Report of the Director General, 2003-04

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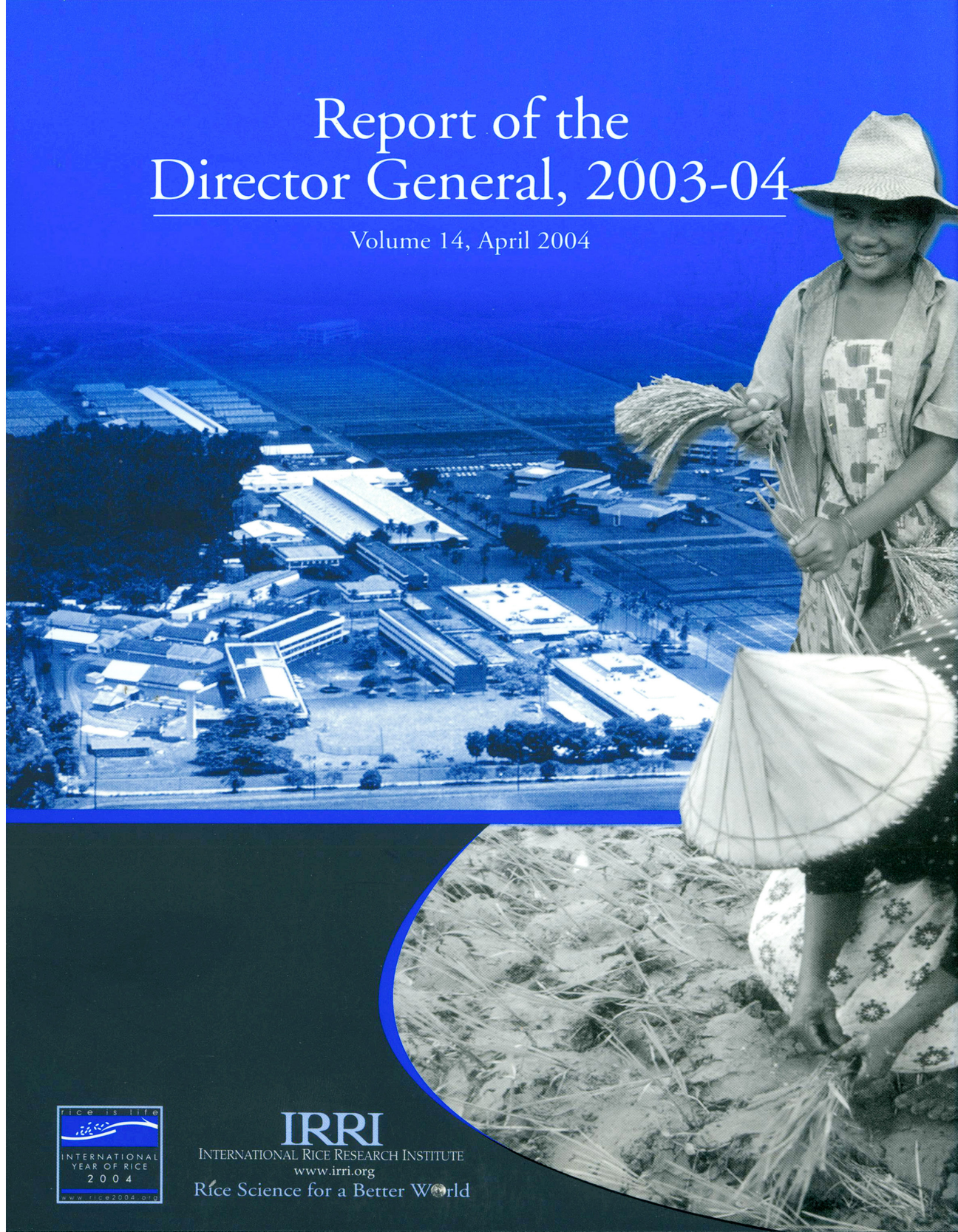

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Report of the Director General 2003–04 Volume 14

Contents

A message from the director general

A time of important preparation for the future—IYR, EPMR, strategic planning, funding shortages, IRRI-CIMMYT alliance

International Year of Rice 2004. With the 16 December 2002 announcement that the 57th Session of the UN General Assembly had adopted 2004 as the International Year of Rice (IYR), 2003 was a busy year of preparation at IRRI. We formed international and institutional committees composed of selected IRRI staff members. The International Committee developed plans and budgets for 2004 events such as the International Rice Science Conference in Korea (13-15 September), the Fourth International Crop Science Conference in Australia (26 September-1 October), the Mekong Rice Conference in Vietnam (15-17 October), the World Rice Research Conference in Japan (4-7 November), the ASEAN AMAF Meeting in Myanmar and Summit in Laos, the CGIAR AGM in Mexico, the McNamara Lecture in Tokyo, the FAO Asia-Pacific Ministerial Conference in Beijing, and various IRRI workshops and seminars.

The Institutional Committee has proposed, overseen, and coordinated all IYR activities at IRRI and involving IRRI in the Philippines, including very successful special days already held at headquarters in 2004—the *Araw ng Magsasaka* (Farmers' Day) on 3 March and International Day on 4 March.

Meanwhile, FAO launched IYR2004 on 31 October 2003 at the United Nations in New York, where FAO Director General Jacques Diouf stressed that "rice is the staple food of more than half the world's population, but its production is facing serious constraints." Later, FAO convened a two-day Rice Conference at its headquarters in Rome, 12-13 February. The Conference brought together leading experts from around the world to present their perspectives on the latest trends and industry developments. I was happy to represent IRRI along with **Mahabub Hossain**, **David Dawe**, and **Gurdev Khush**. I think participants at both of these international events did good jobs mobilizing the international community to face the most pressing issues confronting the global rice sector, from local farming practices to international trade.

Sixth EPMR. In March 2003, the CGIAR's interim Science Council announced that the Sixth External Program and Management Review (EPMR) of IRRI would be conducted in March-April 2004. Subsequently, I appointed an EPMR task force, chaired by **Mahabub Hossain** (SSD), that provided the leadership for IRRI to prepare for this important activity. Other task force members were **Mike Jackson** (DPPC), **Kwame Akuffo-Akoto** (Finance), **Darshan Brar** (PBGB), **Tom Mew** (EPPD), **Gene Hettel** (CPS), **Renee Lafitte** (CSWS), and **Vethaiya Balasubramanian** (IPMO / TC). As task force secretary, Dr. Jackson was the main contact with the iSC / SC and the review panel. In early August, **Prof. Richard Flavell**, chief scientific officer of Ceres Inc., was named the review panel chair.

The EPMR task force compiled an impressive set of requested documents that were placed on a special Web site for the review panel members in advance of their first visit to IRRI for the preliminary phase in late November-early December 2003. In addition to Prof. Flavell, the panel members were **Mr. John Griffith**, retired specialist in finance and general management; **Dr. Huhn-Pal Moon**, vice administrator, Rural Development Administration, Korea; **Dr. Ann Hamblin**, director, Agricultural Production and Natural Resources, Bureau of Rural Sciences, Canberra; **Dr. Martin Kropff**, professor of weed science, Agricultural University, Wageningen; and **Dr. Ammar Siamwalla,** former president, Thailand

Development Research Institute. **Ms. Sirkka Immonen** and **Mr. John McKim** joined the panel as resource person for the Science Council and consultant on management issues, respectively. During its main-phase visit to the Institute, 11-24 March 2004, the panel further consulted with staff and completed and delivered an eight-chapter report. We are now preparing our response.

Institute strategy-planning workshops in May, July, and August. Management organized two-day strategy-planning workshops for IRS and NRS in May and July, respectively. The workshops solicited IRS and NRS inputs in examining IRRI's strategic plan, vision, mission, and the opportunities and challenges facing the Institute and were very useful in developing a strategic framework that will guide the Institute's development over the next decade. Participants at both workshops analyzed the external environment in which IRRI operates and how this affects what the Institute does. By the end of both meetings, several strategic goals had been formulated, among which was a renewed commitment to keep IRRI at the forefront of rice science. **Dr. Peter Malvicini**, Cornell University research associate, facilitated both workshops.

On 12 August, a cross-section of IRS and NRS met during a mini-workshop to consolidate the results of the May and July workshops. Again with assistance from Dr. Malvicini, participants shared and affirmed strategic goals, consolidated the goals and action points, and then organized and prioritized the consolidation. Participants were **Kwame Akuffo-Akoto**, **Vethaiya Balasubramanian**, **Albert Borrero**, **Tom Clemeno**, **Corinta Guerta**, **Gene Hettel**, **Mahabub Hossain**, **Mike Jackson**, **Renee Lafitte**, **Duncan Macintosh**, **Graham McLaren**, **Piedad Moya**, **Elisa Panes**, **Mila Ramos**, **Donna Robles**, **Tess Rola**, **Rudy Toledo**, **Rolando Torres**, and **To Phuc Tuong.** The consolidated outputs, circulated to all staff via the intranet, are being considered in updating the current strategic plan document and revising the Institute's Medium-Term Plan.

Team IRRI established. Over the last several years, IRRI has seen some serious reductions in core funding to the CG centers. The unfortunate reality is that this decrease in core funding will continue. Thus, centers have to evaluate their comparative advantages, how they can better use the funds they have, and how they can raise more funds. Like other large, established, and successful institutes, IRRI has to adjust to the new environment—and must do this as quickly and as efficiently as possible.

To facilitate this effort, I established in early April the "Team IRRI" task force, which is responsible for raising awareness of the changing environment and identifying possible responses to it. Team IRRI members are **Mark Bell** (chair), **Bas Bouman**, **Tom Clemeno**, **Gary Jahn**, **Katherine Lopez**, **Duncan Macintosh**, **Graham McLaren**, **Lilian Mendoza**, **Sushil Pandey**, **Parminder Virk**, and **Ian Wallace**.

Their major task is to collect suggestions from IRRI staff and to help develop an effective feedback mechanism on how the Institute can adapt to changing circumstances. The team, which has been looking at various ways to improve communication and collect feedback, welcomes receiving staff input at any time.

IRRI-CIMMYT alliance. In April 2003, the Boards of Trustees of IRRI and CIMMYT agreed to explore opportunities for closer collaboration. In September 2003, the Rockefeller Foundation was asked to provide leadership for the process of exploring various options for an IRRI-CIMMYT Alliance. In November 2003, Dr. Gordon Conway, president of the Rockefeller Foundation, proposed establishing an Oversight Committee and a Working Group to examine recent recommendations that there be closer ties between IRRI and CIMMYT. In January 2004, Ken Cassman, Dunstan Spencer, Bob Clements, Gary Toenniessen, and Jikun Huang were named to the Working Group. At press time, the Oversight Committee membership was still being finalized, with Dr. Conway as the chair. The Working Group will visit IRRI, China, and India, as it works toward preparing a report for submission to the Oversight Committee, which will meet in

September 2004. A well-written article on this issue appeared in the 27 February 2004 issue of Science [303(5662):1281-1283].

Naming and designating elite IRRI germplasm

The Institute believes that there is a need for an appropriate mechanism to help trace IRRI-developed elite rice germplasm so that impact can be more easily documented. An ad hoc committee was convened to draw up general guidelines for naming IRRI elite lines and recommend more permanent mechanism for naming these lines. To this end, an IRRI Committee for Naming Elite Germplasm was established in May composed of **David Mackill** (chair), **Graham McLaren**, **Edwin Javier**, **Sant Virmani**, **Tom Mew**, **Shaobing Peng**, and **Vethaiya Balasubramanian**. The committee is currently 1) developing a naming system to be used for IRRI elite germplasm and to submit to the DDG-R, DDG-P, and me for approval; 2) adopting the approved naming system and determining the guidelines on how breeding lines would be proposed and criteria for deciding which lines to rename; and 3) reviewing and evaluating the nominated IRRI elite lines to be named and making recommendations to me for approval.

Strategic Initiative Fund

In early 2003, IRRI Management established a Strategic Initiative Fund (SIF) to bridge gaps in areas of geographic / agro-political priority (i.e., projects of capacity-building activities in a rice-producing developing country that are not currently given priority by donors) and / or scientific or technical investigations that could lead to significant impact / return but are not currently successful in attracting special project funding. Management allocated up to US$200,000 from the 2003 core research program budget for this initiative. The first four projects selected are 1) Physiological strategies for enhancing yield and NRM, $54,000; principal investigator (PI) / project manager (PM): **John Sheehy** (Project 4, Program 2 for 2003-05); 2) Breeding aerobic rice cultivars for the tropics, $50,000; PI / PM: **Gary Atlin** (Project 7, Program 3 for 2003-05); 3) Myanmar: a case for the future, $50,000; PI / PM: **Mark Bell** (Organize a new training workshop series in Myanmar during 2004-05); and 4) Toward improving and sustaining rice productivity in Central Asia and the Caucasus region (CAC), $40,000; PI / PM: **Abdel Ismail** (Project 12 for 2003-04).

Update on IRRI staffing and BOT membership

New long-term IRS classification and title scheme. A new IRS classification and title scheme was finalized in September 2003 through the effort of the staff task force and a series of discussions involving OU heads and the Management Committee. After consultations and agreement with the research OU heads, weighted impact evaluation for each research IRS was put into place and will be used in classification and future PAS activities. In this new classification system, IRS given the ranks of scientist and senior scientist were informed of their new titles in their 2003 annual letters, which were distributed shortly before the Christmas break (see the personnel list beginning on page 117). In addition, I am pleased to announce the first two principal scientists coming out of this new classification system, effective 1 March 2004. They are **Twng-Wah Mew**, principal scientist, plant pathology, and **Sant Singh Virmani**, principal scientist, plant breeding.

