
Lino M. 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*
Gaudencio S. Indico, *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*
Godofredo M. Mercado, *technician II - research*
Andres 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*[4]

Seed Health Unit

Patria G. Gonzales, *MS, associate scientist*
Janice Q. Bautista, *BS, assistant scientist*
Carlos C. Huelma, *BS, assistant scientist*
Evangeline G. Gonzales, *BS, secretary III*
Atanacio B. Orence, *technician III - research*
Isabel L. Penales, *technician III - research*
Salome P. Bulaquiña, *data encoder*
Florencio I. Lapiz, *BS, technician II - research*
Aurelio A. Gamba, *technician II - research*
Jay A. Angeles, *BS, technician I - research*[4]
Jose F. Banasihan, *technician I - research*

Biometrics and Bioinformatics

Christopher Graham McLaren, *PhD, senior scientist, biometrics specialist and head*
Richard Bruskiewich, *PhD, senior scientist, bioinformatics specialist*
Thomas Metz, *PhD, international research fellow, research informatics*
Ravindra Babu, *MS, visiting research fellow*[1]
Martin Senger, *consultant*[4]
Alexander B. Cosico, *BS, associate scientist*
Arllet M. Portugal, *MS, associate scientist*
Gloria D. Reyes, *PhD, associate scientist*[5]
Victor Jun M. Ulat, *MS, associate scientist*
Violeta I. Bartolome, *MOS, senior specialist, statistics - consulting and training*
Timothy Nino S. Travers, *BS, assistant scientist*[4]
Emily C. Deomano, *MS, assistant scientist*
May Ann B. Sallan, *BS, specialist - database administration*
Myla Rystie U. Anacleto, *BS, programmer*[4]
Archie Roland G. Llorca, *BS, programmer*[4]
Warren Vincent E. Constantino, *BS, systems analyst/programmer*[5]
Michael Jonathan M. Mendoza, *MS, systems analyst/programmer*[5]
Clarissa I. Pimentel, *BS, systems analyst/programmer*[5]
Lilibeth M. Sison, *BS, systems analyst/programmer*[5]
Ma. Teresa R. Ulat, *BS, systems analyst/programmer*[5]
Rowena F. Valerio, *BS, systems analyst/programmer*[4]
Lourdes C. Paunlagui, *BS, officer - administrative coordination*
William H. Eusebio, *officer - database administration*
Don L. Pabale, MS, *officer - database admimnistration*[4]

Genetic Resources Center

Nigel Ruaraidh Sackville Hamilton, *PhD, senior scientist, evolutionary biology and head*
Kenneth L. McNally, *PhD, senior scientist, molecular genetics/ molecular taxonomy*
Isaiah N. Mukema, *MS, international research fellow, GIS specialist*
Byung-Ohg Ahn, *visiting research fellow*[3]
Kyung-Ho Ma, *collaborative research fellow*[3]
Jatinder Kaur, *PhD, consultant*[1]
A. Jakir Hussain, *PhD, consultant*[1]
Flora C. de Guzman, *MS, senior associate scientist*
Renato A. Reaño, *MS, associate scientist*
Ma. Socorro R. Almazan, *BS, assistant scientist*
Maria Celeste N. Banaticla, *MS, assistant scientist*[5]
Amita B. Juliano, *BS, assistant scientist*[10]
Rhodesia C. Manzano, *MS, assistant scientist*[4]
Ma. Elizabeth B. Naredo, *BS, assistant scientist*
Adelaida P. Alcantara, *BS, specialist - database administration*
Roniela Q. Herrera, *BS, specialist - database administration*[5]
Sheila Mae E. Quilloy, *BS, researcher*[5]
Ma. Corina D. Habito, *BS, programmer*[4]
Teresita C. Santos, *BS, secretary III*
Genelou A. Atienza, *BS, technician III - research*[4]
Jeffrey A. Detras, *BS, technician III - research*[5]
Nelia A. Resurreccion, *BS, technician III - research*
Bernardino T. Almazan, *technician III - research*
Vicente M. Arcillas, *technician III - research*
Emerlinda E. Hernandez, *technician III - research*
Vanica R. Lacorte, *BS, technician III - research*[4]
Felix R. Llanes, *technician III - research*
Minerva I. Macatangay, *technician III - research*
Bernardo P. Mercado, *technician III - research*
Gregorio M. Mercado, *technician III - research*
Merlyn C. Redondo, *BS, technician III - research*[4]
Mario A. Rodriguez, *technician III - research*
Maricris L. Zaidem, *BS, technician III – research*[4]
Melencio R. Lalap, *assistant*
Melencio J. Apostol, *BS, technician II - research*[5]
Ma. Concepcion F. Lotho, *BS, technician II - research*[5]
Remegio L. Aguilar, *technician II - research*
Noel R. Banzuela, *technician II - research*
Jeffe O. Cadion, *BS, technician II - research*[5]
Leanilyn O. Castanar, *BS, technician II - research*[5]
Belinda R. Caspillo, *technician II - research*[5]
Lyruth S. Domagsang, *BS, technician II - research*[4]
Arnold B. Gonzales, *technician II - research*
Romulo R. Quilantang, *technician II - research*[5]
Florencio F. Villegas, *technician II - research*
Jenniffer P. Eleuterio, *BS, assistant - database administration*[4]

Lydia G. Angeles, *BS, technician I - research*
Alicia A. Lapis, *BS, technician I - research*
Marynel V. Malabanan, *BS, technician I - research*[5]
Yolanda P. Malatag, *BS, technician I - research*
Rancy M. Bauyon, *technician I - research*[5]
Liza Q. Berces, *technician I - research*[5]
Imelda P. Boncajes, *technician I - research*
Nerissa L. Boongaling, *technician I - research*[5]
Jane D. Carandang, *technician I - research*[5]
Rosa B. Carandang, *technician I - research*[5]
Isabelita P. De Mesa, *technician I - research*
Hipolito M. Elec, *technician I - research*[5]
Minerva N. Eloria, *technician I - research*
Minerva C. Gulde, *technician I - research*[5]
Edwin H. Jarabejo, *technician I – research*[4]
Nora M. Kuroda, *BS, technician I - research*[4]
Wilma L. Lumaybay, *technician I - research*
Gilbert G. Mamiit, *technician I - research*[5]
Emmanuel T. Manaig, *technician I - research*[4]
Veronica V. Mangubat, *technician I - research*
Violeta T. Manila, *technician I - research*[5]
Mae C. Merluza, *technician I - research*[5]
Rhodora M. Pamplona, *technician I - research*[5]
Nenita T. Penales, *technician I - research*[5]
Alicia B. Perez, *technician I - research*[4]
Jacqueline M. Ragudo, *technician I - research*
Maridee P. Reyes, *technician I - research*
Liza B. Yonzon, *technician I - research*

Grain Quality and Nutrition Research Center

Melissa A. Fitzgerald, *PhD, international research fellow*
Adoracion P. Resurreccion, *MS, associate scientist*
Rosario R. Jimenez, *BS, assistant scientist*
Vito M. Butardo, Jr., *BS, researcher*
Mariafe P. Navarro, *MS, researcher*[4]
Rosa Paula O. Cuevas, *BS, accountant*[1]
Inofra I. Sandoval, *BS, technician III - research*
Artemio V. Madrid, Jr., *technician III - research*
Ana Lyn J. Genil, *BS, secretary II*
Juan L. Alzona, *technician II - research*
Teodoro L. Atienza, *technician II - research*

Communication and Publications Services

Gene Hettel, MA, *editor and head*
Bill Hardy, *PhD, science editor/publisher*
Adam Barclay, *Grad Dip Science, international research fellow*[4]
Danielle Marechal, *consultant*[4]
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*
Victor L. Alarcon, *BS, specialist - multimedia/web development*
Ginalyn H. Santos, *BS, specialist - multimedia/web development*
Maria Guadalupe B. Yandoc, *BS, specialist - technical writing*
Antonette Abigail E. Caballero, *MS, officer - administrative coordination*
Christina G. Peralta, *BS, officer - fulfillment & customer relations coordination*
Ariel D. Javellana, *BS, officer - photography*
Jose M. Ibabao, *officer - video Production*
Emmanuel A. Panisales, *BS, associate - graphics design*
George R. Reyes, *BS, associate - graphics design*
Juan V. Lazaro, IV, *associate - graphics design*
Aileen D. Rondilla, *BS, associate - photography*[1]
Jose Raymond D. Panaligan, *associate - photography/video*[4]
Rogelio R. Quintos, *BS, secretary III*
Diadema I. Martinez, *BS, assistant - editorial*
Reynaldo L. Stevens, *printer*
Cynthia C. Quintos, *BS, secretary II*

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 development*
Natalia V. Delos Reyes, *BS, librarian - electronic resources & serials*
Maria Consuelo S. Parducho, *associate*
Maria Aisa M. Atienza, *BS, assistant - library*[1]
Jonnel G. de Jesus, *BS, assistant - library*[4]
Marilyn O. Bonador, *BS, assistant*
Emmanuel P. Mendoza, *BS, assistant*
Corvette M. Apolinario, *assistant*
Isagani P. Garcia, *assistant*
Francisco A. Jaraplasan, *assistant*
Mauro T. Malabrigo, Jr., *assistant*

Intellectual Property Management Unit

Gerard F. Barry, *PhD, head*

Information Technology Services

Paul O'Nolan, *MS, IT manager*
Alma Redillas-Dolot, *consultant*[4]
Tim Overett, *consultant*[4]
Rogelio P. Alvarez, Jr., *BS, manager*
Wilbert Jay C. Almoro, *BS, assistant manager II*
Loreto R. Puyod, *BS, assistant manager II*
Eric B. Clutario, *BS, assistant manager II - MIS*
Lino Roy M. Suarez, *BS, assistant manager II*[4]
Nestor D. Marcelo, Jr., *BS, assistant manager I - MIS*
Faiga A. Amping, *BS, systems analyst/programmer*
Sheila C. Verdan, *BS, systems analyst/programmer*[1]
Ildefonso B. Cosico, *BS, officer - systems administration*
Annaliza R. Ramos, *BS, secretary III*
Nevado M. Ignacio, *BS, technician III - IT*
Bonifacio C. De Ocampo, *technician III - IT*

Jesus S. Fugen, *technician III - IT*
Bayani N. Perido, *technician III - IT*
Jovy P. Gador, *BS, assistant - telecoms*
Arminda B. Laluz, *BS, assistant - telecoms*
Rizza A. Escondo, *BS, secretary II*

Visitors and Information Services

Duncan I. Macintosh, *BA, head*
Tim Overett, *consultant*[3]
Robert Hill, *consultant*[3]
Adam Barclay, *consultant*[1]
Maria Charina Asuncion G. Ocampo, *BA, BL, manager - community relations*
Bita S. Avendaño, *MS, assistant manager I*
Paul Benjamin R. Hilario, *BS, assistant manager I - riceworld*
Juanito F. Goloyugo, *MS, specialist - information service*
Zorayda T. Menguito, *BS, associate*
Joselito A. Platon, *BS, associate - community project*
Arvin A. Benavente, *BS, officer - audio/visual*
Ria Anna B. Dimapilis, *BS, associate - visitors*[4]
Chrisanto G. Quintana, *assistant - information service*[4]
Al A. Benavente, *assistant - information service*[1]
Harris L. Tumawis, , *assistant - riceworld*