Changes in responsibility. In April 2003, **T.P. Tuong** was named the new head of Crop, Soil, and Water Sciences (CSWS). Also in April**, John Bennett**, IRRI biotechnologist, was appointed as the new Theme 1 (Improving water productivity) leader of the Challenge Program on Water and Food. He is devoting about 50% of his time to this duty. In November 2003, he organized the Theme 1 kickoff workshop at IRRI during which participants focused on how farmers can gain timely access to water, use it efficiently for crop production, and produce more food with less water under circumstances of actual or economic water scarcity.

Renee Lafitte was appointed as the new team leader for Project 7, *Genetic enhancement for improving productivity and human nutrition in fragile environments*, under Program 3, replacing Dr. Bennett to allow him more time to devote to CP activities.

In August, **Swapan Datta**, IRRI plant biotechnologist, was appointed as the rice crop leader of the CGIAR HarvestPlus Challenge Program. Initially, Dr. Datta has been devoting about 50% of his time to this duty while continuing his current IRRI research responsibilities. He organized the HarvestPlus Rice Crop Meeting held at IRRI 6-8 October 2003, during which participants planned strategies to alleviate malnutrition through the development of high-nutrition rice.

IRRI posted **Zhikang Li**, plant molecular geneticist, at the Chinese Academy of Agricultural Sciences (CAAS), where he is now molecular geneticist and coordinator of the International Network for Molecular Breeding. The appointment, which was based on the memorandum of agreement for collaboration in functional genomics and molecular breeding through the posting of an IRRI scientist at CAAS and effective for 3 years, started 1 December 2003.

Jagdish K. Ladha, currently senior scientist, soil science, and coordinator of the Rice-Wheat Consortium, will be moving to Delhi in June 2004 to better facilitate his research activities. At that time, he will also become liaison scientist for India.

Departures and arrivals since the last DG Report. On 30 September, **Tang Sheng-Xiang**, IRRI liaison scientist for China, departed after 6 years of service and contribution to the Institute. Dr. Tang was replaced by **Zhao Kai-Jun**, who brings more than 10 years' research experience in plant genetics and breeding of rice and other crops.

Andrew Martin Mortimer, weed ecologist in CSWS (1996-2003), departed after 7 years of advancing the Institute's rice weed management agenda. He was replaced by **David Johnson**.

Stephan Haefele joined CSWS as soil scientist / agronomist. **Gerard F. Barry** joined the Partnerships Program as the new Golden Rice Network coordinator. **Yolanda Chen-Fanslow** joined EPPD as scientist, entomology.

Melissa Fitzgerald will be arriving 15 April 2004 as an international research fellow in the newly established Grain Quality and Nutrition Research and Training Center.

Departing in the coming days and months will be **Thanda Wai**, intellectual property rights specialist (2001-March 2004); **Albert Atkinson**, training and coursewares specialist (2001-May 2004); **Ho-Yeong Kim**, senior scientist and IRS seconded from the Rural Development Administration in Korea (2001-June 2004); **Karl Goeppert**, IRRI representative and project team leader for the Lao-IRRI Project (2002-May 2004); **Ram Kathin Singh**, liaison scientist for India (1995-June 2004); and **Twng-Wah Mew**, principal scientist, plant pathology (1975-August 2004).

The Institute welcomed three new members of the Board of Trustees for 2004-06 terms—**Ruth Khasaya Oniang'o** (Kenya), **Baowen Zhang** (China), and **Ronald L. Phillips** (United States)—and bid farewell to **Mrs. Angeline Kamba** (Zimbabwe, 1998-2003, chair, 2001-03), **Song Jian** (1998-2003, China), and **Mike Gale** (United Kingdom, 2001-03). **Keijiro Otsuka** (2002-04, Japan) assumed the BOT chair on 1 January 2004.

A complete listing of staff arrivals and departures, which includes postdoctoral fellows and international research fellows, begins on page 87.

Significant activities and events since last *DG Report* in 2003 and early 2004

Visit to Korea. Upon invitation from the Rural Development Administration (RDA) and to sign a memorandum of agreement between IRRI and RDA that will provide funds to IRRI over the next 3 years, I visited RDA on 15-20 June. I held discussions with Mr. Yung-Wook Kim, RDA administrator, and his colleagues Dr. Hyun-Pal Moon, deputy administrator, Dr. Seok-Dong Kim, director general

for research and development, and Dr. Dae-Geun Oh, director of the International Technical Cooperation Center. We agreed to build a stronger partnership between RDA and IRRI.

IRRI includes children in its audience to convey messages about rice. The *Graindell* book, the Web site **(www.graindell.com)**, and community were launched on 15 July during the National Children's Book Day celebration at Museo Pambata in Manila, which annually promotes international understanding through children's literature. **William Padolina,** DDG-Partnerships; my wife Pamela; and I participated in the program.

In IRRI's first venture into publishing for children, *Graindell* captures our goal for all children of the world—i.e., a home for tomorrow where no one will go hungry. The local launch of the book in the Los Baños community took place at IRRI on 18 July 2003. In April 2004, IRRI and McDonald's will collaborate in promoting the *Graindell* book during the *Bright Minds Read Week* campaign, to be held at all 241 branches of McDonalds in the Philippines. Tagalog and Japanese translations of the book are in the works.

New IRFGC Web site launched. The new Web site of the International Rice Functional Genomics Consortium (IRFGC) was launched worldwide 13 May via the IRRI Web site, which is serving as its host. One of the core mandates of the IRFGC is to share information about its rice functional genomics activities and the Web site (www.iris.irri.org / IRFGC) is an initial step in this direction.

Special IPM course in Myanmar. The Training Center conducted a special IPM course at the Myanma Agricultural Services (MAS) Central Agriculture Research and Training Center, Yangon City, 16-25 July. Jointly sponsored, organized, and implemented by IRRI and MAS, the course trained 20 young professionals who are working on rice pest management research, education, and extension. The participants represented MAS, Yezin Agricultural University, and the Agriculture Institute. Trainees, MAS officials, and local experts are interested in organizing similar training activities in the future.

Open Academy for Philippine Agriculture. This was formalized on 28 July with the signing of a Memorandum of Understanding (MOU) at the Department of Agriculture in Quezon City. Led by Department of Agriculture Secretary Luis Lorenzo, Jr., and Department of Science and Technology Secretary Estrella Alabastro, the MOU was also signed by IRRI, the University of the Philippines Open University, Pampanga Agricultural College, the University of Southern Mindanao, Central Luzon State University, and the International Crops Research Institute for the Semi-Arid Tropics.

ASEAN ministerial meetings. During the week of 18-22 August, IRRI attended its first-ever ministerial meetings of the Association of South East Asian Nations (ASEAN). DDG-P **William Padolina** represented the Institute at the 25th meeting of the ASEAN Ministers of Agriculture and Forestry (AMAF) and the 3rd meeting of the AMAF + 3 meeting. The "+ 3" stands for China, South Korea, and Japan. During various sessions held in Kuala Lumpur, Malaysia, Dr. Padolina discussed the future of rice research in Asia and the importance of the International Year of Rice 2004, which is putting rice at the center stage of Asia's cultural and economic development and recognizing both the achievements of the past and challenges of the future.

BOT in Bangladesh. The Board of Trustees held a successful series of meetings in Dhaka, 11-12 September. The gathering kicked off with the opening of the PETRRA (Poverty Elimination Through Rice Research Assistance) Communications Fair and a field visit to the Bangladesh Rice Research Institute. Other activities included courtesy calls on the Prime Minister of Bangladesh, Khaleda Zia; the Secretary of the Ministry of Agriculture; the USAID Mission Director in Bangladesh; and the offices of DFID in Dhaka.

Highland development strategies discussed in Kunming. An international workshop on "*Strategies for Sustainable Development of Agricultural Production Systems in the Highlands of the Greater Mekong Subregion (GMS) Countries*" was held

in Kunming, Yunnan, China, 12-16 September. The workshop was organized jointly by the Consortium for Unfavorable Rice Environments (CURE), the Bureau of Agriculture of Yunnan Province, the Yunnan Academy of Agricultural Sciences, and IRRI, with sponsorship from the Asian Development Bank and the Ministry of Agriculture of the People's Republic of China. Participants agreed to conduct a comparative case study from several sites to analyze different transition pathways and diagnose interventions needed to achieve income growth with food security while conserving the fragile resources of the uplands.

IRRC activities and review. The steering committee of the Irrigated Rice Research Consortium (IRRC) composed of senior NARES leaders from seven major Asian rice-growing countries met in Singapore, 18-19 September. Participants examined the progress and future direction of the IRRC. Earlier, on 16 September, the external review of IRRC Phase II (2001-04) started with a field visit and meeting of the review team with Indonesian partners in Solo, Indonesia. Review team members **Ernst Mutert** and **Urs Schiedegger**, donor representatives **Carmen Thoennissen** and **Rolf Haerdter**, and steering committee member **S.N. Shukla** representing Dr. Kalloo from India participated in the Indonesia site visit. IRRI participants in Solo were **Roland Buresh**, **Christian Witt**, **Monina Escalada**, and **Ria Tenorio**. The panel gave Phase II a favorable review. As a follow-up, preparations for IRRC Phase III (2005-08) are now under way.

Vietnam-IRRI meeting. **Ren Wang, Mahabub Hossain,** and **Suan Pheng Kam** and IRRI's national partners in Vietnam met in Hanoi 18-19 September to revitalize collaboration. At a Vietnam-IRRI Workplan Meeting at the Ministry of Agriculture and Rural Development—the first such gathering since November 1998—participants agreed on three common research goals: 1) establishing and maintaining food security both nationally and at the household level, 2) reducing poverty, and 3) protecting the environment.

PhilRice and IRRI hold policy dialogue on agricultural innovation systems. A policy dialogue on *Maximizing Impact of Agricultural Innovation Systems in Rice Production* held at PhilRice, 21-22 October, attracted rice scientists from PhilRice and IRRI, representatives from the Department of Agriculture, NGOs, media, farmer representatives, and agricultural officers from the low-yielding rice provinces of Aklan, Albay, Bohol, Camarines Sur, Iloilo, Quezon, Sorsogon, Western Samar, Zamboanga del Sur, and the model province Isabela. The participants assessed technology needs of the farmers in these provinces with low rice yields.

CURE inaugurates new project and launches Web site. During a special workshop, 27-29 January 2004, at the National Agricultural Science Complex in New Delhi, India, the Consortium for Unfavorable Rice Environments (CURE) inaugurated a new project, *Integrating and mobilizing rice knowledge to improve and stabilize crop productivity to achieve household food security in diverse and less favorable rainfed areas of Asia*. The Asian Development Bank selected this project for funding support under its 8th Regional Technical Assistance facility. Also, in early 2004, CURE launched its Web site at www.irri.org/cure.

Visitors to IRRI shoot upward

In 2003, we welcomed 86,550 visitors, an increase of 30,641, or up nearly 55% from the 55,909 visitors in 2002. Among these distinguished visitors were 3,515 government officials, 3 ambassadors, and various members of the diplomatic community and representatives of various donor and international organizations such as ADB and USAID. We attribute the increase in visitors to extensive professional promotion as well as to new activities that were introduced for elementary, high school, and college students, who made up 83% of all visitors in 2003. Specialized programs were elaborated for the different categories of visitors to suit their needs. See the table on page 104, which provides details on 17 regional and international conferences, workshops, and symposia hosted or co-hosted by IRRI and attended by 683 delegates from at least 35 countries.

Honors and Awards

Researchers on IRRI's national staff won, for the third consecutive year, the world's most prestigious award for a scientific support team in publicly funded agricultural research. This CGIAR Excellence in Science Award, announced on 29 October during the CGIAR annual general meeting in Nairobi, was presented to the winning team comprising 33 NRS in our Genetic Resources Center (GRC). These researchers manage the International Rice Genebank and play a central role in the center's significant scientific advances in the conservation and use of rice genetic resources.

On 20 March 2003, in Arlington, Virginia, The Council for Agricultural Science and Technology (CAST), an international consortium of 37 scientific and professional societies based in Washington, presented **K.L. Heong**, IRRI entomologist, with the prestigious 2003 Charles A. Black Award, an honor presented annually by CAST for outstanding achievement by an agricultural, environmental, or food scientist in contributing to the advancement of science in the public policy arena. Then, on 6 November, in the Houses of Parliament, London, the insecticide reduction initiative in Vietnam, led by Dr. Heong and his team, **Monina Escalada** (of IRRI's International Programs Management Office), and Vietamese NARES partners **Nyugen Huu Huan** and **Vo Mai**, was presented with the International Green Apple Environment Award by the Green Organization based in the United Kingdom.

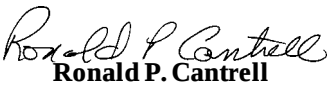
In April, *TIME* magazine's Asian Web site named **David Dawe**, IRRI economist, as one of 20 Asian heroes. This group, including former Philippine President Corazon Aquino and broadway diva Lea Salonga in the first round of *TIME*'s Asian Heroes online readers' poll, was shortlisted from more than 10,000 entries sent in to the Web site in the months prior to the announcement.

During the Annual Conference of the International Fertilizer Association (IFA), 26-29 May in Philadelphia, PA, USA, **Vethaiya Balasubramanian**, IRRI agronomist, received the 2003 IFA International Award. He was recognized for his research efforts in fertilizer use in terms of research quality, originality, and practical application.

As in every year, numerous other IRS and NRS received various awards and honors. See the complete listing beginning on page 65.

Research progress

This *DG report* highlights achievements for the 12 projects in IRRI's MTP for 2004-06. On the following pages, detailed summaries of research progress and next step activities, by project, are presented. See the Appendix on page 127 for a listing of all our partners who work with us in carrying out our important research.



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Project summary and highlights

Genetic resources conservation, evaluation, and gene discovery

Project 1: Germplasm conservation, characterization, documentation, and exchange

THE PROJECT

Since its foundation, 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 N_2-fixing bacteria). Plant breeders and researchers worldwide use these genetic resources to develop new rice varieties. Effective use requires characterization (Output 1), evaluation (Output 2), and information access (Output 3).

RESEARCH PROGRESS IN 2003

Output 1. Conserve and characterize rice and biofertilizer genetic resources
Researchers now use molecular techniques to describe diversity and identify novel alleles (different versions of a gene) affecting important traits. Defining the core collection of the International Rice Genebank Collection serves as the entry point to mining it for alleles (cataloging existing alleles). The choices made and strategies used to create the core collection determine the range of alleles that will be available for mining.

In 2003, processing of the core collection of germplasm accessions ran ahead of schedule to stock a leaf tissue bank for supplying DNA for high-throughput detection of diversity in alleles. Processing of 10,582 *Oryza sativa* accessions for the leaf tissue bank is 90% complete, leaving as a priority the accelerated extraction of genomic DNA from the same pool of samples. Leaf tissue lyophilized (freeze-dried) 8 years previously still produced high-quality DNA, indicating a stored-tissue lifetime at least that long and thus confirming this approach toward streamlining production of large quantities of DNA for research.

Knowledge of the genetic diversity of wild rice as well as cultivated varieties enriches the pool of traits available to plant breeders and so enhances rice-improvement programs. We characterized species of the *Oryza officinalis* complex of wild rice using morphological and molecular markers, generating variation patterns that will be the bases for authenticating wild rice accessions valued for their resistance to pests and diseases.

We identified a set of candidate target genes for resilience against pests, diseases, drought, salinity and submergence, as well as for high provitamin A potential. Identifying alleles of these genes is positively contributing to our breeding for stress tolerance. A core collection of germplasm screened for salinity tolerance at the seedling stage yielded a few dozen accessions that showed good tolerance and, upon confirmation, will be available to the breeding program. Having identified nearly 5,000 accessions with names associated with "yellow" or "gold," we multiplied them for provitamin A analysis, but high cost and lack of funding constrained progress.

Output 2. Exchange rice germplasm and evaluate it internationally

Key to meeting the challenge of efficient and profitable rice production is making available to farmers well-adapted, pest-resistant, and high-yielding rice varieties. The organized exchange and dissemination of improved rice germplasm and genetic donors is the role of the IRRI-led International Network for Genetic Evaluation of Rice (INGER). Today, farmers are able to grow improved high-yielding rice varieties that have been tested and distributed through INGER. This safe exchange of germplasm among national agricultural research and extension systems (NARES) and international centers increases the diversity of rice and the choices available to rice farmers.

In 2003, INGER recorded 563 new elite variety entries, with NARES contributing 139 of these, or more than their combined contributions during the previous 5 years. Continued growth in contributions from NARES promises greatly increased genetic diversity in the INGER gene pool. Meanwhile, we identified the best entries for yield and stress resilience from the nurseries distributed to NARES in 2001. These elite lines promise to lower farmers' production cost by reducing pesticide use and reducing the risk of crop loss due to drought and other abiotic stresses.

Output 3. Develop International Rice Information System (IRIS) for use by rice breeders and researchers

Future improvements in productivity must come from knowledge-intensive strategies, and the driving force for those strategies must be a comprehensive, widely accessible information system linking data from conservationists, breeders, and crop scientists. To achieve this, IRRI joined other CGIAR centers to design the International Crop Information System (ICIS). The rice implementation of ICIS is the International Rice Information System (IRIS). IRIS integrates information from germplasm collections, breeding projects and testing programs for rice researchers using knowledge-intensive crop-development strategies. To facilitate searches, IRIS uses unique germplasm identifiers and common trait descriptors.

Last year saw the onset of consolidation, behind a single, integrated Web-query interface, of all IRRI germplasm information, as well as the merger of INGER, IRIS, and the International Rice Genebank Collection Information System into a single germplasm data platform. The aim is to create a one-stop germplasm-information shop for breeders and other researchers. Meanwhile, workshops at IRRI and in Australia set in motion the design of applications for a genetic-resources information-management system and inventory-management system for ICIS.

Because the historical data from INGER nurseries provide valuable information on cultivar adaptation and genetic diversity in cultivated rice, we have begun loading this data into IRIS, though work has been delayed by a shortage of skilled staff. In addition, we have completed the incorporation into IRIS of the irrigated, rainfed lowland, upland, and aerobic rice-breeding projects; work continues incorporating the hybrid, cold-tolerance, and wide-hybridization projects.

NEXT STEP ACTIVITIES IN 2004

Output 1. Conserve and characterize rice and biofertilizer genetic resources

- Finish processing of leaf tissue for the 980 remaining *O. sativa* (*Os*) accessions and continue preparation of DNA samples. Continue processing of the non-*sativa* core collection for both leaf tissue and DNA production.
- Begin phenotypic screening in collaboration with crop physiologist using appropriate methods and traits to generate data for association genetics.
- Carry out hybridization of selected accessions of *O. officinalis* complex to confirm their taxonomic status.

- Use structural markers for molecular characterization of the core collection and other wild rice accessions to provide information on the diversity and structure of the core collection and to confirm biosystematic relationships of the wild species.
- Define locus-specific primers to detect molecular variants of genes having important known functions. Once such variants are confirmed to have beneficial phenotypic effects, they can be incorporated into crop improvement programs.
- Screen more accessions for tolerance for salinity and other abiotic stresses.

Output 2. Exchange rice germplasm and evaluate it internationally

- Continue encouraging NARES to contribute germplasm to INGER.
- Conduct training-workshop on plant variety protection (PVP) to improve knowledge base of INGER partners on PVP and distinctness uniformity stability test (DUST).

Output 3. Develop International Rice Information System (IRIS) for use by rice breeders and researchers

- Continue consolidating Genetic Resources Center (GRC) and INGER data into IRIS and developing a new ICIS interface for gene bank management, including inventory management.
- Develop more advanced germplasm × trait query interfaces.
- Complete data cleaning and entry of remaining nurseries as resources permit.
- Complete integration of information management for all IRRI breeding projects and training of data curators in those projects.

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Project summary and highlights

Genetic resources conservation, evaluation, and gene discovery

Project 2: Functional genomics

THE PROJECT

Rice improvement relies on a thorough understanding of the biology of rice plant and the complex interactions by which genes, developmental processes, and environmental factors guide plant growth. Genomics, the science of deciphering DNA sequence structure, variation, and function in totality, will become the engine that drives discovery of plant traits that contribute to solving intractable problems in crop production. Through genomics, we will discover every rice gene, the functional diversity of the various versions of these genes in the gene pool, and the overall architecture of genetic and physiological (including biochemical) systems in rice. This knowledge will lead to new strategies for genetic improvement that will allow farmers to grow rice more efficiently and profitably.

The draft rice genome sequence became available late in 2002 through the efforts of the International Rice Genome Sequencing Project and private-sector contributions. A completely sequenced rice genome represents an enormous pool of information for improving rice through marker-aided selection or genetic transformation. However, fully exploiting this wealth of information provided by *structural genomics* will not be possible until we understand the biological functions encoded by the sequenced DNA. We therefore pursue a parallel effort in *functional genomics*, developing the genetic resources that we need to discover which biological functions belong to specific DNA sequences.

The overall goal of the functional genomics project is to understand complex biological functions. Our strategy is to combine the information provided by structural genomics with discoveries gleaned from specially manufactured genetic resources (such as mutants in which certain genes are disabled) and well-characterized germplasm, using innovative research techniques developed for this purpose. A genome-wide experimental approach will give us unprecedented power to find new genetic information and dissect metabolic pathways important for making rice more resilient against stress. Through creating genetic resources for trait discovery, IRRI will be well placed to use genomic databases and to promote accessibility of these resources to the rice-growing world.

In today's climate of tightening protection of intellectual property rights, IRRI should strive more than ever to safeguard and improve public access to rice genetic information. 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, because the institute possesses an excellent capacity to produce genetic resources, the expertise necessary for identifying important traits, and an extensive collaborative network to evaluate newly found traits in multiple environments.

RESEARCH PROGRESS IN 2003

Output 1. Develop genetic resources—mutants, near-isogenic lines, and mapping populations—and characterize them for genome-wide assignment of biological functions to DNA sequences

IRRI now has a large stock of genetic material available for use in gene discovery. As of August 2003, we had produced more than 60,000 first-generation mutants using four mutagens: fast neutron, gamma ray, diepoxybutane, and ethyl methanesulfonate. By the end of 2003, the Institute essentially completed

assembly of the world's largest collection of indica rice mutants, with 30,000 fourth-generation lines available for distribution, including 16,000 already distributed.

Noteworthy findings in 2003 are two mutants selected for drought tolerance, which are undergoing genetic analysis to confirm the inheritance of the drought response. Also undergoing further characterization are putative mutants with enhanced cold tolerance, enhanced tolerance for iron toxicity, and improved resistance to bacterial blight, blast, and sheath blight. These gain-of-function mutants provide entry points for identifying candidate genes conferring resilience against these stresses.

Another approach to generating foundation resources for rice breeding—an approach that better addresses the naturally occurring genetic diversity of rice—is genome-wide substitution of indica genes into a japonica background to produce lines for systematic phenotyping, or analysis of gene expression. In 2003, we established 35 chromosome-segment-substitution lines representing 23 chromosomal segments of the indica variety Milyang in a background of the japonica variety Akihikari, covering over 80% of the indica introgressed genome.

With genetic stock production reaching an advanced stage, the emphasis will shift to high-quality phenotyping, data consolidation and documentation, and the propagation and dissemination of genetic materials to partners in national systems and advanced research institutes.

Output 2. Establish high-throughput gene array facilities for genotyping and expression analysis of desirable agronomic traits

IRRI's Gene Array and Molecular Marker Application (GAMMA) laboratory, which became operational in 2002, has been productively used to strengthen the capacity of IRRI scientists and visiting national partners to apply genotyping information to reverse genetics and allele mining. We assembled a library of 10,000 copy DNAs for microarray analyses of panicle development and stress response, the expression analysis of which has helped narrow the number of candidate genes for drought tolerance.

A new development is the application of whole-genome rice oligomeric (short-chain) arrays provided by the Beijing Genomics Institute to gene expression analysis, which will help broaden access of genome-wide analytical tools.

Output 3. Identify candidate genes, favorable alleles, and metabolic pathways for tolerance for abiotic and biotic stresses and for nutritional enhancement

Combining positional cloning with analysis of independently derived mutants bearing the gene controlling the spotted leaf mutation (*Spl11*), we discovered that this gene encodes a class of enzymes (ubiquitin ligase) that control protein turnover and quality. Knowledge of this key control point in the regulation of disease response will help us identify downstream, or interacting, genes that confer broad-spectrum resistance in rice.

We also narrowed the DNA segment containing a gene that governs phosphorus uptake and so is key to developing rice that grows well in phosphorus-deficient soil. In the search for genes that confer drought tolerance, we combined DNA sequence inferences with evidence derived from variety of gene expression to identify candidate genes for drought response.

Output 4. Develop databases and bioinformatic support for functional genomics

We established a database and statistical support for microarray analysis and integrated it with the IRIS laboratory information management system. Such improvements in data management will facilitate international collaboration in discovering gene function. We further developed the ICIS as a platform to support activities in functional genomics and trained researchers to apply genome databases and tools.

Output 5. Establish an international working group to provide a public resource platform and broaden access to genetic resources and genomic technologies
In January 2003, the International Rice Functional Genomics Working Group evolved into a consortium with the formation of a steering committee of 21 scientists from 16 institutions. The consortium (www.iris.irri.org/IRFGC), with its four subcommittees on mutants, gene expression, databases, and functional verification, provides a new structure for sharing resources and developing collaboration among national research systems and advanced research institutes (ARIs). The consortium has been recognized as a receptacle for public goods contributed by public projects.

Output 6. Disseminate resources and information to NARES through the Asian Rice Biotechnology Network (ARBN) and training workshops
We integrated into IRRI's breeding programs, and shared with NARES and advanced research institutes (ARIs), microarray slides and candidate genes for disease resistance, in particular to rice blast, that were discovered through functional genomics research. Sixty-four researchers from NARES and ARIs participated in the second workshop in a series on microarrays and bioinformatics held in December 2002. The workshop provided an opportunity to discuss the mechanisms of bringing new tools in genomics to the network and to assess the needs of the NARES in different crop-improvement programs. The third workshop in the series, *"Applying genomic technologies to identify induced and natural variation in stress-response genes,"* took place in February 2004.

NEXT STEP ACTIVITIES IN 2004

Output 1. Develop genetic resources—mutants, near-isogenic lines, and mapping populations—and characterize them for genome-wide assignment of biological functions to DNA sequences
- Complete production of 40,000 mutant lines for distribution and update mutant database.
- Establish in-house operation for Targeting Induced Local Lesions In Genome (TILLING) for reverse genetics.
- Continue to use marker-aided selection (MAS) to complete the coverage of chromosome regions, do further backcrossing to purify the genetic backgrounds, and prepare the hybrid population for advanced genetic analysis.

Output 2. Establish high-throughput gene array facilities for genotyping and expression analysis of desirable agronomic traits
- Apply genome-wide oligo chips to analyze phenotypically well-characterized genetic stocks.
- Prepare 'expressional candidate gene arrays' to facilitate screening of germplasm (cultivars and other genetic materials).

Output 3. Identify candidate genes, favorable alleles, and metabolic pathways for tolerance for abiotic and biotic stresses and for nutritional enhancement
- Use a range of stress response mutations to reveal downstream genes responsible for resistance to diseases, insects, and abiotic stresses.
- Combine mapping and expression data to establish causal relationships between genotypes and phenotypes in selected traits (phosphorus-deficiency tolerance, disease resistance).
- Determine molecular variation using TILLING in selected stress response loci.

Output 4. Develop databases and bioinformatic support for functional genomics
- Integrate informatics and comparative genomics research into each component of gene discovery by mutant analysis, mapping, and expression analysis.