Training Center

Mark A. Bell, *PhD, head*[1]
David Shires, *MEd, international research fellow*
Eugenio C. Castro, Jr., *MS, associate scientist*
Maria Angeli G. Maghuyop, *MS, specialist - training*
Gina E. Zarsadias, *MS, assistant manager I*
Maria Socorro S. Arboleda, *BS, officer*
Eric John F. Azucena, *BS, officer*[1]
Lauro M. Atienza, *BS, officer-training*
Ma. Teresa A. Clabita, *BS, officer*
Dennis Ian L. Gavino, *BS, officer*[1]
Sergio R. Magadia, *BS, officer*
Imee L. Aspiras, *BS, officer - administrative coordination*
Melanie M. Quinto, *secretary III*
Macario B. Montecillo, *assistant - training logistics*
Priscilla P. Comia, *BS, secretary II*
Jennifer D. Hernandez, *BS, secretary II*[5]

International Programs Management Office

Headquarters-based

Mark A. Bell, *PhD, head,*[1] *consultant*[3]
Vethaiya Balasubramanian, *PhD, senior scientist, agronomy and IRRI Africa coordinator*
Monina M. Escalada, *PhD, international research fellow, development communication*
Phil Gibson, *consultant*[1]
Yoke Sau Cheng Metz, *consultant*[4]
Jan Orsini, *consultant*[4]
Ngo The Dan, *PhD, consultant*[4]
Julian A. Lapitan, *MS, senior manager*
Ma. Angeles M. Quilloy, *BS, associate scientist*
Margaret Ann S. Jingco, *BS, officer - administrative coordination*
Cecilia V. Lopez, *BS, officer - administrative coordination*
Edna R. Reyes, *secretary III*

Country-based

Bangladesh
Noel P. Magor, *PhD, IRRI representative for Bangladesh and manager, EC-supported project*
M.A. Hamid Miah, *PhD, liaison scientist for Bangladesh*
Ahmad Salahuddin, *manager, coordination and capacity development*[5]
Mamunul Haque, *assistant manager II, communication*[5]
Alam M. Murshedul, *PhD, assistant manager - project research*[4]
Khandakar Enamul Kabir, *administrative coordinator*
Shaila Arifa Nabi, *MS, researcher*[5]
Tahmina Banu, *MS, accountant I*
A. S. M. Zahiruddin, *accountant I*[5]
Shahjadi Parvin, *MA, secretary II*[5]
Fauzia Sultana, *MA, secretary II*[1]
Shamima Sultana, *MA, secretary II*[5]
Md. Ahsanullah, *motor transport operator*[5]
Babul Das, *motor transport operator*[1]
Nuruzzaman Badal, *motor transport operator*[5]
Jopinath Bazi, *motor transport operator*[5]
Anthony Sarder, *motor vehicle operator*
Alimullah, *guard*[5]
Fazlu Miah, *guard*[5]
Ruhul Amin, *office attendant*[5]
S. M. Suzat, *office attendant*[5]

Cambodia
Marie Kim Leng, *BS, administrative coordinator*

China
Kai-Jun Zhao, *PhD, IRRI liaison scientist for China*
Zhongqiu Wang, *BA, administrative coordinator*
Yonghong Sun, *BA, secretary/cashier*[4]

India
Jagdish K. Ladha, *PhD, IRRI representative for India*
Sivaprasad Bandarupalli, *PhD, associate scientist*
Gopal Krishna Agarwal, *CA, officer - administrative coordination*[4]
Jamal Pervez Noor, *BCom, finance and administrative officer*[1]
Ayodhya Lodhi, *driver/utilityman*
Vinod Kumar Singh, *driver/utilityman*[1]
William Samuel, *driver cum utility assistant*[4]
Chander Mohan, *BCom, office clerk/messenger*[1]
Savita Sharma, *BA, steno-typist*
Anurudh Singh, *assistant - housekeeping*[4]
Prempal, *assistant - housekeeping*[4]

Indonesia

Mahyuddin Syam, *MPS, liaison scientist for Indonesia/Malaysia/ Brunei Darussalam*
Iwan Adidharmawan, *BS, accounting supervisor*
Bambang Soewilanto, *BS, administrative coordinator*
Juanita Bawolye, *BA, executive secretary*
Diah Wurjandari Soegondo, *researcher*
I Made Agus Mahardhika, *driver*[5]

Korea

Ji-Ung Jeung, *PhD, senior research scientist*[5]
Seung-Hee Han, *BS, administrative coordinator*[5]

Lao PDR

Gary C. Jahn, *PhD, coordinator for the Greater Mekong Subregion; IRRI representative and Lao-IRRI project manager; senior scientist, entomology*
Bouachanh Keopha, *administrator*[5]
Ounheuane Phouthachit, *administrator/accountant*[1]
Vilayvanh Sihabouth, *administrator/accountant*[4]
Thiphavong Boupha, *PhD, economist and translator*[5]
Thany Keovongvichith, *BA, English language translator*[5]
Sansai Samountry, *accountant*[5]
Sone Mosky, *BS, training officer*[5]
Khampay Onesanga, *driver*[5]
Bounmy Sengthong, *driver-general services*[5]
Kham Souk Mosky, *driver-general services*[5]
Khamchanh Joutdala, *guard*[5]
Chanh Sommaniphone, *guard*[5]
Oudone Srithirath, *guard*[5]
Samien Luanglath, *guard/cleaner*[5]

Myanmar

U Ba Hein, AEE, *assistant scientist/assistant manager*[4]
Ohnmar Tun, *BAg, administrative coordinator*
Nanda Soe Myint, *driver/office aide*

Nepal

Bhaba Prasad Tripathi, *PhD, assistant manager/assistant scientist*[4]

Pakistan

Riaz Mann, *PhD, manager - project research*[3]

Thailand

Dome Harnpichitvitaya, *MS, assistant scientist II*[1]
Apinporn Phuengwattanapanich, *MS, administrative coordinator*
Punjama Tasana, *BA, senior accountant*
Chaiporn soising, *BS, field technician*[1]
Pramote Tanupant, *BS, field technician*[1]
Amporn Sookyong, *office assistant*
Vitchu Chowanapong, *BS, office clerk*

Vietnam

Nguyen Thu Ha, *BS, accountant*[4]
Nguyen Thanh Huyen, *BS, administrative coordinator*
Nguyen Van Khang, driver[4]

Director General's Office

Sylvia R. Arellano, *BS, executive assistant II*
Rosalinda D. Del Rosario, *BS, executive secretary*

Office of the Deputy Director General for Research

Adonna M. Robles, *MS, executive assistant I*
Lucia V. Gamel, *BS, executive secretary*
Ma. Velinda E. Hernandez, *BS, secretary II*

Office of the Deputy Director General for Partnerships

Ramon A. Oliveros, *MS, executive assistant I*
Rosalie P. Trinidad, *BS, executive secretary*
Frances Florifel B. Tesoro, *BS, secretary III*

Office of the Director for Program Planning and Coordination

Corinta Q. Guerta, *MS, manager*
Ma. Sol V. Ogatis, *BS, assistant manager I*
Zenaida M. Federico, *BS, executive secretary*

Finance

Melba M. Aquino, *BS, senior manager*
Loriza E. Dagdag, *BS, senior manager*
Elisa S. Panes, *BS, senior. manager*
Ma. Donnina S. Lopez, *BS, assistant manager II - accounting*
Nestor C. Lapitan, *BS, assistant manager II - treasury*
Edelisa M. Bardenas, *BS, assistant manager I - accounting*
Mary Grace R. Bautista, *BS, assistant manager I - accounting*
Reymunda C. Labuguen, *BS, assistant manager I - accounting*
Clarissa B. Mateo, *BS, assistant manager I - accounting*
Rodelita D. Panergalin, *BS, assistant manager I - accounting*
Miriam M. Telosa, *BS, assistant manager I - accounting*
Leny M. Medenilla, *BS, assistant manager I - budget*
Julie C. Carreon, *BS, assistant manager I - treasury*
Vilma T. Ramos, *BS, executive secretary*
Maria Judy M. Anicete, *BS, officer - accounting*
Maria Preciosa C. Dela Cuz, *BS, officer - accounting*
Judith E. Dionisio, *BS, officer - accounting*
Michelle V. Ella, *BS, officer - accounting*
Maricel I. Encanto, *BS, officer - accounting*
Iris M. Ferrer, *BS, officer – accounting*[4]
Jonalyn R. Gumafelix, *BS, officer - accounting*
Leonor R. Herradura, *BS, officer - accounting*
Evelyn V. Inocencio, *BS, officer - accounting*
Alvin Z. Leal, *BS, officer - accounting*
Annie C. Magcamit, *BS, officer - accounting*
Mae Christine I. Maghirang, *BS, officer – accounting*[4]

Flordeliza P. Malonzo, *BS, officer - accounting*
Luisa D. Urriza, *BS, officer - accounting*[4]
Maria Zenaida V. Borra, *BS, officer - budget*
Eleah R. Lucas, *BS, officer - budget*
Lily G. Aquino, *BS, officer - treasury*
Cindy Shella S. Salazar, *BS, officer - treasury*[4]
Betty Sarah R. Carreon, *BS, officer - treasury*
Gemma N. Corcega, *BS, officer - treasury*
Grace P. Abanto, *BS, associate - accounting*
Sheryl C. Herez, *BS, associate – accounting*[4]
Paulito J. Oleta, *BS, associate - accounting*
Roderick B. Maligalig, *BS, assistant - accounting*[1]
April Jane D. Muere, *BS, assistant - accounting*[4]
Jane B. Carlos, *assistant - budget*
Noel T. Lantican, *BS, assistant - property and assets*
Marilyn I. Villegas, *data encoder*
Jelo D. Magat, *BS, secretary II*[4]
Jonathan O. Masalonga, *BS, secretary II*[1]

Office of the Director for Administration and Human Resources

Maria Liza R. Milante, *BS, officer - administrative coordination*

Human Resources Services – Employee Relations

Lilian M. Mendoza, *MS, manager*
Kathryn Rose C. Victoria, *BS, officer - HRS coordination*

Human Resources Services – International Staff

Selene M. Ocampo, *BS, officer - HRS coordination*
Nida E. Reyes, *BS, officer - HRS coordination*

Human Resources Services – National Staff

Fe V. Aglipay, *MS, manager*
Gladys Faith B. Tan, *BS, specialist - HRS*[1]
Sylvia P. Avance, *MS, specialist - HRS*
Myrna Benilda C. Pablo, *MS, specialist - HRS*[4]
Alfredo R. Reyes, *BS, officer - HRS coordination*
Iluminada B. Oleta, *BS, secretary III*
Larry A. Montermoso, *assistant*

Food and Housing Services

Ma. Obdulia B. Jolejole, *BS, senior manager*
Leody M. Genil, *BS, assistant manager I*
Melinda M. Cuyno, *BS, officer*
Benita M. Pangan, *MS, officer*
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*

International School Los Baños

Joan L. Belsonda, *BS, officer - administrative coordination*[5]