- Assess future alternatives and linkages with Genetic Resources Challenge Program (GRCP) on functional genomics tools.

Output 5. Establish an international working group to provide a public resource platform and broaden access to genetic resources and genomic technologies

- Increase NARES involvement and participation under International Rice Functional Genomics Consortium (IRFGC).
- Develop an IRFGC position paper on rice gene function discovery towards 2010.
- Establish specific projects to support IRFGC goals using a variety of bilateral and multilateral funding sources (e.g., USAID, GRCP).

Output 6. Disseminate resources and information to NARES through the Asian Rice Biotechnology Network (ARBN) and training workshops

- Develop polymerase chain reaction markers for additional candidate genes involved in stress resistance and use them for detecting polymorphisms among donors and progeny.
- Conduct an annual training workshop on application of functional genomics tools.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

Project 3: Genetic enhancement for yield, grain quality, and stress resistance

THE PROJECT

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, the adoption of improved varieties offering a yield potential of 10 t / ha is almost complete. Meanwhile, irrigated rice area is shrinking, irrigation water is being diverted for other uses, agricultural labor is moving to industries, and concern is rising about the overuse and misuse of pesticides and fertilizers. Taken together, these developments mean farmers have to learn to produce more rice using less land, water, labor, and chemical support.

At the same time, micronutrient deficiencies, especially of iron, zinc, and vitamin A, afflict millions of poor Asians—people who receive most of their nutrition from rice and so would be healthier if the rice they consumed contained more of these micronutrients. At the same time, rising living standards in most of Asia are fueling demand for high-quality rice.

To meet the challenges of raising the size of the rice harvest while improving its quality to make it tastier and more effective against the "hidden hunger" of micronutrient deficiency, we need varieties with higher yield potential, multiple resistance to diseases and insects, tolerance for problem soils, superior grain quality, and higher micronutrient content.

This project uses conventional breeding and biotechnological approaches to develop new plant type (NPT) cultivars and rice hybrids with about 20% higher yield than existing high-yield varieties. Opportunities exist to develop even higher yielding rice cultivars and hybrids. We use molecular breeding to incorporate yield-enhancing genes from exotic and wild species into cultivars that are useful as such and as parents of superior hybrids. We also use conventional and genetic-engineering approaches to improve the pest resistance of varieties and hybrids. To increase the durability of resistance, we pyramid several genes through molecular marker-aided selection (MAS).

Finally, we use conventional breeding and genetic engineering to enhance the palatability and nutrition of rice varieties, including higher content of such micronutrients as iron, zinc, and provitamin A.

The ultimate aim of the project is to develop rice varieties and hybrids that combine all these desirable features. At the same time, we develop agronomic management practices for NPTs and hybrids and study their economic impact.

RESEARCH PROGRESS IN 2003

Output 1. Develop germplasm possessing high yield, multiple resistance, and superior grain quality

In 2003, we identified high-yielding NPT lines possessing multiple resistance to diseases and insects and possessing high-quality grains that are long and slender. One NPT line was selected for release in China as *Dianchao 2*. We evaluated five second-generation elite NPT lines developed from crosses between indica and tropical japonica, including one that yielded 10.2 t / ha in the dry season.

We used genes transferred from wild rice species to develop lines with wide-spectrum resistance to brown planthopper, bacterial blight, and tungro. We are mapping these genes for use in MAS. In addition, we pyramided into high-yielding aromatic lines several genes offering resistance to bacterial blight and identified three lines with pyramided resistance genes and good agronomic traits that can be used as breeding donors by national agricultural research and extension systems (NARES).

To help farmers meet the anticipated water crisis, we identified elite breeding lines that suffer no significant yield loss under alternate-wetting-and-drying (AWD) conditions. There appears to be a great deal of genetic variability for this water-saving growing condition that can be exploited to breed water-efficient irrigated varieties. Toward developing NPT lines suitable for direct seeding, we bred lines able to germinate under water, as well as tolerate zinc-deficient, saline conditions.

As part of our effort to make rice more nutritious, we identified advanced breeding lines and aromatic rice possessing elevated levels of iron, including three first-generation NPT lines.

Output 2. Develop rice hybrids possessing stronger heterosis, improved grain quality, and multiple resistance to diseases and insects

In 2003, we identified elite two- and three-line hybrids possessing improved grain quality—better than the commercial hybrid *Mestizo 1*—and heightened iron content. These are now available for evaluation and use by NARES. Five rice hybrids developed by IRRI and evaluated in the wet and dry seasons of 2003 produced grain yields of 10.3-10.5 t / ha, significantly higher than the yields of NPT lines and inbred check varieties. These hybrids had 125 spikelets per panicle, grain filling approaching 80%, and a harvest index (percentage of above-ground plant mass in the seed) approaching 55%.

Our development of elite parental lines with improved grain quality and outcrossing ability, as well as heightened resistance to bacterial blight and the insect pests brown planthopper and green leafhopper, indicates that these traits can be bred into commercial hybrids. It should also help improve hybrid rice seed yields and so lower the cost to farmers who adopt hybrid technology.

We developed new thermosensitive genetic male sterility (TGMS) lines with a low critical-sterility point that will be useful in attaining male-sterility stability in the field, facilitating the development of two-line hybrids for commercialization in the tropics. In addition, our pyramiding of three TGMS genes promises to enhance the stability of this trait in the field even when sudden temperature changes occur. The characterization of one of these genes promises improved understanding of the TGMS mechanism.

Our identification of three hybrids with no significant yield decline when grown under water-saving AWD conditions indicates that farmers will not need to choose between saving water and the benefits of hybrid technology.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

Output 1. Develop germplasm possessing high yield, multiple resistance, and superior grain quality

- Focus efforts on improving the grain quality of elite NPT lines.
- Select NPT lines with 140-150 spikelets per panicle for agronomic trials.
- In developing alien introgression lines with wider spectrum of resistance to brown planthopper, bacterial blight, and tungro, map the genes for use in MAS.
- Intensify the screening irrigated germplasm suitable for AWD conditions.
- Use promising donors for high micronutrient content to initiate a breeding program to transfer target traits into an elite background.
- Evaluate pyramided lines for agronomic potential and reaction to bacterial blight.

Output 2. Develop rice hybrids possessing stronger heterosis, improved grain quality, and multiple resistance to diseases and insects

- Continue sharing with NARES heterotic two- and three-line hybrids possessing acceptable grain quality.
- Evaluate more elite and commercial two- and three-line hybrids for micro-nutrient content in the grain.
- Continue evaluating IRRI rice hybrids compared with inbreds for confirming their yield advantage.
- Share the new CMS and TGMS lines with NARES and use them extensively for developing new rice hybrids at IRRI.
- Intensify screening newly developed hybrids under the AWD method.
- Study the effect of two-gene and three-gene combinations on the critical sterility / fertility point and transfer the genes to elite lines through marker-aided breeding.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

Project 4: Managing resources under intensive rice-based systems

THE PROJECT

Favorable irrigated environments that are highly productive and sustainable, or potentially so, produce nearly three quarters of the world's rice. In Asia, two intensive rice-production systems—double cropping of rice and rice rotated with wheat—each cover 24 million hectares. The doubling of rice production in Asia over the past 30 years has arisen largely from the increasingly bountiful harvests in these systems brought about by improved rice varieties, expanded irrigation, and higher rates of fertilizer use.

Stagnating yield growth in recent years, however, suggests that it may be difficult to grow enough rice to satisfy the future nutritional needs of a growing population of urban poor and rural landless, especially when combined in many areas with postharvest losses and labor scarcity. Meanwhile, farmers' misuse or overuse of pesticides and fertilizers, and their profligate use of water, raise environmental worries.

Current irrigated yields, averaging less than 5 t / ha, are well below the estimated potential yield of 8 t / ha of existing rice cultivars. Farmers will require new and reframed knowledge, techniques, and machinery to bridge this yield gap. Knowledge is key to ensuring that larger harvests go hand-in-hand with improved profitability, while minimizing environmental impact both within and beyond the rice ecosystem.

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. These technologies must integrate management of soil, water, and pests with particular attention to conserving biodiversity and ecological health. Fully developing these technologies requires research on crop physiology, the chemistry of nutrient cycling, the ecology of the rice crop in its environs, and mechanization systems. Understanding farmers' management approaches and the limitations they face will enhance the adoption of improved technologies.

RESEARCH PROGRESS IN 2003

Output 1. Develop and deploy crop and soil management principles and practices that increase productivity and protect environment

Increased recognition that the burning of crop residues is a major contributor to air pollution and respiratory disease has spurred efforts to develop alternative methods of handling these residues and to anticipate the consequences of these alternatives. In 2003, we compiled results from a long-term experiment on the effects of rice straw and water management on soil properties, soil organic matter, and rice yield. We also initiated field research in cooperation with national agricultural research and extensions systems (NARES) in China and India to evaluate alternatives to burning straw and their effects on soil fertility.

We further developed site-specific nutrient management (SSNM) in several ways. The concept of adjusting fertilizer applications for a target yield and taking into account naturally occurring nutrients in the soil, through balanced nutrition and real-time nitrogen management, are now effectively integrated into an SSNM approach. Hundreds of farmers evaluated the approach in more than 80 villages in eight Asian countries. To improve its effectiveness for nitrogen management,

we developed a more easily reproduced leaf color chart with standardized color formulations. We also refined approaches to site-specific management of phosphorus and potassium by studying nutrient balances in long-term experiments and on-farm monitoring of indigenous nutrient supply. These refined guidelines are now available to NARES, enabling them to tailor management of these nutrients to meet site-specific crop and soil conditions while maintaining soil fertility and productivity.

We explored the potential of reducing nitrogen and pesticide use while improving yield stability through management of a healthy crop canopy. Experiments in Vietnam, Bangladesh, and the Philippines helped define and quantify the healthy canopy concept and determine if it can provide a framework for integrating SSNM with pest control and crop establishment in an integrated approach to crop management.

We also studied the impact of climate change on yield modeling, in particular, how higher night temperatures may constrain yields.

Output 2. Develop and deploy improved pest management practices to increase productivity and conserve and enhance the environment

We continued to improve our techniques and understanding of pest control through interplanting different rice varieties. Initiated experimentally in 1997 to control blast in high-value but susceptible traditional glutinous varieties in the southwestern Chinese province of Yunnan, the interplanting of disease- and pest-susceptible varieties between rows of resistant hybrids has spread to cover an estimated 260,000 ha in Yunnan and 330,000 ha in neighboring Sichuan Province. Farmers now interplant about 90 different traditional varieties with modern hybrids, significantly increasing their income and allowing the conservation in the field of this invaluable rice heritage that would otherwise be largely confined to genebanks.

In 2003, we evaluated in farmers' fields in Yunnan and at IRRI the effect of different patterns of interplanting on various diseases and insect pests, plant growth, yield, and competition between the two cultivars. Initial results at IRRI showed that interplanting susceptible and resistant cultivars could control diseases other than blast. While cultivar mixtures cannot be expected to manage all pests, confirming its efficacy against multiple pests and diseases will provide further incentive to farmers to adopt the environment-friendly and cost-effective strategy. These ongoing experiments will help create understanding of the mechanisms at work and serve as a basis for identifying planting patterns that minimize cultivar competition and maximize the positive interactions between traditional and modern cultivars. We also conducted experiments to quantify reported low rates of lodging (plants falling over) in interplanted fields.

In the southern Philippines, we tested the efficacy against tungro disease of mixing seeds of IR64, a tungro-susceptible but popular cultivar with good eating quality, and those of a physically similar but resistant line that matures over the same growing period and so could be harvested together. Among the ratios tested, a 1:1 seed mixture had the lowest tungro intensity, which was about half as bad as that suffered by fields of IR64 planted in monoculture. We will repeat the experiments in farmers' fields with severe tungro outbreaks to see how well this simple strategy works under high disease pressure and also test the acceptability to consumers of the mixed crop's cooking and eating quality.

Output 3. Develop mechanization systems that improve the efficiency and sustainability of rice production

In 2003, we identified and developed techniques and equipment to improve grain and seed storage in the tropics. Trials of hermetic grain storage vessels in Cambodia, Indonesia, Vietnam, Laos, and Myanmar showed that sealed storage systems doubled seed life, reduced insect numbers to less than one insect per kilogram, reduced moisture uptake during the wet season, and maintained high

milling yields. We will commence tests at IRRI of hermetic storage of brown rice, which offers higher micronutrient content than polished rice.

Other innovations included the development of an affordable grain-moisture meter and a milling chart, and the successful milling of basmati rice to export standard with an NGO and commercial rice mill in Bangladesh. We completed initial training of collaborators in Cambodia for studies on how to prevent loss of stored grain to rodents.

Output 4. Increase resource-use efficiency in rice-wheat systems

In 2003, we evaluated in Nepal an integrated crop management strategy involving SSNM, with promises to increase the productivity of the rice-wheat system in that country of half. We also determined the leaf color chart critical values for the main rice varieties planted in the rice-wheat system in Nepal.

We modeled the potential yield of rice and wheat on the Indo-Gangetic Plain and evaluated the effect of rising minimum temperatures on the potential yield of rice and wheat. Large yield gaps exist for both crops, and the anticipated adverse effects of higher minimum temperatures highlighted the problem of environmental pollution.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

Output 1. Develop and deploy crop and soil management principles and practices that increase productivity and protect environment

- Publish research findings from IRRI long-term experiments on the effects of straw management on soil fertility and yield.
- Continue cooperative research with NARES in China and India to develop alternatives to straw burning that increase soil fertility.
- In China, extend participatory farmers' research (PFR) approach to four provinces.
- Continue adaptive research and wider scale delivery of SSNM as a component of integrated crop management.
- Evaluate and refine concepts for larger scale extrapolation of plant and soil-based estimates of indigenous nutrient supplies.
- Complete and report two years (four seasons) of multilocation research comparing N, P, and K refinements in SSNM.
- Assess impact of leaf color chart (LCC) use on crop yield, resource management, and profitability in Philippines, Vietnam, Indonesia, and India.
- Re-evaluate strategies for local production of LCCs in order to improve quality control.