Legal Services

Walfrido E. Gloria, *MS, senior counsel*
Cherryl C. Breva, *BS, secretary III*

Materials Management Services

Frisco L. Guce, *BS, senior manager*
Felicisimo N. Kalaw, *BS, assistant manager I*
Remedios E. Ballesfin, *BS, assistant manager I - central files*
Conception Elybeth A. Alcantara, *BS, officer*
Angelica P. Valintos, *BS, officer - administrative coordination*
Anatolio A. Magampon, *BS, officer - property disposal*
Zenaida M. Belarmino, *BS, officer - purchasing*
Lourdes A. Belison, *BS, officer - purchasing*
Anthony C. Daluz, *BS, officer - purchasing*
Luzviminda G. Oleta, *BS, officer - purchasing*
Priscilla T. Cabral, *BS, officer - shipping*
Louell R. Tanzo, *BS, assistant - central files*
Wilmer B. Jacob, *assistant - mailroom*
Felix C. Estipona, *assistant - Makati Office*
Anicia R. Malabanan, *data encoder*
Maureen C. Pader, *data encoder*
Francisco T. Quilloy, *materials expediter*
Ernesto L. Nimedez, Jr., *BS, warehouseman*
Fred B. Angeles, *warehouseman*
William M. Estrellado, *warehouseman*
Jose L. Sibal, *warehouseman*
Delfin M. Lacandula, Jr., *attendant*
Fortunato P. Presto, *attendant - MMS*[4]

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*
Fidel L. Alvarez, *technician III - carpentry*
Levi C. Malijan, *technician III - carpentry*
Virgilio V. Verano, *technician III - carpentry*
Luisito R. Vitan, *technician III - civil*
Robert F. Austria, *BS, technician III - drafting*

Roberto E. Escueta, *BS, technician III - electrical*
Rufino R. Gibe, *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 & instrument repair*
Ramon R. Suarez, *technician III - electronics & telephone*
Danilo F. Banasihan, *technician III - instrument & telephone*
Rodolfo G. Calibo, *technician III - physical plant*
Melencio E. Tapia, *technician III - plumbing*
Manolo M. De Guia, *technician III - refrigeration & airconditioning*
Leonardo S. Mangubat, *technician III - refrigeration & airconditioning*
Dionisio A. Ng, *technician III - refrigeration & airconditioning*
Juan L. Petrasanta, *technician III - refrigeration & airconditioning*
Ricardo C. Tabilangon, *technician III - refrigeration & 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*
Jennifer R. Jarlego, *BS, secretary I*

Safety and Security Services

Glenn A. Enriquez, *BS, senior manager*
Crisanto P. Dawinan, *BS, assistant manager I - occupational safety & health*
Alvin C. Reyes, *BS, assistant manager I - safety and security services*[4]
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*[1]
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*
Roduardo 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, *driver*[4]
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*

_____

[1]*Left during the year*
[2]*On leave*
[3]*Joined and left during the year*
[4]*Joined during the year*
[5]*On project appointment*
[6]*Transferred from Entomology and Plant Pathology*
[7]*Transferred from Plant Breeding, Genetics, and Biotechnology*
[8]*Transferred from Genetic Resources Center*
[9]*Transferred from Agricultural Engineering*
[10]*Died during the year*

Appendix 1. IRRI's research partners

NARES

Argentina
Instituto Nacional de Tecnologia Agropecuaria-Estacion Experimental Agropecuaria

Bangladesh
Agricultural Advisory Society
Bangabandhu Sheikh Mujibur Rahman Agricultural University
Bangladesh Academy for Rural Development
Bangladesh Agricultural Development Corporation
Bangladesh Agricultural Research Council
Bangladesh Agricultural Research Institute
Bangladesh Agricultural University
Bangladesh Bureau of Statistics
Bangladesh Fisheries Research Institute
Bangladesh Institute of Development Studies
Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders
Bangladesh Rice Research Institute
Bangladesh Water Development Board
Department of Agricultural Extension
Department of Agriculture -Kamal
Health Education and Economic Development
Integrated Action Research and Development
Jahangirnagar University Dhaka
Local Government Engineering Department
Rajshahi University
Rural Development Academy
University of Dhaka

Bhutan
Renewable Natural Resources Research Center

Brazil
Empresa Brasileira de Pesquisa Agropecuária
Instituto Rio Grandense Do Arroz

Brunei
Brunei Agricultural Research Council

Cambodia
Battambang Provincial Department of Agriculture
Cambodian Agricultural Research and Development Institute
Day Eth Research Station
Ministry of Agriculture, Forestry and Fisheries
Phrey Phdau Agricultural Research Station
Prey Veng Provincial Department of Agriculture

Chile
Instituto Nacional de Investigacion Agropecuaria-Centro de Investigacion Regional

China
Anhui Rice Research Institute
China Agricultural University
China National Rice Research Institute
China National Hybrid Rice Research and Development Center
Chinese Academy of Agricultural Mechanization Sciences
Chinese Academy of Agricultural Sciences
Chinese Academy of Sciences

Country Extension Bureau
Fudan University
Fujian Academy of Agricultural Sciences-Rice and Wheat Research Institute
Gong Zu-Ling Rice Research Institute
Guangdong Academy of Agricultural Sciences
Guangxi Rice Research Institute
Guangzhou Plant Protection Research Institute
Hainan Research and Development Base for Hybrid Rice
Heilongjiang Rice Research Institute
Hu Bei Crop Research Institute
Huazhong Agricultural University
Hunan Agricultural University
Hunan Hybrid Rice Research Center
Hunan Plant Protection Institute
Hunan Rice Research Institute
Kunming Food Crops Research Institute
Lancang Food Crops Research Institute
Nanchang Rice Research Institute
Nanjing Agricultural University
National Center of Irrigation and Drainage Development
National Natural Science Foundation of China
Ningbo Agricultural Research Institute
Peking University
Shenyang Agricultural University
Sichuan Academy of Agricultural Sciences
Sichuan Rice Research Center
Wenzhou City Academy of Agricultural Sciences
Wuhan University
Yangzhou University
Yunnan Academy of Agricultural Sciences
Yunnan Agricultural University
Zhejiang Academy of Agricultural Sciences
Zhejiang University

Colombia
Centro Internacional de Agricultura Tropical

Ecuador
Instituto Nacional de Investigaciones Agropecuarias

Egypt
Agricultural Research Center
Ministry of Agriculture and Land Reclamation
Rice Research and Training Center

Ethiopia
Pawe Agricultural Research Center

Guatemala
Institute de Ciencia y Tecnologia Agricolas

Haiti
Ministry of Agriculture, Natural Resources and Rural Development

Honduras
Program Nacional de Arroz DICTA-SAG

India
Acharya NG Ranga Agricultural University (formerly Andhra Pradesh Agricultural University)
Aduthurai Regional Agricultural Research Station
Agricultural College and Research Institute -Trichy
Anand Agricultural University
Assam Agricultural University
Banaras Hindu University
Bidhan Chandra Krishi Vishwa Vidyalaya
Birsa Agricultural University
CCS Haryana Agricultural University, Rice Research Station, Kaul (Kaithal)
Central Agricultural Research Institute
Central Agricultural University
Central Rainfed Upland Rice Research Station (Hazaribagh)
Central Rice Research Institute
Central Soil Salinity Research Institute
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur
Charan Singh Choudhary Haryana Agricultural University
Department of Agricultural Extension-Tamil Nadu
Department of Agriculture and Cooperation
Department of Plant Protection, Quarantine and Storage
Directorate of Rice Research
Ghahraghat Crop Research Station
Goa University
Govind Ballabh Pant University of Agriculture and Technology
Gujarat Agricultural University
Himachal Pradesh Agricultural University
Holy Cross Vocational Training Institute
ICAR Reseach Complex for North Eastern Hill Region
Indian Agricultural Research Institute
Indian Council of Agricultural Research
Indian Statistical Institute
Indira Gandhi Agricultural University
Institut Francais de Pondicherry
Jawaharlal Nehru Krishi Vishwa Vidyalaya
Karjat Regional Agricultural Research Station
Kharland Research Station
Kuvempu University

Lonavala Agricultural Research Station
Maharana Pratap University of Agriculture and Technology
Malan Rice Research Station
Marathwada Agricultural University
Mithapur Agricultural Research Institute
Nand Educational Foundation for Rural Development
Narendra Deva University of Agriculture and Technology
National Bureau of Plant Genetic Resources
National Center for Agricultural Economics Policy Research
Orissa University of Agricultural Technology
Punjab Agricultural University
Rajendra Agricultural University
Regional Research Station-Kapurthala
Rewa Rice Research Station
Sardar Vallabh Bhai Patel University of Agriculture and Technology
Shere-E-Kashmir University of Agriculture and Technology
Soil and Water Management Research Institute
Tamil Nadu Agricultural University
Tamil Nadu Rice Research Institute
Tata Energy Research Institute
Titabar Regional Agricultural Research Station
University of Agricultural Sciences
University of Calcutta
University of Delhi
University of Hyderabad
Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR Institute)
West Bengal Directorate of Agriculture
West Bengal Rice Research Station
Zonal Agricultural Research Station - Jagdalpur

Indonesia
Agricultural Service Center
Assessment Institute for Agricultural Technology
Bogor Agricultural University (Institut Pertanian Bogor)
Central Research Institute for Animal Sciences
Hasannudin University
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 Crop Research and Development (formerly Central Research Institute for Food Crops)
National Assessment Institute for Agricultural Technology
Provincial Agricultural Services (Dinas Pertanian Tanaman Pangan Propinsi)
Research Institute for Food Crops Biotechnology
Rice Research Institute
Sukarami Research Institute for Food Crops

Iran
Agricultural Biotechnology Research Institute of Iran
Rice Research Institute of Iran
University of Mazandaran

Kenya
Kenya Agricultural Research Institute

Khazakstan
Pre-Aral Research Institute of Agroecology and Agriculture

Kyrgyztan
Kyrgyz Center of Agrarian Sciences and Consulting Services

Lao PDR
Department of Agricultural Extension
German Development Service-Lao PDR
GTZ Bokeo Project
Huay Khot Research Station
Luang Namtha Research Station
Ministry of Agriculture and Forestry
National Agricultural Research Center
NARC Rice Research Station
National Agriculture and Forestry Research Institute
Phone Ngam Research Station
Savannakhet Provincial Department of Agriculture
Thano Rice Research Station
World Vision Laos, Savannakhet Project

Malaysia
Agriculture Research Center-Tuaran
Malaysian Agricultural Research and Development Institute
Universiti Kebangsaan Malaysia
Universiti Pertanian Malaysia

Mozambique
National Agricultural Institute of Mozambique

Myanmar
Agricultural Research Department
Central Agricultural Research Institute
Hmawbi Central Rice Model Farm
Jadote Research Farm
Kyaukse Center for Agricultural Farm

Letpadan Research Farm
Mahlaing Agricultural Research Farm
Myanma Agriculture Service
Myaungmya Center for Agricultural Farm
Taryaw Research Farm

Nepal
Department of Agriculture
Khumaltar Agricultural Research Station
National Rice Research Program
Nepal Agricultural Research Council
Regional Agricultural Research Station
Tribhuvan University- Institute of Agriculture and Animal Science

Nicaragua
Centro Nacional de Estandarizacion de Maquinaria Agricola (under the Departemento da Pesquisa Agricola - Ministere du developpement rural et de l' agriculture)

Pakistan
Atomic Energy Agricultural Research Center
D.I. Khan Agricultural Research Station
Mingora Agricultural Research Station
National Agricultural Research Center
On-Farm Water Management
Pakistan Agricultural Research Council
Pindi Soil Salinity Research Station
Regional Agricultural Research Station-Tando Jam
Rice Research Institute
Instituto Nacional de Investigacion Agraria
Universidad Nacional de San Martin

Philippines
Advanced Science and Technology Institute
Benguet State University
Bulacan Agricultural State College (formerly Bulacan National Agricultural State College)
Bureau of Agricultural Statistics
Bureau of Plant Industry
Bureau of Plant Industry at the Los Banos National Crop Research and Development Center
Bureau of Soil and Water Management (under DENR)
Central Luzon State University
Central Mindanao University
Dapitay sa Kaumhan
Department of Agriculture
Department of Environment and Natural Resources
Department of Science and Technology
Ecosystem Research and Development Bureau
Forest Products Research and Development Institute
Leyte State University (formerly Visayas State College of Agriculture)
Local Government Academy
Los Baños College of Fisheries
Los Baños Freshwater Fisheries Research Station
Los Baños Science Community
Mariano Marcos State University
National Food Authority
National Irrigation Administration
National Post Harvest Institute for Research and Extension
Pampanga Agricultural College
Philippine Council for Agriculture, Forestry and Natural Resources and Development (formerly PCARD)
Philippine Council for Aquatic and Marine Research and Development
Philippine Rice Research Institute
University of Southern Mindanao
University of the Philippines Los Baños
University of the Philippines-Diliman
Western Mindanao State University
Western Visayas State University

Sri Lanka
Center for Agricultural Research and Programming
Department of Agriculture, Sri Lanka
Field Crops Research and Development Institute
Regional Agricultural Research and Development Center
Rice Research and Development Institute
Rice Research Institute
Seed and Plant Materials Division
University of Peradeniya

Surinam
Anne van Dijk Rice Research Centre Nickerie (Anne van Dijk Rijst Onderzoekscentrum Nickerie)

Tajikstan
Tajik Agricultural Academy of Sciences

Thailand
Asian Institute of Technology
Chiang Mai Service Center for Crop and Production Resources
Chiang Mai University
Department of Agriculture
Huntra Rice Experiment Station
Kasetsart University

Khon Kaen Plant Material and Technical Service Center (formerly Khon Kaen Rice Research Station)
Khon Kaen University
Krabi Rice Experiment Station
Mae Hong Son Rice Experiment Station
Ministry of Agriculture and Cooperatives
Ministry of Public Health
Pathum Thani Rice Research Center
Phimai Rice Research Station
Phitsanulok Rice Research Center
Prachin Buri Rice Research Center
Reseaux de recherche et d' innovation technologique
Rice Research Institute
Sakhon Nakhon Rice Research Center
Suphanburi Rice Research Center
Surin Rice Research Station
Ubon Ratchathani Rice Research Center
Ubon Ratchathani University

Timor Leste
Ministry of Agriculture, Forestry and Fisheries

Turkey
Ege University
Thrace Agricultural Research Institute

Turkmenistan
Ministry of Agriculture and Water Management

Uzbekistan
Uzbekistan Research Institute for Rice (under Scientific Production Center of Agriculture of the Ministry of Agriculture and Water Management of Uzbekistan)

Vietnam
Agricultural Breeding Center
Agricultural Extension Center - Can Tho Province
Agricultural Genetics Institute
An Giang University
Bac Lieu People's Committee
Can Tho University
Center for Remote Sensing and Geomatics
Cuu Long Delta Rice Research Institute
Department of Agriculture - Can Tho Province
Department of Agriculture and Rural Development-Bac Lieu Province
Food Crops Research Institute (Gia Loc)
Hanoi Agricultural University
Hue University of Agriculture and Forestry
Hybrid Rice Research Center
Information Centre for Agriculture and Rural Development
Institute of Agricultural Sciences
Integrated Resources Mapping Centre
Masvingo Agronomy Institute
Ministry of Agriculture and Cooperatives
Ministry of Agriculture and Food Industries
Ministry of Agriculture and Rural Development
Ministry of Higher Education
National Institute of Plant Protection
National Institute of Soils and Fertilizers
National IPM Program
Nong Lam University (formerly the University of Agriculture and Forestry)
Plant Protection Department
Research Institute for Aquaculture No. 2
Sub-Institute of Water Resource Planning
Thai Nguyen University
Vietnam Agricultural Science Institute
Vietnam Institute of Agricultural Engineering and Post-Harvest
Vietnam National University

ARIs

Australia
Charles Sturt University
Commonwealth Scientific and Industrial Research Organisation
Curtin University of Technology
Department of Primary Industries
Macquarie University
New South Wales Department of Primary Industries - Agriculture
The University of Queensland
University of Adelaide
University of New Castle-Australia
University of Sydney
ARC Seibersdorf Research (under ARC)

Belgium
Universite Catholique De Louvain - Unite de Physiologie Vegetale
University of Gent

Canada
Agriculture and Agri-Food Canada
McGill University
Semiarid Prairie Agricultural Research Center - AAFC Saskatchewan
Simon Fraser University
University of Alberta
University of British Columbia
University of Western Ontario

Denmark
Danish Institute of Agricultural Sciences
FOSS
Riso National Laboratory
Royal Veterinary and Agricultural University

France
Agropolis
Centre de coopération internationale en recherche agronomique pour le développement (Centre for International Cooperation in Agricultural Research for Development)
Institut de recherche pour le développement (formerly ORSTOM)
Institut National Agronomique Paris Grignon
Institut National de la Recherche Agronomique
Montpellier II University Centre des Sciences Humaines
Paris X University
Research and Technology Exchange Group
Unite de Recherche en Genomique Vegetale
University of Perpignan

Germany
Center for Environmental Research
Christian Albrecht University-Kiel
Martin Luther University Halle-Wittenberg
Max Planck Institute for Chemical Ecology
MIPS Bioinformatics Center
Technische Universitat Darmstadt
Universitaet Bayreuth
University of Bonn
University of Freiburg
University of Hannover
University of Hohenheim
University of Leipzig
Zentrum für Entwicklungsforschung (Center for Development Research)

Italy
Centro di Richerche Sul Riso

Japan
Aoyama Gakuin University
Chiba University
Foundation for Advanced Studies in International Development
Hokkaido University
Hokuriku Research Center
Japan International Cooperation Agency
Japan International Research Center for Agricultural Sciences
Japan Rice Genome Program
Kagoshima University
Kamikawa Agricultural Experiment Station
Kyushu National Agricultural Experiment Station
Kyushu University
Ministry of Agriculture, Forestry and Fisheries
Nagoya University
National Agricultural Research Center
National Agriculture and Bio-Oriented Research Organization
National Graduate Institute for Policy Studies
National Institute of Agricultural Science and Technology
National Institute of Agrobiological Sciences
National Institute of Agro-Environmental Sciences
National Institute of Crop Science
Plantech Research Institute
Tohoku University
Tsukuba University
University of Kyoto
Waseda University

Korea
Pohang University of Science and Technology
Rice Research Institute
Rural Development Administration

Netherlands
Groningen University
Plant Research International
Wageningen University and Research Centre

Portugal
Instituto de Biologia Experimental e Tecnologia

Singapore
National University of Singapore

Spain
Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (National Institute for Agricultural and Food Research and Technology)
Valencian Institute for Agricultural Research

Sweden
Stockholm School of Economics
University of Lund

Switzerland
CIBA-Geigy Limited
Swiss Federal Institute of Technology (Eidgenössische Technische Hochschule Zürich)

United Kingdom
CABI Bioscience
Horticulture Research International
Imperial College (University of London)
John Innes Center
Natural Resources Institute
The University of Reading
University of East Anglia
University of Liverpool
University of New Castle upon Tyne-Center for Land Use and Water Resources Research
University of Sheffield

United States of America
Colorado State University
Cornell University
Fred Hutchinson Cancer Research Center
Institute for Genomic Research
International Benchmark Sites Network for Agrotechnology Transfer Project
Kansas State University
National Center for Genetic Resources Preservation
National Center for Genome Resources
Nitrogen Fixation by Tropical Agricultural Legumes
North Carolina State University
Ohio State University
Oklahoma State University
Pennsylvania State University
Purdue University
Research Corporation of the University of Hawaii
Rutgers University
Texas Tech University
United States Department of Agriculture
University of Arizona
University of Arkansas
University of California-Davis
University of California-Riverside
University of Florida-Gainesville
University of Georgia
University of Hawaii
University of Illinois
University of Minnesota
University of South Florida
University of Utah
University of Washington
Virginia Polytechnic Institute and State University
Yale University

Venezuela
Fundacion Nacional del Arroz
Instituto Nacional de Investigacion Agropecuaria

International

Africa Rice Center
Agent Links European Network
Asia and Pacific Seed Association
Caribbean Agricultural Research and Development Institute
Center for International Forestry Research
Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
Centro Internacional de Mejoramiento de Maiz y Trigo
Fondo Latinoamericano de Arroz de Riego
Food and Agriculture Organization of the United Nations
Gramene: A Comparative Mapping Resource for Grains
International Board for Plant Genetic Resources
International Board for Soil Research and Management
International Center for Agricultural Research in the Dry Areas
International Center for Biosaline Agriculture
International Center for Research in Agroforestry (World Agroforestry Center)
International Center for Research in the Semi-Arid Tropics
International Center for Soil Fertility and Agricultural Develoment (formerly International Fertilizer Development Center)
International Center of Insect Physiology and Ecology
International Food Policy Research Institute
International Institute for Rural Reconstruction
International Institute of Tropical Agriculture
International Irrigation Management Institute
International Livestock Research Institute
International Network for the Improvement of Banana and Plantain
International Plant Genetic Resources Institute
International Potato Center
International Service for the Acquisition of Agri-biotech Applications
International Water Management Institute
SEAMEO Regional Center for Graduate Study and Research in Agriculture
United Nations Environment Programme-Global Resource Information Database
WorldFish Center

NGOs

Bangladesh
APEX - A Voluntary Organization of Community Development
Association for Integrated Development Comilla

Bangladesh Development Society
Bangladesh Rice Exporters Association
Center for Policy Dialogue
Debi Chowdhurani Palli Unnayan Kendra
Friends in the Village Development Bangladesh
Grameen Krishi Foundation
PRA Promoters Society
PROSHIKA
Rangpur Dinajpur Rural Service
Shushilan
Uttaran
Wave (Welfare Association for Village Environment) Foundation

Benin
Songhai Center

Cambodia
Cambodia Rice Millers Association

India
Barwale Foundation (formerly Mayhco Research Foundation)
Krishi Vigyan Kendra (Cuttack, Orissa)
MS Swaminathan Research Foundation
Ram Krishna Mission
The Confederation of ASEAN Journalists

Myanmar
Myanmar Rice and Paddy Traders Association

Nicaragua
Asociacion Nicaraguense de Arroceros

Philippines
Ayala Foundation, Inc.
Infanta Integrated Community Development Assistance, Inc.
Process Foundation

Switzerland
Syngenta Foundation for Sustainable Agriculture

Thailand
Population and Community Development Association

Timor Leste
Catholic Relief Service

United States of America
Public Intellectual Property Resource for Agriculture
The Samuel Roberts Noble Foundation, Inc.

International
CARE International
International Development Enterprise

Private organizations

Bangladesh
Agro Business Corporation
MARK Industries (pvt.) Ltd.
Socioconsult Ltd.