Output 2. Develop and deploy improved pest management practices to increase productivity and conserve and enhance the environment

- Finish data analysis to improve ecological understanding of pest management and agronomic complementarity under different diversification systems.
- Identify the most favorable planting pattern and formulate recommendations for farmers.
- Conduct experiments in China involving mixtures of traditional and japonica cultivars.
- Conduct surveys in selected counties to characterize the injuries due to insect pests, diseases, and weeds and yield in farmers' fields with cultivar mixtures.
- Conduct experiments in farmers' fields with severe outbreaks of tungro to determine the efficacy of seed mixture at high disease pressure. Sensory evaluation will be done to determine consumer acceptability of the eating and cooking qualities of the mixtures.

Output 3. Develop mechanization systems that improve the efficiency and sustainability of rice production

- Identify and develop techniques and equipment to improve grain and seed storage in Cambodia, Indonesia, Vietnam, Laos, and Myanmar.
- Test hermetic storage studies on brown rice at IRRI.
- Support development of grain quality standards in Bangladesh.
- Conduct rice market surveys on quality in Indonesia, Cambodia, and Laos.

Output 4. Increase resource-use efficiency in rice-wheat systems

- Conduct chemical analysis and data interpretation to establish the relationship of soil and soil organic matter parameters and productivity for the rice-wheat system.
- Evaluate integrated crop management in zero / minimum tillage.
- Evaluate LCC-based N management in basmati and hybrid rice.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

Project 5: Enhancing water productivity in rice-based production systems

THE PROJECT

The present and future food security of Asia depends heavily on irrigated rice, a system that is a major consumer of freshwater resources. In Asia, irrigated agriculture uses 90% of total diverted freshwater, and about half of that irrigates rice. A semiaquatic plant typically grown in continuously flooded paddies, irrigated lowland rice requires substantially more water to produce a given amount of grain than any other major crop. Meanwhile, irrigated agriculture faces stiffening competition from industrial and domestic users. This situation is aggravated by dramatically rising costs in recent decades for developing irrigation systems. Declining water supplies, emerging water markets (in India and Bangladesh, for example), and rising water costs (either charges by volume or the power outlay for pumping groundwater) are increasingly forcing rice farmers to use less water. Farmers urgently need new irrigated rice-based systems and technologies that save water by improving water productivity in terms of the grain produced with a given volume of water.

Substantial progress has already rewarded efforts to develop water-saving irrigation techniques, such as reducing losses to percolation and seepage by allowing the soil to dry out to some extent before reapplying irrigation water. Investigation in this area will continue, but combating the looming water crisis requires exploring more radical changes in crop management techniques. These include cultivating rice in saturated soil on raised beds or, as in the case of aerobic rice, as an irrigated upland crop.

Saving water in the field is economically important for farmers but may have little effect on the hydrology of the irrigation system or basin. This is because the water "lost" from a field may be recovered for irrigation further downstream. Interactions among different components of the water balance in an irrigation system require us to look beyond the field level as we strive to develop socially acceptable and economically viable irrigated rice-based systems that save water.

RESEARCH PROGRESS IN 2003

Output 1. Develop strategies for enhancing water productivity at the farm level

In 2003, we investigated crop performance and water use under various novel and promising water-saving technologies in experiments conducted in China and the Philippines. We now offer an array of technologies for water savings that farmers can use according to the level of water scarcity. Alternate wetting and drying (AWD) is a suitable option under relatively moderate water scarcity, with the difference in yield between this water-saving technology and the conventional flood irrigation strongly dependent on the depth of groundwater.

Growing aerobic rice varieties—as a high-input, high-yield, dry-field crop like maize or wheat—is a feasible strategy for more severely water-short environments. In field experiments at IRRI and in Beijing, China, we obtained rice yields of up to 5.7 t / ha using half of the water required for flooded rice. Aerobic varieties also performed well under flooding, offering a yield of up to 6.8 t / ha. However, in a long-term aerobic rice field experiment at IRRI, we found a gradual increase of nematodes with continued cropping under aerobic conditions. After six seasons of continuous aerobic rice cropping, there was a gradual yield decline in variety *Apo* (compared with flooded conditions), but this trend was not

obvious when all tested varieties were averaged together. In field experiments in Central Luzon, aerobic rice yields in one field experiment declined dramatically from around 5 t / ha in the wet season to close to nothing in the subsequent dry season as a consequence of nematode buildup. The development of aerobic rice technology should focus on reversing this yield decline and closing the yield gap between flooded and aerobic rice.

We also found that raised beds increased water productivity compared with flooded flat fields but did not offer advantages over flat fields subjected to the same level of water stress—and that the raised beds themselves proved difficult to sustain. In two consecutive seasons, both raised beds and the system of rice intensification offered lower yields than puddle transplanting, dry or wet direct seeding, or zero tillage.

Pilot farmers tested novel water-saving technologies in terms of on-farm crop performance, water use, and the profitability of rice production. In the Philippines, farmers using both deep and shallow wells to supply irrigation systems obtained average water savings of 20% with AWD and earned $60 / ha more net profit. At the village level, AWD eased tensions surrounding the distribution of scarce water resources. The practice, now actively taken up by the National Irrigation Authority, is starting to have impact for farmers in the case study areas.

Regarding aerobic rice, on-farm testing in Henan, China, produced rice yields averaging 4.4 t / ha with water use 30% below that of lowland rice. Farmers indicated that aerobic rice yields would need to improve to about 6 t / ha before they would adopt the technology. In the Philippines, we established participatory varietal selection sites and farmer-participatory R&D on aerobic rice, emphasizing crop establishment, fertilization, weed control, and machinery use. A few promising varieties emerged, but the dry season proved to be more problematic than the wet.

In China, we completed work on the effects of irrigation on income, poverty, and inequality. Irrigation played an important role in improving income, reducing poverty, and equalizing rural incomes. Tightening access to irrigation water threatens to reverse these trends unless countered by investment in improving water productivity.

Output 2. Investigate interactions among the hierarchical scales of irrigation systems and identify strategies for translating water savings at the farm scale into savings at the scale of irrigation systems

In 2003, we quantified water use and water productivity at different special scales in irrigation systems. Long-term monitoring in Cambodia of the water level of the Mekong River and in tube wells suggested that the river water level directly affected wells up to 30 km west of the Mekong and that the aquifer appeared to recharge fully each year to a level 2-2.5 meters below the surface.

In Vietnam, we found water productivity to be very low within irrigation subsystems, offering a lot of scope for improvement. Lining canals reduced loss through seepage from them and improved canal conveyance capacity but did not significantly improve water productivity because of failure to improve other management factors to so make better use of the increased canal discharge.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

Output 1. Develop strategies for enhancing water productivity at the farm level

- Continue field experiments in China and the Philippines with modifications based on analysis of results obtained so far.
- Combine experiments and simulation study, using Oryza2000, to identify the effects of AWD and aerobic rice cultures on water productivity and hydrology at the system level.
- Conduct experiments to determine if changes in soil fertility or nematode buildup are responsible for the yield decline in continuous aerobic rice systems.

- Increase number of pilot sites and participating farmers in research involving on-farm crop performance, water use, and profitability of rice production under novel water-saving technologies.
- Conduct farmer survey to determine the role of on-farm reservoirs (ponds) in the adoption of water-saving technologies in the Zhanghe Irrigation System of Hubei, China.
- Conduct ORYZA2000 training course in China (and other locations on demand) and continue further development of the ORYZA2000 model.

Output 2. Investigate interactions among the hierarchical scales of irrigation systems and identify strategies for translating water savings at the farm scale into savings at the scale of irrigation systems

- Publish results of long-term monitoring of the water level in the Mekong River and in tube wells in Cambodia.
- Publish results of work on water use and water productivity at different spatial scales in irrigation systems in Vietnam.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

Project 6: Irrigated Rice Research Consortium (IRRC)

THE PROJECT

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. The Irrigated Rice Research Consortium (IRRC) provides a framework for partnership combining IRRI and national agricultural research and extension systems (NARES) that facilitates and strengthens NARES' research and technology delivery in these systems. The IRRC is active in every major Asian country that grows irrigated rice and includes on its steering committee policymakers from Bangladesh, China, India, Indonesia, Malaysia, Philippines, and Vietnam, thereby ensuring support from local governments and NARES. The IRRC also seeks partnerships with NGOs and the private sector to identify solutions to farmers' problems and to facilitate their adoption.

The IRRC is organized in workgroups composed of interdisciplinary teams of research and extension workers at sites in three or more countries. The workgroups are designed to identify and address important problems of productivity and sustainability, which are reflected in their names: Nutrient Management or Reaching Toward Optimal Productivity (RTOP), Water Saving, Hybrid Rice, Weed Ecology, Rodent Ecology, and Postharvest. The workgroups are coupled to an overarching Achieving Impact workgroup, which provides farmer-participatory appraisals and monitors and evaluates adoption and impact.

PROGRESS IN 2003

External review

In 2003, an external review of Phase II of the IRRC set the future direction of the consortium and laid the groundwork for future financial support. The 2.5-week-long review began at the meeting of the IRRC steering committee in September, which the review panel attended. The panel examined documentation of the IRRC's achievements, met with NARES partners, visited IRRC sites in five countries, consulted with IRRI staff members, and finally presented their report to IRRI management and the donor.

"Based on the encouraging achievements so far and considering that much work remains to be done to consolidate IRRC's approach and delivery of products, the panel recommends funding of a third phase of IRRC during 2005-08 to the donors," the report stated. "The target during IRRC Phase III should be [facilitating and enhancing] knowledge-intensive crop management on-farm in irrigated rice-based systems of Asia."

Enhanced framework

In response to a recommendation from the ad hoc Technical Advisory Committee of the IRRC, which was endorsed by the IRRC steering committee, the consortium formed a new workgroup on postharvest loss reduction. The new workgroup began implementing activities based on a market-driven systems approach. At the same time, the Achieving Impact workgroup received additional support to conduct trainings and meetings to strengthen cooperation among the other workgroups in the integration of promising technologies.

The IRRC has successfully provided a structure for partnership among NARES and IRRI that facilitates through research and extension the identification, evaluation, integration, and dissemination of appropriate technologies. Through its Postharvest workgroup, the IRRC now addresses a request from NARES for more active involvement in postharvest management.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

- A task force of IRRI staff members will study the report presented by the panel that conducted the IRRC external review in 2003, draft a response to the IRRC review report, and follow up on specific recommendations made by the panel.
- The IRRC Coordination Unit will organize a series of meetings leading towards submission of a Phase III (2005-08) proposal to the Swiss Development and Cooperation Agency (SDC) by September-October 2004.
- Submit 2003 progress report to SDC in March 2004.
- Consolidate achievements of and lessons learned by all workgroups in IRRC Phase II (2001-04).
- Update IRRC Web site (www.irri.org/irrc) to gear towards research-delivery and impact.

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Project summary and highlights

Improving the productivity and livelihood for fragile environments

Project 7: Genetic enhancement for improving productivity and human health in fragile environments

THE PROJECT

More than 700 million of Asia's poor obtain 50-80% of their calories from rice grown in rainfed lowlands and uplands and in deepwater and coastal areas. Farmers in these fragile environments face drought and submergence, diverse pests and diseases, and poor soils. They minimize risk by limiting inputs, but this results in low yields—less than 2 t/ha compared with more than 5.5 t/ha in favorable irrigated lowlands. Risk reducers that offer more promise include enhanced seedling vigor, heightened tolerance for or avoidance (through early maturity) of drought and submergence, improved ability to grow in soils with toxic levels of salt, iron, or aluminum or deficient in phosphorus or zinc, and strengthened resistance to pests and diseases, especially the blast fungus.

Improving the efficiency and value of rice production in fragile areas promises immense gains to food security, human nutrition, poverty reduction, and environmental protection. In addition to providing more calories from higher yields, improved varieties have the potential to offer such enhanced levels of vitamin A, lysine, iron, and zinc. Because rice is prominent in the Asian diet, inexpensive and easily stored, it is an ideal vehicle for enhancing nutrition among the poor.

In recent decades, researchers have discovered potential answers to many of these problems and aspirations in the genes of cultivated and wild rice. Scientific advances in biochemistry, physiology, and biotechnology have already produced promising genetic material and clear breeding strategies that can now be tapped for genetic enhancement of varieties for fragile environments. High levels of iron, zinc, and provitamin A and tolerance for drought, submergence, phosphorus deficiency, and saline soils are traits that we now enjoy good prospects of breeding into different rice cultivars.

IRRI is uniquely positioned to bridge, on the one hand, the upstream research done in advanced research institutes and the private sector in industrialized countries and, on the other, the downstream research by NARES in developing countries to create varieties for rice farmers in highly diverse rainfed ecosystems.

Boosting the impact of this project are NARES-IRRI breeding networks, farmer participatory selection that recognizes the central role of women, and linkage with INGER (in Project 1) and the Consortium for Unfavorable Rice Environments (CURE, in Project 9). The ARBN (in Project 2) facilitates the development and dissemination to NARES of germplasm and databases and the training of NARES scientists in new breeding, selection, and evaluation techniques. Animal and human nutritional studies on the bioavailability and food safety of micronutrient-rich rice are in progress.

RESEARCH PROGRESS IN 2003

Output 1. Develop superior germplasm for rainfed lowlands

Validation in 2003 of screening methods to directly select for high yield under managed drought conditions represented progress toward breeding that trait into elite lines. Most of the 58 lines selected under managed stress performed as well or better than the popular cultivar IR64 in subsequent testing in managed

environments, a result that supports the strategy of screening cultivars under managed drought.