Cambodia
Crenn and Associates

China
Fujian Science and Technology Publishing House

India
Indian Farmers Fertilizer Cooperative Ltd.

Indonesia
National Seed Company

Italy
Sardo Piemontese Sementi

Myanmar
Agricultural Corporation

Spain
Koipesol Semillas

Switzerland
Novartis International AG (merger of CIBA-Geigy Ltd. and Sandoz)

United Kingdom
Lion Bioscience AG
Natural Resources International Limited

United States of America
Li-Cor Inc.
Nabisco Research and Development
Perlegen Sciences, Inc.

Vietnam
National Seed Company No. 2
South Seed Company
Southern Seed Joint Stock Company
Voice of Ho Chi Minh Radio Broadcasting

Appendix 2. Selected acronyms used throughout this publication

AEU	Agricultural Engineering Unit
ARBN	Asian Rice Biotechnology Network
BBU	Biometrics and Bioinformatics Unit
BOT	Board of Trustees
BPH	brown planthopper
BRRI	Bangladesh Rice Research Institute
CCER	Center-commissioned External Review
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)
CMS	cytoplasmic male sterile
CORRA	Council for Partnerships on Rice Research in Asia
CPS	Communication and Publications Services
CRIL	IRRI-CIMMYT Crop Research Informatics Laboratory
CRO	Community Relations Office (VIS)
CSSP	Crop Science Society of the Philippines
CSWS	Crop, Soil, and Water Sciences Division
CURE	Consortium for Unfavorable Rice Environments
DA	Department of Agriculture
DDG-OSS	Deputy Director General for Operations and Support Services
DFID	Department for International Development (UK)
DPPC	Director for Program Planning and Communications (formerly Director for Program Planning and Coordination
DPRK	Democratic People's Republic of Korea
EE	entertainment-education (approach)
EIRLSBN	Eastern Indian Rainfed Lowland Shuttle Breeding Network
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agency for Agricultural Research)
EMS	environmental management system
EPMR	External Program and Management Review
EPPD	Entomology and Plant Pathology Division

ES	Experiment Station
FAO	Food and Agriculture Organization
FARMSTEAD	Fish and Rice Management System to Enable Agricultural Diversification
FoSHoL	Food Security for Sustainable Household Livelihoods
GAMMA	Gene Array and Molecular Marker Application
GCP	Generation Challenge Program
GIS	geographic information system
GQNRC	Grain Quality and Nutrition Research Center
GRC	Genetic Resources Center
ICAR	Indian Council of Agricultural Research
ICIS	International Crop Information System
ICOP	in-country outreach program
ICM	integrated crop management
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
ILRI	International Livestock Research Institute
INGER	International Network for Genetic Evaluation of Rice
INRM	integrated natural resource management
IPM	integrated pest management
IPMO	International Programs Management Office
IPMU	Intellectual Property Management Unit
IPR	intellectual property rights
IRAD	Institut de recherche pour le développement (France)
IRFGC	International Rice Functional Genomics Consortium
IRG	International Rice Genebank
IRIS	International Rice Information System
IRRC	Irrigated Rice Research Consortium
ITIL	IT Infrastructure Library
ITS	Information Technology Services
IWMI	International Water Management Institute (Sri Lanka)
LCC	leaf color chart
LEARN-IT	Linking Extension and Research Needs through Information Technology
LIMS	Laboratory Information Management System
MAS	marker-assisted selection
NARES	national agricultural research and extension systems
NCGRP	National Center for Genetic Resources Preservation (Fort Collins, Colorado)
NGO	nongovernment organization
NIAS	National Institute for Agrobiological Sciences (Japan)
NIL	near-isogenic line
NRM	natural resource management
NRS	nationally recruited staff
NSBMs	nonseed biological materials
PBGB	Plant Breeding, Genetics, and Biotechnology (formerly Biochemistry) Division
PETTRA	Poverty Elimination Through Rice Research Assistance (Bangladesh)
PhilRice	Philippine Rice Research Institute
PNRI	Philippine Nuclear Research Institute
PVS	plant varietal selection
QA	quality assurance
QTLs	quantitative trait loci
RDA	Rural Development Administration (Korea)
RKB	Rice Knowledge Bank
RWC	Rice-Wheat Consortium for the Indo-Gangetic Plains
SHU	Seed Health Unit
SNP	single nucleotide polymorphism
SSD	Social Sciences Division
SSNM	site-specific nutrient management
TC	Training Center
TEEAL	The Essential Electronic Agricultural Library
TGMS	thermosensitive genic male sterility
TILLING	Targeting Induced Local Lesions IN Genomes
TNAU	Tamil Nadu Agricultural University
UPLB	University of the Philippines Los Baños
USAID	United States Agency for International Development
VIGS	virus-induced gene silencing
VIS	Visitors and Information Services
WARDA	Africa Rice Center (West Africa Rice Development Association; Benin)
WOS	Web of Science

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, 2005 AND 2004

Corporate information

Board of Trustees

Ex officio members

Dr. Emerlinda R. Roman (joined Feb 2005)
Dr. Francisco Nemenzo (left Feb 2005),
President, University of the Philippines

Mr. Domingo F. Panganiban (joined July 2005)
Mr. Arthur C. Yap (left July 2005),
Secretary, Philippine Department of Agriculture

Dr. Robert S. Zeigler (joined March 2005),
Director General

Dr. William G. Padolina (left March 2005),
Acting Director General, IRRI

Members-at-large

Dr. Shigemi Akita
Dr. E.A. Siddiq
Mr. Fazle Hasan Abed
Dr. Kay Beese
Dr. Achmad Mudzakkir Fagi
Dr. Eun-Jong Lee
Dr. Keijiro Otsuka
Prof. Baowen Zhang
Dr. Ruth K. Oniang'o
Dr. Ronald L. Phillips
Dr. Elizabeth Jean Woods
Dr. Ralph Anthony Fischer

Dr. William G. Padolina,
Secretary to the Board

Mr. Kwame Akuffo-Akoto,
Treasurer to the Board

Headquarters

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; 891-1292
+1 (650) 833-6621 (USA direct)

Email: irri@cgiar.org
Web: www.irri.org

IRRI Makati Office

10th Floor, Suite 1009, Condominium 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 Practice of
PriceWaterhouseCoopers Global

Finance and Audit Committee

Membership

The Finance and Audit Committee is composed of four Trustees who 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 operating 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, shall preside over all meetings of said 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.

Current Composition and Designation of Finance and Audit Committee

Mr. Fazle Hasan Abed - Chairperson
Dr. Kay Beese - Vice Chairperson
Prof. Ruth Oniang'o - Member
Dr. Keijiro Otsuka - Member
Dr. R.L. Phillips - Member
Prof. Baowen Zhang - 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 2005

The year ending 31 December 2005 was a "transformational year" for IRRI. The Institute embarked on new challenges during the year. The significant highlights are discussed in this statement.

New Strategic Plan for IRRI

The Institute is now in the final stages in the preparation of a 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 2005. An IRRI rice breeder was posted in Africa, hosted by WARDA at IITA-Ibadan. He is pursuing collaboration with WARDA to help solve high-priority rice research problems in Africa. Capacity building for NARES in the region will also be supported and promoted. An initial seed fund of $1 million has been allocated from the Institute's reserves to initiate the move to Africa.

Appointment of New Director General

Robert (Bob) Zeigler replaced Ronald P. Cantrell, who retired as IRRI's director general in December 2004. Dr. Zeigler, an internationally respected plant pathologist with more than 20 years' experience in agricultural research in the developing world, assumed his position on 20 March 2005.

IRRI-CIMMYT Alliance

The two Boards of Trustees agreed to launch three Alliance Programs, which will be implemented over a period of three years: (1) Intensive Production Systems in Asia, (2) World Cereals Research Informatics, and (3) Cereal Systems Knowledge Bank and Capacity Building. A Joint Committee on Governance and Management of the IRRI-CIMMYT Alliance was formed with a task of reviewing options to develop over time a unified leadership and governance system commensurate with the shared activities of the Alliance. Before the end of the third year, it was agreed that the centers would jointly commission an external review of the Alliance and its programs, with a strong focus on its future evolution.

Financial Status

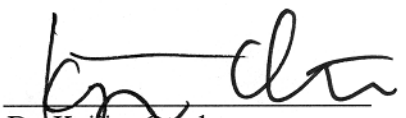
Revenue for 2005 amounted to $30.9 million against expenditures of $33.9 million, resulting in a deficit of $3.0 million before unrealized foreign exchange translation loss. The deficit has two components. The first is a deficit in the year's operations of about $1.3 million. Although actual expenditures were within planned levels, several significant and unexpected cuts in unrestricted grants late in the year coupled with the steep rise in value of the U.S. dollar (after the 17 Sept. Board meeting) resulted in the deficit. 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 ($1.7 million) of the deficit was due to the implementation of the planned use of reserves for identified new research initiatives. The Institute's net assets at the end of 2005 amounted to $45.3 million, 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 2005. I would like to express my sincere best wishes to Dr. Kay Beese, Dr. Shigemi Akita, Dr. E.A. Siddiq, Dr. Francisco Nemenzo, and Mr. Arthur Yap, who left the Board during the year. The Institute gained from their invaluable contribution to the governance of IRRI. Dr. Emerlinda R. Roman and Mr. Domingo F. Panganiban joined the board as ex officio members 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, 2005 and 2004

Management Statement of Responsibility for Financial Reporting

The accompanying financial statements of the International Rice Research Institute (IRRI), for the year ended December 31, 2005 and 2004 are the responsibility of management. IRRI management also claim 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 though it's 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.

Dr. Robert S. Zeigler
Director General

Kwame Akuffo-Akoto
Director of Finance

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

FINANCIAL STATEMENTS AND SUPPLEMENTARY INFORMATION
AS OF AND FOR THE YEARS ENDED DECEMBER 31, 2005 AND 2004

TABLE OF CONTENTS

PricewaterhouseCoopers
29th Floor Philamlife Tower
8767 Paseo de Roxas
1226 Makati City, Philippines
Telephone + 63 (2) 845 2728
Facsimile + 63 (2) 845 2806
www.pwc.com

Report of Independent Auditors

To the Board of Trustees of
International Rice Research Institute

We have audited the accompanying statements of financial position of the International Rice Research Institute (a nonstock, not-for-profit organization) as of December 31, 2005 and 2004, and the related statements of activities, changes in net assets and cash flows for the years then ended. These financial statements and the supplementary schedules referred to below are the responsibility of the Institute's management. Our responsibility is to express an opinion on these financial statements and supplementary schedules based on our audits.

We conducted our audits in accordance with International Standards on Auditing. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that ouraudits provide a reasonable basis for our opinion.

As explained in Note 2 to the financial statements, the Institute's financial statements are prepared on the basis of accounting practices prescribed for international agricultural research centers under the auspices of the Consultative Group on International Agricultural Research (CGIAR).

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, 2005 and 2004, and the results of its activities and its cash flows for the years then ended in conformity with the CGIAR guidelines.

PRICEWATERHOUSECOOPERS

Report of Independent Auditors
To the Board of Trustees of
International Rice Research Institute

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 , 2005 and 2004 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 7, 2006

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF FINANCIAL POSITION
DECEMBER 31, 2005 AND 2004
(In Thousands of US Dollars)

	Notes	2005	2004
A S S E T S			
CURRENT ASSETS			
Cash and cash equivalents	3	21,861	35,035
Short term investments	4	39	2,836
Accounts receivable - net			
Donors	5	6,876	4,244
Employees		153	116
Other CGIAR Centers		335	163
Others	6	1,807	713
Inventories - net	7	475	382
Prepaid expenses		253	172
Total current assets		31,799	43,661
NONCURRENT ASSETS			
Property and equipment - net	8	8,524	9,127
Other assets	9	19,671	10,196
Total non-current assets		28,195	19,323
Total assets		59,994	62,984
LIABILITIES AND NET ASSETS			
CURRENT LIABILITIES			
Accounts payable			
Donors	10	6,382	5,068
Other CGIAR Centers		85	160
Others	11	1,078	997
Accruals and provisions	12	7,110	6,122
Total current liabilities		14,655	12,347
NET ASSETS	14		
Undesignated		-	2,189
Designated		45,339	48,448
		45,339	50,637
Total liabilities and net assets		59,994	62,984

(The notes on pages 7 - 19 are an integral part of the financial statements)

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF ACTIVITIES
FOR THE YEARS ENDED DECEMBER 31, 2005 AND 2004
(In Thousands of US Dollars)

		2005					
	Notes	Unrestricted	Temporarily Restricted***	Sub-total	Challenge Programs	Total	2004
REVENUES							
Grants (Exhibit 1)		12,861	11,185	24,046	4,891	28,937	32,636
Other revenues	16	1,858	-	1,858	-	1,858	2,540
		14,719	11,185	25,904	4,891	30,795	35,176
OPERATING EXPENSES							
Program-related (Exhibit 3)		11,921	10,679	22,600	4,891	27,491	27,227
Management and general (Exhibit 3)		7,154	506	7,660	-	7,660	7,893
		19,075	11,185	30,260	4,891	35,151	35,120
Recovery of indirect costs		(1,266)	-	(1,266)	-	(1,266)	(1,906)
		17,809	11,185	28,994	4,891	33,885	33,214
NET SURPLUS (DEFICIT) FROM ORDINARY ACTIVITIES		(3,090)	-	(3,090)	-	(3,090)	1,962
UNREALIZED FOREIGN EXCHANGE TRANSLATION GAIN (LOSS)		(2,295)	-	(2,295)	-	(2,295)	1,532
NET SURPLUS (DEFICIT)		(5,385)	-	(5,385)	-	(5,385)	3,494
MEMO ITEMS							
Operating expenses - by natural classification:							
Personnel costs		8,153	4,296	12,449	851	13,300	12,917
Supplies, services and others		7,864	3,801	11,665	1,090	12,755	13,124
Collaborators/Partners		243	1,311	1,554	2,590	4,144	4,589
Operational travel		1,008	1,538	2,546	360	2,906	2,226
Depreciation		1,807	239	2,046	-	2,046	2,264
Recovery of indirect costs		(1,266)	-	(1,266)	-	(1,266)	(1,906)
		17,809	11,185	28,994	4,891	33,885	33,214

*** of which US$3.14 million is attributed funding

(The notes on pages 7 - 19 are an integral part of the financial statements)

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF CHANGES IN NET ASSETS
FOR THE YEARS ENDED DECEMBER 31, 2005 AND 2004
(In Thousands of US Dollars)

			Designated								
			Vested	*Non-Vested*							
	Note	Undesignated	Invested In Fixed Assets	Fixed Assets Acquisition	Staff Separation	Risk Management	Unrealized FOREX Translation	Research Initiative Fund (Note 14)	Total Non-Vested	Total Designated Net Assets	Total Net Assets
Balances, January 1, 2004		10,010	8,491	12,613	6,632	-	-	9,025	28,270	36,761	46,771
Board of Trustees appropriation	14	(10,146)	-	-	-	5,160	4,986	-	10,146	10,146	-
Capital reserve replenishment		-	(1,909)	1,909	-	-	-	-	1,909	-	-
Acquisition of fixed assets		-	2,633	(2,261)	-	-	-	-	(2,261)	372	372
Net surplus (deficit) for the year		2,325	(88)	-	-	-	1,532	(275)	1,257	1,169	3,494
Balances, December 31, 2004		2,189	9,127	12,261	6,632	5,160	6,518	8,750	39,321	48,448	50,637
Board of Trustees re-designation		(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 surplus (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

(The notes on pages 7 - 19 are an integral part of the financial statements)

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

STATEMENTS OF CASH FLOWS
FOR THE YEARS ENDED DECEMBER 31, 2005 AND 2004
(In Thousands of US Dollars)

	Notes	2005	2004
CASH FLOWS FROM OPERATING ACTIVITIES			
Net surplus (deficit)		(5,385)	3,494
Adjustments for:			
Depreciation of assets	8	2,046	2,264
Provision for decline in value of investment		-	1
Provision for doubtful accounts		-	-
Interest income		(1,130)	(1,706)
Net book value of disposed property and equipment		133	88
Net surplus (deficit) before working capital changes		(4,336)	4,141
(Increase) decrease in:			
Accounts receivable		(3,935)	4,762
Short term investments		2,797	1,144
Inventories		(93)	(18)
Prepaid expenses		(81)	168
Increase (decrease) in:			
Accounts payable		1,320	(2,213)
Accruals and provisions		988	526
Cash generated from (absorbed by) operations		(3,340)	8,510
Interest received		1,130	1,706
Net cash provided by (used in) operating activities		(2,210)	10,216
CASH FLOWS FROM INVESTING ACTIVITIES			
Increase in other assets		(9,475)	(1,380)
Net movement of fixed assets/acquisition reserve		87	372
Acquisition of property and equipment	8	(1,576)	(2,988)
Net cash used in investing activities		(10,964)	(3,996)
NET INCREASE (DECREASE) IN CASH AND CASH EQUIVALENTS		(13,174)	6,220
CASH AND CASH EQUIVALENTS AT BEGINNING OF YEAR		35,035	28,815
AT END OF YEAR		21,861	35,035

(The notes on pages 7 - 19 are an integral part of the 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, 2005 AND 2004
(In Thousands of US Dollars)

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.

The accompanying financial statements and supplementary schedules of the Institute were approved and authorized for issue by the Board of Trustees on April 7, 2006.

Note 2 - Significant accounting policies

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.

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:

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 in 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 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 balance sheet date.

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. 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:

	2005	2004
Cash on hand and in banks	6,456	9,584
Cash equivalents	15,405	25,451
	21,861	35,035

Note 4 - Short term investments

This account consists of:

	2005	2004
With original maturities of more than 3 months but less than one year	19	1,336
Long term investments due to mature within one year	20	1,500
	39	2,836

The balance as of December 31, 2004 includes a callable principal protected note (PPN) with a bank, originally acquired in 1999 which matured in April 2005.

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.

	2005	2004
Unrestricted	2,826	1,308
Restricted	3,988	2,993
Challenge programs	158	146
	6,972	4,447
Allowance for doubtful accounts	(96)	(203)
	6,876	4,244

Note 6 - Accounts receivable - others

This account consists of:

	2005	2004
Advances to suppliers	1,563	627
Others	244	111
	1,807	738
Allowance for doubtful accounts	-	(25)
	1,807	713

Note 7 - Inventories

This account consists of:

	2005	2004
Spare parts	551	607
Supplies and other inventories	239	239
	790	846
Allowance for obsolescence	(315)	(464)
	475	382

Note 8 - Property and equipment

This account consists 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$4,841 thousand and US$4,834 thousand in 2005 and 2004, respectively.

Depreciation expense amounted to US$2,046 thousand and US$2,264 thousand in 2005 and 2004, respectively.

Note 9 - Other assets

This account consists of:

	2005	2004
Long term investments	19,665	10,190
Refundable deposits	6	6
	19,671	10,196

As of December 31, 2005, long term investments consist of six (6) instruments of varying amounts held in custody by four (4) financial institutions.

Note 10 - Accounts payable - donors

This account consists of grants received in advance applicable to succeeding years.

	2005	2004
Unrestricted	1,194	841
Restricted	4,123	3,903
Challenge programs	1,065	324
	6,382	5,068

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:

	2005	2004
Accruals		
Trade	1,961	1,949
Capital projects	69	125
Others	2,736	1,778
	4,766	3,852
Provisions	2,344	2,270
	7,110	6,122

Provisions consist of accumulated leave credits due to internationally and nationally recruited staff as of December 31, 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$299 thousand and US$291 thousand in 2005 and 2004, respectively.

Note 14 - Net assets

Designated

On April 2, 2004, the Board of Trustees of the Institute approved the designation of undesignated net assets amounting to US$8,760 thousand as a risk management reserve.

On April 1, 2005 the Board of Trustees approved the reallocation of US$4,986 thousand from risk management reserve to unrealized foreign exchange translation gains reserve and designated an additional US$1,386 thousand of undesignated net assets to the risk management reserve to bring the balance up to an equivalent of 60 days of operating expenditure.

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, 2004	7,549	-	-	-	1,476	9,025
Board of Trustees appropriation	-	-	-	-	-	-
Capital reserve replenishment	-	-	-	-	-	-
Acquisition of fixed assets	-	-	-	-	-	-
Net surplus (deficit) for the year	-	-	-	-	(275)	(275)
Balances, December 31, 2004	7,549	-	-	-	1,201	8,750
Board of Trustees re-designation	(7,549)	10,000	2,043	1,000	(44)	5,450
Capital reserve replenishment	-	-	-	-	-	-
Acquisition of fixed assets	-	-	-	-	-	-
Net surplus (deficit) for the year	-	-	(1,215)	(256)	(267)	(1,738)
Balances, December 31, 2005	-	10,000	828	744	890	12,462

On September 16, 2005 the Board of Trustees approved the re-designation of US$3,261 thousand, 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$45,339 thousand and US$48,448 thousand as of December 31, 2005 and 2004, 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, 2005.

Note 15 - Leases

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:

a. 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.

b. 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.

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.

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.

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.

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 an operating lease.

Note 16 - Other revenues

This account consists of:

	2005	2004
Investment income	1,130	1,706
Realized foreign exchange gain	293	112
Self-sustaining activities	306	377
Miscellaneous	129	345
	1,858	2,540

Note 17 - Indirect cost rate

The indirect cost recovery rate computed as per the CGIAR Financial Guideline No. 5 is 20.99% and 21.04% in 2005 and 2004, 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.