Vietnamese farmers sowed AS996, an award-winning wide cross of *Oryza sativa* and the wild species *O. rufipogon* for acid-sulfate soils, on 100,000 ha following its release as a national variety in 2002. This variety promises to help increase and sustain rice productivity in less favorable areas. Meanwhile, blast-resistant lines of the widely planted and highly valued aromatic variety *Khao Dawk Mali*, popularly known as Thai jasmine rice, are now undergoing farmer-participatory varietal selection in Thailand.

Output 2. Develop superior germplasm for flood-prone areas and infertile lowlands
Farmers cooperating in participatory plant breeding and varietal selection trials in the coastal wetlands of Bangladesh, under the project Poverty Elimination Through Rice Research Assistance, selected superior lines from a salinity-tolerant breeding population. Six of 18 lines were popularly selected and are undergoing expanded trials. Complementing progress in conventional breeding for salt tolerance was the training of five Bangladeshi scientists in marker-assisted selection techniques and the application of three salt-tolerance markers to breeding populations. This means that these molecular techniques can now be incorporated into the Bangladeshi breeding program.

Meanwhile, we initiated research into the physiological mechanisms associated with submergence tolerance in a particular tolerant variety—underwater stem elongation and consumption of nonstructural carbohydrates—to facilitate identification of the pathways and genes involved.

Output 3. Develop superior germplasm for infertile uplands
We identified markers tightly linked to drought tolerance and confirmed the performance of previously selected upland-by-lowland crosses. Having identified candidate genes for resistance to rice blast disease, we made available markers for tracking effective alleles (forms of a particular gene) in advanced breeding lines and have selected 50 lines for trials. Field testing in Indonesia of lines with high phosphorus uptake and finely mapped for the *Pup1* gene confirmed its value in acid, phosphorus-deficient environments. And we identified loci in the genomes of wild rice species for tolerance for aluminum and iron toxicity.

Output 4. Develop aerobic rice germplasm for water-scarce tropical environments
As water for irrigating rice becomes more scarce and expensive, farmers' ability to profitably grow reliable supplies of affordable rice will depend on their sharply reducing the amount of water they use. One promising approach toward saving water is aerobic rice, a dry-field crop like wheat or maize that can produce yields approximating those of flooded rice when grown intensively under favorable conditions but using much less water. First-generation lines of aerobic rice, selected in 2003 through advanced international evaluation, are now with NARES in southern China for testing. IRRI-developed, second-generation aerobic rice germplasm underwent initial field evaluation in 2003. Meanwhile, greenhouse experiments confirm that greater root mass below 30 cm in the superior aerobic cultivar *Apo* helps the plant effectively extract water as the soil dries, which is an important component of aerobic adaptation.

Output 5. Develop micronutrient-enriched rice to combat malnutrition in fragile environments
A study in which 300 women were fed high-iron rice for 9 months found modest improvement in blood iron levels, showing the bioavailability of iron in rice endosperm. The results of this groundbreaking human trial of a biofortified staple food are being prepared for publication. Transgenic indica rice with enhanced nutrition for humans performed well in screenhouse trials but has been held back from field trials for lack of biosafety guidelines in target countries. A workshop on

Rice Breeding for Better Nutrition took place at IRRI in April 2003 and resulted in a workplan that went into effect in January 2004.

Output 6. Enhance NARES-IRRI partnerships in rice breeding
Farmer-participatory breeding is now integrated into NARES' upland and lowland breeding programs in Bangladesh, India, Laos, Philippines, and Indonesia, in some places with the involvement of nongovernment organizations. NARES-IRRI collaborative breeding networks for upland and aerobic rice are now fully functional in eastern India and Southeast Asia and supported by training activities.

NEXT STEP ACTIVITIES IN 2004

Output 1. Develop superior germplasm for rainfed lowlands
- Validate screening methods for direct selection for grain yield under managed drought stress and identify traits and genetic regions that change with selection.
- Evaluate AS996 and other sister lines in collaboration with NARES and genotype them to characterize alien introgression.
- Develop at least 15 isogenic lines carrying different blast-resistance genes in four genetic backgrounds and complete crossing and selection in two remaining genetic backgrounds and distribute the lines.
- Collect lowland drought-tolerant lines from different areas to evaluate important underlying mechanisms and enter into a database.

Output 2. Develop superior germplasm for flood-prone areas and infertile lowlands
- Monitor farmer acceptance of salinity-tolerant varieties tested under participatory varietal selection in the coastal wetlands of Bangladesh.
- Identify a closer marker using newly developed BC_4F_4 near-isogenic lines (NILs) and confirm the value of the segments in work to incorporate salinity tolerance into high-yielding and traditional varieties in Bangladesh.
- Identify and share with NARES promising introgression lines (*O. sativa* x *O. rufipogon*) evaluated in multilocation trials for increased elongation ability.
- Conduct comparative quantitative trait loci (QTL) mapping: Zn-deficient field vs mechanism-specific screening procedures.

Output 3. Develop superior germplasm for infertile uplands
- Compile and contrast marker information derived from different crosses in the effort to identify markers tightly linked to genes conferring drought tolerance.
- Cross blast-selected lines with drought-tolerant lines and test expression-QTL in advanced lines to make markers available for tracking effective alleles for quantitative blast resistance in advanced breeding lines.
- Evaluate the *Pup1* phosphorus uptake gene confirmed in acidic, P-deficient environments, clone the gene, and test additional markers for closer linkage.
- Test superior NILs for yield across a variety of stress environments and screen for trait differences, evaluate pyramided AB-QTL lines that have undergone a second selection cycle, select the best lines from the additional ones evaluated, confirm performance, and distribute lines to NARES.

Output 4. Develop aerobic rice germplasm for water-scarce tropical environments
- Identify collaborators for aerobic rice testing network.
- Enter superior lines in observational yield trials (OYT) in initial field evaluations of IRRI-developed, second-generation aerobic rice germplasm.

Output 5. Develop micronutrient-enriched rice to combat malnutrition in fragile environments

- Publish results of the bioefficacy study on high-iron rice.
- Develop marker-free nutritious rice.
- Present results of the study on the "Genetic mechanism of iron and zinc loading in the grain" at a conference and prepare a paper for publication.
- Put in effect the workplan developed during the workshop on *Rice Breeding for Better Nutrition*, 7-11 April 2003, and continue this kind of capacity building for our NARES partners for developing micronutrient-dense rice.

Output 6. Enhance NARES-IRRI partnerships in rice breeding

- Establish sound funding base for continued operation of NARES-IRRI collaborative breeding networks.

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Project summary and highlights

Improving productivity and livelihood for fragile environments

Project 8. Natural resource management for rainfed lowland and upland rice ecosystems

THE PROJECT

The farm families who live and work in highland and rainfed lowland rice areas are among the poorest people in the world. Rice yields in these difficult ecosystems, where 80 million families farm a total of 60 million hectares, are low and unstable. Erratic water supplies, crop diseases and pests, and problem soils cause risk that discourages farmers from investing in improved rice-production and resource-management techniques. Unsustainable farm practices degrade the natural resource base, condemning communities to ever deepening poverty. Many inhabitants of these areas, especially the highlands, belong to socially and politically marginalized ethnic minorities. As much as anyone in the world, these people need progress toward meeting the Millennium Development Goals.

RESEARCH PROGRESS IN 2003

Output 1. Develop and evaluate crop and natural resource management practices for improved livelihood in rainfed lowlands

Uncertainty attends rice farming in rainfed lowlands. Rice usually grows here in bunded (embanked) fields that are flooded for at least part of the cropping season, but lack of water control allows both flooding and drought. Adverse climate, pests, weeds, poor soils, and a lack of suitable modern technologies prevent farmers from improving their productivity and livelihoods.

One simple but effective way to boost productivity is improving seed health. In 2003, the Seed Health Improvement Project (SHIP) used various upscaling strategies to extend clean seed technology to an ever larger number of poor Bangladeshi farmers. Today, 10,000 farmers in seven districts of Bangladesh participate in SHIP, up from to 210 farmers when the project started in 1999.

In an initiative that addresses several Millennium Development Goals, we guided the efforts of Bangladeshi rice farmers in six villages to stop spraying their fields with insecticides without losing yield. This enables poor rice farmers to save money, protect their health, and preserve their environment. Having examined fertilizer and insecticide interactions late in 2003, we established the goal for 2004 of having all farmers in these six villages stop using insecticide and, through use of the leaf color chart, optimize their applications of nitrogen fertilizer.

In Indonesia, we completed reports on how toposequence position affects soil, water availability, weed communities, and yield loss from weeds. We identified opportunities to increase farmers' income by adjusting nutrient inputs and weed-control measures across the toposequence according to the presence and duration of water in the rice field. These improved practices brought yield gains of 500 kg / ha and promise to underpin new principles of management for nutrient and weed control. Next steps are to develop and test simple decision tools for real-time, site-specific nutrient and weed management according to location in the toposequence.

In India, Bangladesh, and Thailand, we evaluated nursery and seedling management techniques for establishing crops in submergence-prone lowlands. We found that seed priming and sprouting (wet seeding) brought faster germination, better crop establishment, and healthier seedlings able to withstand early flooding. Lower seeding density, coupled with improved seedling nutrient status regarding phosphorus, zinc, and nitrogen, improved seedling survival after submergence. This indicates that proper nursery management can significantly reduce seedling mortality when flooding occurs after transplanting. We will validate these results in farmers' fields in India and Bangladesh starting from the June-October season of 2004.

Studies on seedling handling and nutrient management of salt-tolerant lines found that older seedlings transplanted without root washing survived better than younger seedlings with washed roots. Higher levels of calcium and phosphorus improved seedling growth and uptake of magnesium and potassium, and calcium significantly reduced sodium uptake. We will evaluate in farmers' fields these management practices to enhance crop survival and productivity in submergence-prone and salt-affected soils.

For drought-prone environments, several activities identified and evaluated innovative approaches for integrated management of nutrients, rice establishment, and crop rotation.

In Raipur, India, we completed 2 years of testing dry line-sowing of rice as an alternative to transplanting or dry seeding-beushening, a traditional practice in which farmers broadcast seed and cross-plow it several weeks later to control weeds and improve nutrient uptake. In a drought year, dry line-sowing produced yields superior to those from transplanting; in a favorable year, yields were comparable. Trials found deep placement of nitrogen fertilizer more effective than traditional management (urea topdressing and beushening). In rice-chickpea systems, line-sown rice was more effective than transplanted rice at utilizing residual soil nitrogen from previous legume crops grown without additional phosphorus.

A 1-year trial in Rangpur, Bangladesh, successfully established sugarcane as a relay crop with wet-season rice and chickpea following rice. We will begin in 2004 participatory evaluation of variations on this rice-sugarcane relay system, which promises higher financial returns for farmers.

We initiated preliminary experiments evaluating additional nutrient- and weed-management options in Thailand, Laos, and India. In greenhouse trials, we evaluated the possible use of the leaf color chart in drought-prone rainfed environments and will progress in the wet season of 2004 to field testing the chart in these countries.

Turning to the economic cost of drought, we estimated it at 5-8% of the value of agricultural output in eastern India, where drought affects rice production every 3 or 4 years. While the main effect of drought is lower rice yield, analysis of farmers' coping mechanisms revealed that delayed rains also prompt them to plant less area to rice. We completed similar farm surveys at research sites in India, Thailand, and China.

Further analyzing how biophysical and socioeconomic factors combine to determine rice productivity in eastern India, we found that productivity growth in drought-prone areas, or nearly half of the rice area in eastern India, has been minimal. In recent years, productivity growth has declined, even in favorable areas, demonstrating the need for improved technologies and policy reforms.

At IRRI headquarters, a long-term experiment on how weed species shift in relation to cropping patterns continued into its 10th season. Meanwhile, monitoring how crop management affects weed populations and the soil seed bank entered its third year in the Barind region of Bangladesh. Changes in weed populations are evident, and data collected over the long term will provide the

basis for developing crop-management recommendations for farmers. Studies in Bangladesh will continue until 2005 to augment the database on long-term changes in weed populations.

We identified the natural enemies of the rice bug in the Philippines but, due to staff cuts, not as planned in Laos or Thailand. As this may be a vital step in ecological management of the pest, we aim to revive this activity in 2005 through the Consortium for Unfavorable Rice Environments (CURE).

Three environmentally defined working groups under CURE—on drought-prone lowlands, submergence- and flood-prone lowlands, and salt-affected environments—developed conceptual frameworks for integrated crop, weed, water and nutrient management to stabilize rice yields and enhance crop intensification. The consortium, launched in 2002, is designed to improve program coordination and promote more integrated and systems-oriented research.

Output 2. Develop and evaluate crop and natural resource management practices for improved livelihood in upland rice systems

In the mountains of South and Southeast Asia, upland rice is usually grown using dry soil preparation and direct seeding in unbunded fields. Shifting cultivation is common. Farmers use a field for 1 to 3 years, until soil depletion and worsening weed and pest infestations force them to abandon the plot for previously fallowed farmland or, if any is available, virgin land.

Many biological and physical constraints limit upland rice yield. Upland soils in Asia are typically erosion-prone and problematic, and rainfall is often spotty. Weeds are the worst biological constraint, compounded by diseases and insect pests. In addition, socioeconomic factors contribute to low yields, as upland rice farmers are very poor and so have little or no access to credit, inputs, or modern technologies.

In 2003, we developed crop, nutrient, and weed management options for upland rice-based systems in Laos. Participatory varietal selection trials identified two traditional upland rice varieties that yield 0.5 t / ha more than others and for which we are now organizing seed multiplication. We studied nutrient cycling in slash-and-burn systems and had 50 farmers evaluate improved fallow systems—including rice-pigeon pea rotation, for which we conducted a simple economic analysis. We estimate that farmers who reduce weeds and improve soil fertility by adopting improved fallow systems stand to improve their incomes by a quarter. Meanwhile, ever shorter fallow times caused by population pressure are forcing farmers into continuous cropping systems, so we are working to develop improved rice-based continuous cropping systems for sloping lands.