EXHIBIT 1

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

SCHEDULES OF GRANT REVENUE
FOR THE YEARS ENDED DECEMBER 31, 2005 AND 2004
(In Thousands of US Dollars)

	2005				
Donors	Total Funds Available	Accounts Receivable	Advance Payment	Grant	Grant 2004
UNRESTRICTED AGENDA					
Australia	1,179	-	(563)	616	558
Belgium	-	-	-	-	98
Canada	863	-	-	863	1,086
China	-	140	-	140	140
Denmark	443	-	-	443	458
Germany	158	-	-	158	301
Japan	-	1,831	-	1,831	2,862
Korea	150	-	-	150	150
Netherlands	637	-	(205)	432	409
Norway	303	-	-	303	294
Philippines	82	15	-	97	90
Sweden	735	-	(226)	509	557
Switzerland	497	-	-	497	316
Thailand	-	40	-	40	58
United Kingdom	2,017	-	-	2,017	2,007
United States	2,400	800	-	3,200	3,730
Vietnam	15	-	-	15	15
World Bank	1,750	-	(200)	1,550	1,650
Subtotal	11,229	2,826	(1,194)	12,861	14,779
TEMPORARILY RESTRICTED					
Asian Development Bank (ADB)	647	233	(91)	789	563
Australia	444	-	(88)	356	260
Bill & Melinda Gates Foundation through Albert - Ludwigs University of Friedburg	117	-	(117)	-	-
Brazil	20	-	(20)	-	5
Canada	125	-	(19)	106	111
European Commission	225	1,705	-	1,930	1,972
France	330	142	-	472	728
Food and Agricultural Organization of the United States (FAO)	-	-	-	-	122
Germany	1,541	-	(537)	1,004	1,017
Graduate Institute for Policy Studies (GRIPS)	-	-	-	-	21
Grain Biotech Australia (GBA)	39	-	(20)	19	1
HTSPE Limited	92	-	-	92	8
India	-	150	-	150	150
International Development Research Centre (IDRC)	14	2	-	16	9

Donors	2005 Total Funds Available	2005 Accounts Receivable	2005 Advance Payment	2005 Grant	Grant 2004
International Fund for Agricultural Development (IFAD)	533	127	(192)	468	547
International Fertilizer Industry Association (IFA)/ International Potash Institute (IPI) Potash and Phosphate Institute (PPI)/Potash and Phosphate Institute of Canada (PPIC)/	216	-	(70)	146	117
Iran	358	-	(280)	78	102
Japan	342	1,100	(238)	1,204	1,337
Korea	1,124	26	(502)	648	572
Monsanto Fund	33	57	-	90	78
Nunza BV	42	-	(21)	21	14
Philippines	42	21	(8)	55	11
Rockefeller Foundation (RF)	1,244	-	(414)	830	717
Spain	(25)	25	-	-	25
Switzerland	1,991	14	(488)	1,517	2,265
United Kingdom	181	20	(14)	187	4,198
United States Agency for International Development (USAID)	857	39	(585)	311	475
United States Department of Agriculture (USDA)	(230)	304	-	74	161
World Bank	905	19	(396)	528	290
Others	113	4	(23)	94	104
Subtotal	11,320	3,988	(4,123)	11,185	15,980
Total Agenda Grants	22,549	6,814	(5,317)	24,046	30,759
CHALLENGE PROGRAMS					
Water and Food	3,156	8	(511)	2,653	727
Generation	2,069	60	(384)	1,745	740
Harvest Plus	573	90	(170)	493	410
Total Challenge Programs	5,798	158	(1,065)	4,891	1,877
	28,347	6,972	(6,382)	28,937	32,636

EXHIBIT 2

THE INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for Profit Organization)

SCHEDULES OF TEMPORARILY RESTRICTED AGENDA
AND CHALLENGE PROGRAMS FUNDINGS
FOR THE YEAR ENDED DECEMBER 31, 2005
(In Thousands of US Dollars)

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2005	Expenditures Total
TEMPORARILY RESTRICTED AGENDA					
Asian Development Bank (ADB)					
Sustaining Food Security in Asia through the Development of Hybrid Rice Technology (Phase 2)	01/01/02 - 31/08/05	1,000	828	172	1,000
Improving Poor Farmer's Livelihood Through Post-Harvest Technology	11/07/05 - 10/07/08	750		58	58
Improving Poor Farmer's Livelihood Through Rice Information Technology	19/11/04 - 18/11/07	1,000		26	26
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	191
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- 31/12/06	900	181	342	523
		4,350	1,009	789	1,798
Australia					
Growing More Rice with Less Water: Increasing Water Productivity in Rice-based Cropping System	01/07/01 - 31/12/05	102	74	28	102
Impact of migration and/or off-farm employment on roles of women and appropriate technologies in Asian and Australian Mixed Farming Systems	01/07/04-30/06/07	369	37	90	127
Seeds of Life - East Timor	01/11/00 - 30/06/05	46	39	7	46
I-learn Rice: Development of Interactive Learning Packages for Rice Production Training (Rice Doctor Project, Phase 2) (Commissioned Organization is the University of Queensland)	01/06/04 - 30/11/05	5		5	5
Fertilization-Independent Formation of Embryo, Endosperm and Pericarp for Apomictic Hybrid Rice	01/07/03 - 30/06/08	1,090	292	226	518
Increased Productivity of Rice-based Cropping Systems in Lao PDR, Cambodia and Australia	01/07/00 - 30/06/05	12	4		4
		1,624	446	356	802
Bill and Melinda Gates Foundation 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 - 27/09/10	168	0	0	0
Canada					
Developing Efficient Methods for Detecting Genes Enhancing Rice Drought Tolerance (CCLF)	01/04/04 - 31/03/07	118	20	38	58
Fund for Africa	01/01/05 - 31/12/05	68		68	68
		186	20	106	126

EXHIBIT 2

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2005	Expenditures Total
European Commission					
Coordinating NGO Interventions for Improving Small and Marginal Farmer's Households, Livelihood and Food Security in Bangladesh	01/07/04 - 30/06/09	1,800	160	299	459
Germplasm Conservation, Characterization, Documentation and Exchange (Asia)	01/01/05 - 31/12/05	393		393	393
Functional Genomics (Asia)	01/01/05 - 31/12/05	395		395	395
Functional Genomics (Africa)	01/01/05 - 31/12/05	95		95	95
Genetic Enhancement for Improving Productivity and Human Health in Fragile Environments (Africa)	01/01/05 - 31/12/05	189		189	189
Genetic Enhancement for Improving Productivity and Human Health in Fragile Environments (Asia)	01/01/05 - 31/12/05	559		559	559
		3,431	160	1,930	2,090
France					
IRRI/France Collaborative Projects	01/01/05 - 31/12/05	472		472	472
Germany					
Food Security and Commercialization in Uplands of Northern Vietnam	01/10/03 - 28/02/06	23	8	1	9
Nutrient Management in Aerobic Rice Systems	01/07/05 - 30/06/08	194		24	24
Genetics of Physiology of Phosphorous Uptake in Rainfed Rice	01/12/01 - 30/06/05	252	207	43	250
Applying Genetic Diversity and Genomic Tools to Benefit Rice Farmers at Risk from Drought	01/02/04 - 31/01/07	597	31	173	204
From Genes to Farmers' Fields: Enhancing and Stabilizing Productivity of Rice in Submergence Prone Environments	01/01/04 - 31/12/06	893	147	365	512
Managing Crop Residues for Healthy Soils in Rice Ecosystems	01/04/03 - 30/09/06	1,417	707	398	1,105
		3,376	1,100	1,004	2,104
Grain Biotech Australia					
IRRI Collaborative Project on "Further Development of the International Crop Information System"	01/08/04 - 31/07/07	60	1	19	20
HTSPE Limited					
Innovations in Communications for Rural Extension Workshop	01/09/04 - 01/06/05	100	8	92	100
India					
IRRI/India Collaborative Project	01/01/05-31/12/05	150		150	150
International Development Research Center (IDRC)					
Efficiency Improvement & Environment Sustainability: Exploring the Economy of Fertilizer-Nitrogen Use of Irrigated Rice in China	01/01/03 - 31/12/05	25	9	16	25
International Fund for Agricultural Development (IFAD)					
Managing Rice Landscapes in the Marginal Uplands for Household Food Security and Environmental Sustainability	26/07/05 - 30/09/08	1,190		127	127
Accelerating Technology Adoption to Improve Rural Livelihood in the Rainfed Eastern Gangetic Plains	22/09/03 - 30/09/06	1,500	468	341	809
		2,690	468	468	936
International Fertilizer Industry Association (IFA)/International Potash Institute (IPI)/Potash and Phosphate Institute (PPI)/Potash and Phosphate Institute of Canada (PPIC)					
Reaching Towards Optimum Products	01/01/01 - 30/06/05	441	341	100	441
PPI/PPIC - Reaching Towards Optional Productivity in Intensive, Irrigated Rice Systems: The Development, Evaluation and Delivery of site- specific Nutrient Management in Myanmar	01/07/02 - 30/06/05	15	12	3	15
The Irrigated Rice Research Consortium Phase III-Site Specific Nutrient Management	01/01/05 - 31/12/08	432		43	43
		888	353	146	499
Iran					
Scientific & Technical Cooperation between IRAN & IRRI	01/01/99 - 31/12/06	1,210	852	78	930

EXHIBIT 2

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2005	Expenditures Total
Japan					
Germplasm Conservation, Characterization, Documentation and Exchange :	01/01/05 - 31/12/05	200		200	200
Rice and Biofertilizer Genetic Resources Conserved and Characterized					
Functional Genomics:	01/01/05 - 31/12/05	200		200	200
Genetic Enhancement for Yield, Grain Quality, and Stress Resistance:	01/01/05 - 31/12/05	200		200	200
Managing Resources under Intensified Rice-Based Systems:	01/01/05 - 31/12/05	200		200	200
Genetic Enhancement for Improving Productivity and Human Health in Fragile Environments:	01/01/05 - 31/12/05	100		100	100
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					
Natural Resource Management for Rainfed and Upland Rice Ecosystems Activities	01/01/05 - 31/12/05	100		100	100
Enhancing Ecological Sustainability and Improving Livelihoods through Ecoregional Approaches to Integrated Natural Resource Management	01/01/05 - 31/12/05	100		100	100
The Ecoregional Concept for INRM Adopted and Systems Approaches Applied for Improving Livelihoods and Sustaining Natural Resources					
Development of Integrated Rice Cultivation System Under Water Saving Conditions	01/10/04 - 30/09/09	1,699	23	96	119
Collaborative Research on Socioeconomic Constraints to Adoption of Technology and Farmer's Response	01/04/05-31/03/07	25		8	8
		2,824	23	1,204	1,227
Korea					
Korea Support to IRRI's program	01/01/05 - 31/12/05	50		50	50
Wide Hybridization and Gene Introgression for Rice Improvement	01/07/03-30/06/06	150	80	47	127
Rice Functional Genomic Approach Against Rice Blast Disease	01/07/03-30/06/06	150	41	45	86
Analysis of Virus Resistance Mechanism in Rice Plants Using Disease-Related Gene Expression Profiles	01/02/03 - 31/12/05	60	39	21	60
Cooperative Funding for Korea-IRRI Collaborative Projects	01/01/99 - 31/12/05	365	242	55	297
Korea-IRRI Collaborative Project (Germplasm Utilization and Value-Added)	01/01/01 - 31/12/05	240	118	25	143
IRRI Korea Office	17/11/01 - 31/12/05	973	725	283	1,008
Large Scale Korean Seed Multiplication Project	01/11/05 - 30/04/06	170		16	16
Improvement of water management to control non-point pollution from rice paddy field	20/04/04-31/12/05	10		4	4
Comparative study on the factors in the decision-making process of Korean & Filipino farmers in environment-friendly agriculture	20/04/04-31/12/05	10		10	10
Molecular Characterization and Allele Mining of Korean Rice Germplasm and Extension to the IRRI Core Collection	01/09/04-31/08/06	40	6	13	19
Development of Water Saving Technology for Increasing Water Productivity in rice Cultivation	01/04/04-31/12/06	48	10	12	22
Study on Leaf Senescence Pattern and Grain Filling of Irrigated Rice	20/04/04-31/12/05	10	1	9	10
Development of Varieties Resistant to Bacterial blight in Japonica Rice	20/04/04-31/12/05	10	2	8	10
Breeding of Super High Yielding Rice Variety	20/04/04-31/12/05	10	10		10
Breeding for Micronutrient-Enriched Japonica Rice for Improving Human Health	01/04/05 - 31/03/08	60		15	15
Identification of Resistance Genes for Biotic Stresses in Rice Through the Location/Expression Candidate Association Approach	01/01/06 - 31/12/08	90			
Korean Seed Multiplication Project	01/07/91 - 31/12/05	272	197	35	232
		2,718	1,471	648	2,119

EXHIBIT 2

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2005	Expenditures Total
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	78	90	168
NUNZA BV					
Further Development of International Crop Information Systems (ICIS) in collaboration with Nunza	01/04/02 - 31/03/06	80	38	21	59
Philippines					
Assessing the Impact of Potential Trade Liberalization of the Philippine Rice Sector	01/01/02 - 31/12/06	37	29	1	30
Hybrid Nucleus and Breeder Seed Production (PhilRice - UPLB-IRRI)	16/01/04 - 15/01/08	11	3	8	11
Developing New Plant Type for Direct Seeding Rice Production Systems in the Philippines	20/05/04 - 19/05/07	90		46	46
		138	32	55	87
Rockefeller Foundation (RF)					
Using Entertainment-Education (EE) Approach to Motivate Rice Farmers to Reduce Pesticide Use in the Mekong Basin	01/01/03-31/12/05	300	186	105	291
Detecting Alleles Conferring Improved Reproductive-Stage Drought Tolerance in Rainfed Rice	01/04/04-31/03/07	276	115	77	192
Marker Aided Breeding for Development of Drought Tolerant IR64 Lines (Support for Dr. Devendra Dwivedi)	01/07/04 - 30/09/05	60	34	26	60
Developing and Disseminating Resilient and Productive Rice Varieties for Drought-Prone Environments in India	01/03/05 - 28/02/08	610		141	141
Introgression of Genes for Drought Tolerance from Oryza glaberrimainto indica rice	01/04/05 - 31/03/08	76		21	21
International Rice Genetics Symposium	01/05/05 - 30/04/06	50		41	41
Research and Training Cost in Advance Techniques of Biotechnology at ARBN Laboratory of IRRI	01/01/05 - 31/12/06	25		5	5
Tilling of Rice (Identification and Characterization of Genes that have the Potential to Enhance Drought Tolerance in Rice)	01/09/03 - 30/08/06	125	39	21	60
Research on Economic Value of Rice Biotechnologies Recently Adopted by Asian Farmers	01/08/03 - 30/11/05	35	34	1	35
Pathway Dissection and Candidate Gene Identification for Drought Tolerance in Rice by a Forward Genetics Approach	01/03/05 - 28/02/08	582		156	156
Support for Post-Doctoral Fellow on Mass Screening of Rice for Drought Tolerance	01/04/02 - 31/03/05	150	113	1	114
Molecular Disection and Marker Assisted Breeding of Drought Tolerance in Rice	01/04/02 - 31/03/05	362	167	13	180
Marker Aided Pyramiding of QTLs for Development of Drought Tolerant IR64	01/04/02 - 30/09/06	117	115	1	116
Screening Methods for Improving Grain Yield under Reproductive Drought Stress in Rainfed Rice	01/04/02 - 30/09/06	446	415	22	437
Training of NARES Scholars at IRRI to Support Bioinformatics Integration of Genetic, Genomic, Proteomic Data for Marker-Aided Selection for Drought Tolerance	01/04/02 - 31/03/05	144	117	27	144
Fine Research on Mapping QTL's for Blast Resistance and the Introgression of Major Genes and QTL's for Durable Blast Resistance in Rice	01/04/99- 30/04/05	45	30	11	41
Molecular Genetics Component	01/04/05- 30/09/06	107		44	44
Physiology Component	01/04/05- 30/09/06	131		91	91
Economic Costs of Drought and Rainfed Farmers' Coping Mechanism	01/04/02-30/09/06	93	66	26	92
		3,734	1,431	830	2,261

EXHIBIT 2

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2005	Expenditures Total
Switzerland					
Lao-IRRI - Rice Research and Training Project Phase V	01/07/03 - 31/03/06	1,852	1,161	594	1,755
The Irrigated Rice Research Consortium - Phase III					
Irrigated Rice Research Consortium Management Team	01/01/05 - 31/12/08	1,446		183	183
Productivity Workgroup	01/01/05 - 31/12/08	402		107	107
Water saving Workgroup	01/01/05 - 31/12/08	356		70	70
Labor Productivity	01/01/05 - 31/12/08	356		65	65
Post production Workgroup	01/01/05 - 31/12/08	353		91	91
Lao PDR Rice Biodiversity Project, Phase 2	01/01/03 - 31/12/05	423	241	118	359
Rice Mutant Bank and Resource Platform for Functional Genomics	01/08/01 - 31/01/06	975	660	289	949
		6,163	2,062	1,517	3,579
United Kingdom					
Promotion of Integrated Weed Management for Direct Seeded Rice in the Gangetic Plains of India	01/01/03 - 31/03/05	78	54	24	78
Validation and Promotion of Technologies for Rice Sheath Blight Management	01/02/05 - 31/01/06	45		22	22
Promotion of Weed Management Options for Irrigated Rice in India: IRRI Component	01/04/05 - 31/01/06	80		51	51
Rice Weed Decision Support : IRRI Component	01/04/05 - 31/01/06	55		22	22
Managing Rice Pest in Bangladesh: Improving Extension Service Information Management for Policy Planning	01/02/05 - 31/01/06	31		12	12
Promotion of Cost-Effective Weed Management Practices for Lowland Rice in Bangladesh	01/01/03 - 31/03/05	155	99	56	155
		444	153	187	340
United States					
United States Agency for International Development (USAID)					
Testing, Comparing, NuMaSS: The Nutrient Management Support System	01/09/03 - 30/09/07	37	14	11	25
Development of Rice Biotechnology Products for Asia: Technical and Pre-regulatory Components	01/01/05-31/12/05	600		167	167
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	91	79	170
KSU - CCGI An Information System to Link Genotype to Phenotyple Comparatively Across Diverse Cereal Crops	01/03/04 - 30/09/06	58	7	2	9
The Development of Adapted Germplasm for India with High Levels of Pro Vitamins Carotenoids	01/01/05 - 31/12/07	400			
Integrated Crop Management Training Workshop in Timor-Leste	01/04/05 - 31/12/05	5		5	5
Assessing the Potential Scale and Impact of Transgenic Outcrossing to Wild and Weedy Rices in Vietnam	01/10/01 - 31/03/05	400	353	47	400
		1,775	465	311	776
United States Department of Agriculture (USDA)					
Participatory Assessment of Social and Economic Impacts of Biotechnology	15/09/01 -31/03/06	120	43	34	77
KSU - Contribution of Three Defense Response Genes in Quantitative Disease Resistance	01/07/03 - 30/06/06	134	75	33	108
Tilling and Ecotilling Resources of Japonica and Indica Rice	01/04/04 - 31/03/07	90		7	7
		344	118	74	192
World Bank					
Upgrading the International Rice Gene Bank Collection at IRRI	01/01/03 - 31/12/06	1,164	598	310	908
Advanced Research Networking for the CGIAR	01/08/04 - 28/02/06	112	20	89	109
Environment Radio Soap Opera for Rural Vietnam	01/07/05 - 15/06/07	132			
Project on Security and Business Continuity	01/03/04 - 31/03/06	441		129	129
		1,849	618	528	1,146

EXHIBIT 2

Donor and Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	Expenditures 2005	Expenditures Total
Others		223	90	94	184
Total Temporarily Restricted Agenda		39,242	11,005	11,185	22,190
CHALLENGE PROGRAMS					
Water and Food	01/11/02 - 31/10/09	12,837	955	2,653	3,608
Generation	01/01/04 - 28/02/08	4,668	740	1,745	2,485
Harvest Plus	09/09/03 - 31/12/07	1,644	476	493	969
Total Challenge Programs Fundings		19,149	2,171	4,891	7,062
GRAND TOTAL		58,391	13,176	16,076	29,252

EXHIBIT 3

INTERNATIONAL RICE RESEARCH INSTITUTE

(A Nonstock, Not-for-Profit Organization)

DETAILS OF OPERATING EXPENSES
FOR THE YEARS ENDED DECEMBER 31, 2005 and 2004
(In Thousands of US Dollars)

	2005								
	Program Related				Management and General				
	Research Programs	Research Support	Technical Support	Sub-total	Management	General Administration	Sub-total	Total	2004
UNRESTRICTED									
Personnel Costs	3,813	839	1,250	5,902	2,251	-	2,251	8,153	6,402
Supplies & Services	2,156	533	835	3,524	754	3,586	4,340	7,864	7,371
Collaborators/Partners	243	-	-	243	-	-	-	243	723
Operational Travel	871	27	81	979	29	-	29	1,008	858
Depreciation	680	253	340	1,273	333	201	534	1,807	1 ,909
Total Operating Expenses	7,763	1,652	2,506	11,921	3,367	3,787	7,154	19,075	17,263
Recovery of Indirect Cost	-	-	-	-	-	(1,266)	(1,266)	(1,266)	(1,906)
Sub-Total	7,763	1,652	2,506	11,921	3,367	2,521	5,888	17,809	15,357
RESTRICTED									
Personnel Costs	4,272	8	16	4,296	-	-	-	4,296	6,049
Supplies & Services	3,096	99	279	3,474	327	-	327	3,801	5,081
Collaborators/Partners	1,311	-	-	1,311	-	-	-	1,311	3,303
Operational Travel	1,253	10	96	1,359	179	-	179	1,538	1,192
Depreciation	239	-	-	239	-	-	-	239	355
Sub-Total	10,171	117	391	10,679	506	-	506	11,185	15,980
CHALLENGE PROGRAMS									
Personnel Costs	851	-	-	851	-	-	-	851	466
Supplies & Services	1,090	-	-	1,090	-	-	-	1,090	672
Collaborators/Partners	2,590	-	-	2,590	-	-	-	2,590	563
Operational Travel	360	-	-	360	-	-	-	360	176
Sub-Total	4,891	-	-	4,891	-	-	-	4,891	1,877
Grand Total	22,825	1,769	2,897	27,491	3,873	2,521	6,394	33,885	33,214

EXHIBIT 4

INTERNATIONAL RICE RESEARCH INSTITUTE
(A Nonstock, Not-for-Profit Organization)

CALCULATIONS OF INDIRECT COST RATE
FOR THE YEARS ENDED DECEMBER 31, 2005 AND 2004
(In Thousands of US Dollars)

	2005	2004
INDIRECT COST		
Administrative expenses	2,670	2,503
Common sustenance services	3,209	3,262
Total indirect costs	5,879	5,765
DIRECT COSTS		
Research programs	24,482	24,239
Research support	4,163	4,114
Operations	627	949
Total	29,272	29,302
Less: Overhead recovery	1,266	1,906
Net direct costs	28,006	27,396
Total operating costs	33,885	33,161
INDIRECT COST RATES:		
Indirect costs	5,879	5,765
Total operating costs	33,885	33,161
Rate	17.35%	17.38%
Indirect costs	5,879	5,765
Direct costs	28,006	27,396
Rate	20.99%	21.04%