Because lowland rice can significantly improve food security in the highlands, we investigated the potential role of lowland rice technologies for the highlands of Laos. The major constraints are limited suitable area valley bottoms, where lowland rice technology is appropriate, and the high cost of creating more such area through terracing. We also evaluated gall midge-resistant varieties of lowland rice for the highlands and improved nursery management for cold tolerance.

We screened rice germplasm for upland cultivars that compete successfully with weeds and identified traits that impart weed competitiveness. Based on the criteria established in the initial selections, we will evaluate a wider selection of materials in collaboration with national partners through CURE.

CURE's three working groups for upland environments developed research plans for integrated crop management in South and Southeast Asia. An international workshop on upland development strategies held in Kunming, China, further developed a common research agenda and demonstrated the need for a cross-country comparative case study of patterns of upland development.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

In conjunction with CURE, coordinated in Project 9, and also working in tandem with Project 7 on crop improvement, Project 8 will conduct the following research activities in crop and natural resources management (CNRM), as well as provide economics and social sciences support, in the fragile rainfed lowland and upland systems of South and Southeast Asia.

Output 1. Develop and evaluate crop and natural resource management practices for improved livelihood in rainfed lowlands

- Complete analysis of economic cost of drought in eastern India and publish findings.
- Take inventory of existing data on new and indigenous technologies specifically suited to the target environments; determine missing information on farmers' practices and perceptions regarding various options; and conduct constraints analysis to identify viable technology options.
- Conduct multiple location on-farm trials and evaluate integrated use of tolerant varieties and various matching crop management practices that enhance crop performance under various ecological stresses:
  - In the drought-prone lowlands (at sites in northeastern Thailand, eastern India, and southern Laos): initiate field experiments to evaluate improved establishment methods and nutrient management techniques that take into account water status according to toposequence position and pest risk.
  - In the submergence-prone lowlands (at sites in Bangladesh and eastern India): validate 1) alternative nursery management practices for transplanted rice, 2) crop establishment options for direct seeded rice, 3) CNRM options that enhance survival during and recovery from short-term submergence and that accommodate cropping sequences (rice-rice, rice-nonrice), and 4) effects on weed population dynamics.
  - In the salt-affected environments (at sites in eastern India): develop and validate nursery and crop establishment strategies and CNRM options to improve survival and productivity under salt stress.
- Conduct policy dialogue on and impact assessment of SHIP in Bangladesh.
- Continue studies to augment the database on the long-term changes in weed populations in Bangladesh.
- Conduct field-testing of the leaf color chart for rainfed systems in Thailand, Laos, and India.

Output 2. Develop and evaluate crop and natural resource management practices for improved livelihood in upland rice systems

- Conduct a cross-country comparative case study of the patterns of upland development in the region.
- Conduct, at multiple locations, on-farm trials of rice-based cropping systems under different terrain and socioeconomic conditions for more sustainable agricultural development in mountainous and plateau areas:
  - In the shifting / rotational upland systems (at sites in northern Laos and northern Vietnam): develop 1) integrated pest, weed, and soil fertility management options for rotational systems on sloping lands and 2) improved nutrient management options for paddies under rapid water flow conditions in the valley floors.
  - In the drought-prone plateau uplands (at sites in eastern India): evaluate improved crop establishment systems that ensure adequate crop stand and effectively manage weeds, develop nutrient management for improved and traditional genotypes, and validate with farmers rice-based cropping systems options for crop diversification and intensification.

- In the intensive upland systems with a long growing season (at sites in Sumatra, Indonesia, and Mindanao in the Philippines): Conduct field trials to tailor interplanting techniques (of farmer-preferred elite lines and traditional varieties) and associated CNRM options to local situations
- Apply economic tools to analyze prospective technologies being tested in Laos and Vietnam.
- Organize seed multiplication, monitor farmers' adoption, and collect economic data for scaling up crop, nutrient, and weed management options developed for upland rice-based production systems in Laos.
- Conduct social (gender), cultural, economic, and policy research to understand enabling conditions needed for impact.

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Project summary and highlights

Improving productivity and livelihood for fragile environments

Project 9: Research consortia for fragile environments

THE PROJECT

In unfavorable environments—rainfed lowlands and uplands—fluctuating water regimes and the prevalence of problem soils keep rice yields low, at 1.0-2.3 t/ha. Poverty and population density are high in both rural and urban areas. Research gains have so far been meager because of variable and difficult conditions and the absence of a well-structured strategic research approach to address key constraints. The continuing challenge in unfavorable rice environments is to increase and stabilize rice productivity, and so improve farmers' household food security and livelihood, while sustaining the resource base. Success demands that we formulate multidisciplinary approaches and foster the development of the strong national research and extension systems (NARES) necessarily for achieving impact in these highly diverse environments.

The Consortium for Unfavorable Rice Environments (CURE) is the framework to address these concerns and to facilitate cooperation in research and development between NARES and IRRI, who jointly identify strategic problems through collaborative research at NARES sites. CURE came about in 2002 with the restructuring and consolidation of the Rainfed Lowland Rice Research Consortium and the Upland Rice Research Consortium into a single consortium.

PROGRESS IN 2003

Steering committee meeting

The second meeting of the CURE steering committee (SC) took place on 12-13 May 2003 at the Philippine Rice Research Institute. The meeting tackled 1) work plans formulated during the planning meetings of the six working groups organized by sub-ecosystem, 2) research progress and achievements of the working groups, and 3) funding strategies.

The progress reported by the working groups demonstrated the effectiveness of the CURE mechanism in conducting integrated, multidisciplinary research at key sites, effectively linking Projects 7 and 8 of IRRI's Medium-term Plan. The SC advised working group leaders to develop further their work plans with more focus on the technical program. The CURE coordinating unit is now compiling the revised work plans and will send them to each committee member before the next meeting, which will be in Indonesia in 2004.

The 2003 meeting saw NARES partners in Cambodia, Myanmar, and Nepal join CURE, bringing the membership to 10 countries. The French Agricultural Research Center for International Development (CIRAD by its French acronym) also attended the meeting as a new key partner within CURE. This expansion of CURE demonstrates its ability to attract the interest of the international research community.

Regarding funding, the SC endorsed proposals presented at the meeting. The Asian Development Bank has since approved a CURE umbrella proposal on food security and livelihood, as has the German Federal Ministry for Economic Development Cooperation a proposal for submergence-prone rainfed lowlands. Also indicating strong donor interest is the advance through evaluation process of two proposals—one on salinity and the other on upper catchments—submitted

to the Consultative Group on International Agricultural Research Challenge Program on Water and Food. The proposal on salinity has since been approved for funding.

Project management training
CURE has resolved to conduct every year a workshop or training program for IRRI staff and NARES representatives in conjunction with the SC meeting. The new CURE structure made clear the need to address in the consortium's first training the tools for project management, replacing a planned workshop on best practices for cultivar testing. The training on tools for project management, in particular the logframe, aimed to ensure that working group leaders and site coordinators—indeed, all involved with CURE—speak the same language at every stage, from project planning to output evaluation.

Technical advice
To ensure the technical soundness of research projects, CURE has included in its structure an ad hoc technical advisory committee (TAC) intended to advise research programs during both planning and review of progress and achievements. The envisioned membership of the ad hoc TAC is working group leaders and representatives from NARES, NGOs, advanced research institutes, and the private sector. The committee, which has not yet been convened, may meet only as and when necessary, rather than biennially as originally envisioned.

Meanwhile, all six working groups—which are composed of site coordinators and researchers from NARES institutes, reflecting CURE's commitment to NARES-led research to ensure relevance and impact—held planning meetings in consultation with NARES members to ensure the technical soundness of the research. Working group leaders will improve their work plans by emphasizing the technical programs, and the revised work plans, and SC members for the next committee meeting will evaluate research results.

The CURE Web site was placed online at www.irri.org/cure.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

- To better evaluate the progress of research, the SC advised working group leaders to further develop their work plans with stronger focus on the technical program. These revised work plans are being compiled by the CURE coordinating unit and will be sent to each SC member before the next SC meeting in Indonesia.
- Conduct an evaluation of training needs or workshop requirements to determine the next training program to be offered by CURE.

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Project summary and highlights

Strengthening linkages between research and development

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

THE PROJECT

International agricultural research supported by the Consultative Group on International Agricultural Research (CGIAR) aims to ensure sustainable food security and alleviate poverty by improving farm efficiency while protecting the environment. Planning and prioritizing rice research requires deep understanding of people's access to and use of natural resources and other forms of capital—physical, financial, human, and social—and their interactions with government agencies, NGOs, and institutions that influence their livelihood strategies. We must understand farmers' current practices, how components of farming systems and livelihood strategies interact, and farmers' criteria for evaluating scientific knowledge before we can assess how effective specific interventions are likely to be. Information and databases on biophysical, socioeconomic, and policy variables—and an understanding of constraints to farmers' adoption of improved technologies in different agroecosystems—can help us better formulate research strategies and policies.

Research managers and policymakers must evaluate how technologies affect the well-being of various socioeconomic groups, poverty rates, and natural resource use in order to assess progress toward meeting the objectives of rice research. Knowing what factors drive decisions at the household level—as well as the larger trends in changing patterns of production, consumption, and trade; input use and pricing policies; and overall socioeconomic conditions—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.

RESEARCH PROGRESS IN 2003

Output 1. Conduct rice-sector analysis and maintain rice statistics database and share with national agricultural research and extension systems (NARES)

In 2003, we completed a study on the impact of successive generations of modern rice varieties on rice production in Bangladesh, Philippines, and Vietnam—but not, as planned, in Indonesia for lack of a partner there interested in this collaboration. The study provided useful information on how the second and third generations of modern varieties affected yield and productivity, which we presented in the workshop *Green Revolution in Asia: Lessons for Africa* organized in Japan by the Foundation for Advanced Studies on International Development.

Output 2. Study rural livelihood systems and analyze the interface among technology, infrastructure, and institutions

We prepared reports on the impact of male migration on gender roles in agricultural production. These reports will have implications on research design and training and extension programs, which often overlook the larger role women play in managing rice farms as their menfolk migrate in search of work on both short-term and long-term bases. Descriptive report results are completed,

and the preliminary results of econometric analysis have been reported. Final reports will be presented in an international workshop at IRRI in June 2004 and published as a book.

Output 3. Assess constraints to adoption of improved rice technologies
We completed our socioeconomic studies assessing hybrid rice in the tropics. A monograph, co-written with NARES partners, on farmers' experience of hybrid rice adoption in Bangladesh, the Philippines, Vietnam, and the Indian states of Andhra Pradesh, Tamil Nadu, and Karnataka appeared in a special review-of-agriculture issue of the Indian publication *Economic and Political Weekly*. Vietnam, which imports hybrid seeds from China, was found to be the only successful example among the areas studied. In the other areas, the gains in profitability offered by hybrids over inbred varieties were marginal, mainly because of the very high cost of seed and lower prices received for hybrid grain due to its inferior quality. The experience illustrated the importance of research focused on improving the grain quality of hybrid rice.

We analyzed constraints to the adoption of modern rice varieties and fertilizers in rainfed areas of eastern India, finding that access to credit and seed are the major determinants of whether or not farmers adopt, along with the composition of their land endowment. Farmers are more likely to adopt varieties developed for irrigated areas if they have relatively favorable fields in the middle of the toposequence, above the submergence-prone lowlands and below the drought-prone uplands.

We studied consumers' and civil society groups' knowledge and perception of genetically modified rice in Bangladesh and the Philippines. The completed survey in Bangladesh informed a policy dialog on biotechnology research at which the minister of agriculture was present. The Philippine study was delayed.

Output 4. Assess impact of rice research on poverty alleviation and sustainable management of natural resources
We completed a study on the impact of rice research on poverty alleviation in Bangladesh and implemented sample household surveys to generate primary information for West Bengal, eastern Uttar Pradesh, and Chhattisgarh states in India. The completed study for Bangladesh shows that most rural households do not own land and so receive limited direct benefit from rice research. However, the indirect benefit of making rice more affordable to the rural landless and urban poor has been substantial. We submitted the results from Bangladesh to the International Food Policy Research Institute as an activity sponsored by the Standing Panel on Impact Assessment of the interim Science Council of the CGIAR. Processing the data from the other sites continues.

An analysis of the expected impact on human nutrition from iron- and zinc-rich rice revealed that many pregnant women in Bicol, Philippines, receive daily iron supplements, and a substantial fraction of them consumes the supplements daily, but only a minority of children receive them for lack of government funding. The result illustrates the scope for reducing iron deficiency in the Philippines, and so the potential benefit of high-iron rice.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

Output 1. Conduct rice-sector analysis and maintain rice statistics database and share with NARES

- Publish revised papers on impact of successive generations of modern varieties on rice production in Indonesia, Bangladesh, and Vietnam.
- Complete the study on the impact of the liberalization of rice trade on producers' and consumers' welfare for the Philippines and Indonesia.
- Complete a comparative study on the structure and efficiency of rice marketing for Thailand, Philippines, and Indonesia.

Output 2. Study rural livelihood systems and analyze the interface among technology, infrastructure, and institutions

- Present final reports on the impact of male migration on gender roles and efficiency in the organization of agricultural production during an international workshop at IRRI in July.
- Begin a new Australian Centre for International Agricultural Research-funded, 3-year project on the impact of labor migration / off-farm employment in mixed farming systems in Philippines, Thailand, Vietnam, and Australia.
- Publish a book on the livelihood systems in Bangladesh containing results of the study on the dynamics of the livelihood systems in Bangladesh supported by the project Poverty Elimination Through Rice Research Assistance.
- Conduct a policy dialogue on the potential of mainstreaming women in agricultural development using homestead as a resource.

Output 3. Assess constraints to adoption of improved rice technologies

- Analyze data from the uplands and prepare research papers looking at constraints to adoption of modern rice varieties and fertilizers in eastern India.
- Conduct policy dialogues on constraints to adoption of agricultural mechanization in Bangladesh.

Output 4. Assess impact of rice research on poverty alleviation and sustainable management of natural resources

- Continue study on the impact of rice research on poverty alleviation in West Bengal, eastern Uttar Pradesh, and Chhattisgarh in India.
- Begin a study on ex-ante impact assessment of biofortified rice as part of the rice component of the HarvestPlus Challenge Program: Breeding Crops for Better Nutrition.
- Complete the mapping of required key variables to carry out small-area estimation of income poverty at the subdistrict level in Bangladesh.
- Compile an electronic atlas of poverty in Bangladesh and disseminate to stakeholders.

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Project summary and highlights

Strengthening linkages between research and development

Project 11: Enhancing ecological sustainability and improving livelihoods through ecoregional approaches to integrated natural resource management

THE PROJECT

Farmers' dependence on a healthy natural resource base links the goals of ensuring food security, alleviating poverty, and protecting the environment. Research to help farmers use resources more efficiently at the field level must therefore go hand-in-hand with broader concerns regarding resource allocation at the agroecosystem level. Recognizing this, the CGIAR in 1995 asked IRRI to convene the Ecoregional Initiative for the Humid and Subhumid Tropics of Asia, or Ecor (I) Asia, one of eight ecoregional programs tackling complex natural resource management (NRM) issues at the regional scale.

Project 11 aims to improve rural livelihoods by enhancing the sustainability of their supporting ecosystem. We adopt a systems perspective, drawing on diverse expertise to tackle the many dimensions of NRM integration across disciplines, geographical and time scales, and the research-development-policy continuum. Our research challenges are to generate integrated natural resource management (INRM) knowledge (including the tools to use it) and to promote its free exchange among researchers, policymakers, and users of natural resources.

While building upon NRM research at low levels of integration (field / farm), we develop additional tools for modeling and analyzing interactions at different levels of biological, physical, and social organization. Successful INRM empowers stakeholders at all levels to make informed resource-management choices by improving their knowledge and their ability to articulate objectives and negotiate demands. As our role is to facilitate this empowerment, we stress developing research and operational methods, and involving stakeholders in the process, as much as we do the delivered research products.

We conduct our research in pilot regions representing the various agroecosystems where rice is a major crop, with emphasis on less-productive, fragile environments. Within each pilot region, we establish strategic partnerships with national and international institutions that fill complementary roles along the research-development continuum.

RESEARCH PROGRESS IN 2003

Land-use modeling

In 2003, we developed land-use planning, analysis, and management models for identifying development scenarios in Vietnam and northeast Thailand. In April, we completed a project funded by the United Kingdom's Department for International Development on land use and water management in the coastal zone of the Mekong Delta of Vietnam. The provincial authorities of Bac Lieu continue to apply the hydraulic model we developed to manage sluice gates that control tidal intrusion of salt water to maximize the productivity of, and income generated by, rice and shrimp farms. A survey at the end of the project confirmed that the new policy on land and water use has had a positive impact on farmers' livelihood in the area.

Associated work in the coastal areas of the Mekong Delta will continue in a project under the Comprehensive Assessment Program of the Consultative Group on International Agricultural Research (CGIAR) System-wide Initiative on Water Management, titled "Increasing water productivity by managing the land-water interface: effective water control for solving conflicts among agriculture, fisheries, and aquaculture in coastal zones." Besides this, the CGIAR Challenge Program on Water and Food for Agriculture approved the complementary project "Managing water and land resources for sustainable livelihoods at the interface between fresh and saline water environments in Vietnam and Bangladesh."

We delivered to stakeholders knowledge banks of promising innovations for land use and crop diversification in the northern Vietnamese province of Bac Kan, as well as guidelines and recommendations on resource management strategies. Some 1,400 copies of the book *Doi Moi in the Mountains*, published in English and Vietnamese by the Mountain Agrarian System Regional Program (SAM by its French acronym), have been distributed to stakeholders, including the Vietnamese Senate, which requested and recommended the book for reference. SAM also developed a CD-ROM compilation in English, Vietnamese, and French of all the results produced by Phase 1 of the project and has distributed about 200 copies of it, as well as making it available online at the Rice Knowledge Bank hosted by IRRI (www.knowledgebank.irri.org).

The SAM network of research and demonstration sites in Bac Kan continues to receive visits by scientists, journalists, and farmers and government officials from neighboring provinces. Phase II of the SAM project conducts, jointly with a consortium of NGOs, training at the Northern Mountainous Agricultural Research Center. Several development projects are applying guidelines and recommendations borrowed from SAM in most of the mountainous provinces of northern Vietnam.

We developed land-use optimization models for typical farm types in Ubon Ratchathani Province in northeastern Thailand and in Ilocos Norte Province in the northern Philippines and explored preliminary development scenarios.

Participatory companion modeling methodology

In 2003, we refined and tested on farm a participatory companion modeling (ComMod) approach to integrated NRM, which combines field surveys, multiagent systems, and role-playing games. In Bhutan, we applied ComMod to water management for transplanted rice, and in northeastern Thailand to land-use changes, water management for rainfed lowland rice, and farmers' choice of which rice varieties to grow. We presented preliminary results from these studies at the annual ComMod meeting in France.

Twelve national agricultural research and extension system (NARES) colleagues from Thailand, Philippines, and Vietnam helped prepare articles on applications of the ComMod approach, and courses on the methodology are being offered by NARES colleagues and IRRI staff at universities in Thailand and the Philippines. Meanwhile, we implemented three one-week training courses on multiagent systems, social sciences, and INRM at Thai universities, and NARES colleagues have initiated the creation of the Asia-Pacific Social Science Association.

We conducted an analysis of Thai cultural aspects of learning processes and their implications on the use and impact of the ComMod approach and, in Vietnam, advanced the modeling of coastal Bac Lieu with collaborators from Cantho University.

The CGIAR Challenge Program on Water for Food provisionally accepted a proposal based on the use of the ComMod approach and tools for collective water management at four sites.

Social studies in Thailand

We surveyed farmers and used role playing to simulate land-use changes in two contrasting villages in Khon Kaen Province of northeastern Thailand to understand their decision-making processes, priorities, and openness to adopting innovative technologies. Staff members of Khon Kaen University are using the results of the surveys to guide their interventions in these villages, and the university's graduate program on agricultural systems organized lectures and discussions on our research methodology.

Similarly, we conducted field surveys and role playing in neighboring Ubon Ratchathani Province to understand how farmers decide which rice varieties to grow in their rainfed lowlands and their crop-management practices in light of variable rainfall, as well as their adoption of farm ponds. We established collaboration in these areas among provincial research, educational, and agricultural-development institutions.

In mixed irrigated and rainfed villages in the northern Thai province of Chiang Rai and the central Thai province of Nakhon Sawan, we completed surveys on the impact of male labor out-migration on gender roles and efficiency in rice farming. When analysis of the data is completed, the study will identify possible strategies and technologies to help female heads of households better manage their farms.

Knowledge consolidation

In addition to end-of-project workshops held at pilot regions for the SAM project (in September 2002) and the saline water management project in Bac Lieu (in February 2003), we conducted a workshop in October 2003, as a culmination of the year's series of multiagent systems training courses, that brought together case study experiences. It is noteworthy that the SAM and Bac Lieu projects both garnered considerable press coverage.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

- Implement the project, "Increasing water productivity by managing the land-water interface: effective water control for solving conflicts among agriculture, fisheries, and aquaculture in coastal zones" for the Mekong River Delta.
- Implement the Water and Food Challenge Project, "Managing water and land resources for sustainable livelihoods at the interface between fresh and saline water environments in Vietnam and Bangladesh."
- Conduct Phase II of the SAM project jointly with a consortium of NGOs including training at the Northern Mountainous Agricultural Research Center, Vietnam.
- Conduct final on-farm experiments of the ComMod process in northern and northeastern Thailand.
- Organize the last three training sessions on the ComMod methodology under the European Union-supported Asia IT&C Project.
- Develop a new application on rice-quality management along the production-processing-marketing supply chain in northeastern Thailand.
- Publish results from field surveys and gaming-simulation experiments and conduct the second round of gaming-simulation with farmers / stakeholders.
- Present and publish a compilation of 14 case studies applying the ComMod approach for INRM in five Asian countries.
- Finalize land-use optimization models developed for typical farm types in Ubon Ratchathani Province, Thailand, and in Ilocos Norte Province, Philippines.
- Implement the new Australian Centre for International Agricultural Research-funded research project on "Impact of migration and / or off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems."

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Project summary and highlights

Strengthening linkages between research and development

Project 12: Facilitating rice research for impact

THE PROJECT

Improved rice technologies can help raise farmers' incomes, reduce farm drudgery, and protect the environment. However, as technologies grow more complex, they become increasingly difficult to present to farmers for their consideration. Reaching hundreds of millions of rice farmers with knowledge-based technologies is an enormous challenge. Project 12 meets this challenge by asking the "what, who, and how" of dissemination: What are the problems and opportunities facing farmers and researchers? Who are the target groups and partners in dissemination? How do we distill and present the message? Addressing these questions, we ensure that research is focused and relevant, and that national partners have the skills to develop, distill, and deliver research products. We achieve the necessary understanding of dissemination pathways and knowledge-assimilation patterns by analyzing problems and opportunities and, through farmer-participatory experiments, identifying, validating, adapting, and promoting potentially useful technologies.

Feedback from farmers allows us to maintain research relevance and efficiency. Integral to this process are partnerships with national research and extension systems (NARES), NGOs, and private-sector specialists. Required throughout is focused training for NARES partners on both research and delivery methodologies, as we aim to bridge the gap between technology development and its use.

PROGRESS IN 2003

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

In 2003, we further consolidated the Rice Knowledge Bank as a single-source, Web-based publication medium for rice knowledge, including the addition of 32 reference guides in RoboHelp and 36 fact sheets produced on a standardized template. The bank now has more than 60 contributing authors. We completed *Rice Doctor*, a Web- and CD-based diagnostic decision-support tool that is one of the bank's most frequently downloaded resources.

The single-source methodology exemplified by the Rice Knowledge Bank has exceeded expectations in terms of ease of production and distribution, management, and updating of content—such that other research centers in the Consultative Group on International Agricultural Research are adopting this approach.

The Rice Knowledge Bank has recorded more than 200,000 visits and more than 1.6 million entries into individual pages. These and other usage statistics suggest that over 25,000 copies of various fact sheets have been downloaded, proving that the knowledge bank is viewed as a credible, demand-driven resource for rice training and extension. Considering the labor and mailing costs of distributing this content by traditional means, the Rice Knowledge Bank has realized considerable return on investment. Similarly, our methodology for single-sourcing to CD-ROM and print has been confirmed with the release of continuously updated versions from 2.0 to 2.1, 2.2, and 2.3 of the knowledge bank contents.

We made available through the Rice Knowledge Bank complete instruction and training materials (reference manuals, class presentations, and lesson plans) on three high-demand topics: rice milling, the leaf color chart, and land leveling. Each of these areas offers—at any time and any place—learning materials that provide users and instructors with all the tools and formats required to learn and teach these topics, greatly improving the efficiency of training / instructional material preparation and distribution.

Material initiated on the Rice Knowledge Bank has been translated into local languages for posting on eight regional sites in Cambodia, Indonesia, Laos, Myanmar, Pakistan, Philippines, Thailand, and Vietnam. We conducted workshops in Bangladesh and Myanmar to establish new in-country partnerships and reinforce existing partnerships for developing regional versions of the knowledge bank.

In Bangladesh, the project Poverty Elimination Through Rice Research Assistance (PETRRA) implemented projects to distill the output of innovation projects in simplified form and make this information available through the Bangladeshi regional site of the knowledge bank.

Meanwhile, we facilitated higher farmer awareness and adoption of resource-efficient technologies in Indonesia and Vietnam. In Indonesia, we distilled, simplified, and published as rice fact sheets for extension staff the information components of integrated crop management including rice varieties, seed quality, young seedlings, the leaf color chart (LCC) for nitrogen fertilizer management, omission-plot / soil testing for phosphorus and potassium fertilizer management, and mechanical weeding. Local adaptation of these materials was slated for late 2003 and early 2004.

In Vietnam, Cuu Long Delta Rice Research Institute researchers developed training materials on seed quality, low seeding rate, drum seeder use, site-specific nutrient management including the use of LCC, and integrated pest management (IPM) for direct-seeded rice. Communication materials have been produced, field-tested, and disseminated to farmers.

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

In 2003, we documented farmers' benefits, adoption, and response to tested technologies at collaborative sites. In Bangladesh, PETRRA conducted research on technology development and testing of uptake methods in 533 villages spread over 37 districts. Forty-one percent of the 11,757 participating farmers were women. Both the seed health and IPM projects demonstrated clear economic returns from improved practices—11% yield gains from improved seed and an average 30% income increase from IPM and nutrient management combined.

In Indonesia, farmers at 26 sites evaluated the integrated crop management (ICM) components of low seeding rate, planting 15- to 20-day-old seedlings at 1-3 per hill, paired row planting, and mechanical weeding with a rotating hoe. Farmers adopting ICM increased their yield by 1 t / ha and their profit by US$50-100 / ha.

In Vietnam, farmers sowing with high-quality seed reduced their seed-use rate by 25-50%, using the LCC for nitrogen-fertilizer management reduced their nitrogen use by 15-20%, and using IPM reduced pesticide use by more than half. The greatest cost reduction arose from reduced pesticide use. Reduced input costs and healthy farming environment encouraged farmers to adopt the technologies.

We trained more than 100 extension and research staff in the use of the LCC, and 3,000 farmers on the Indo-Gangetic Plain now use the charts. Myanmar requested and distributed more than 5,000 LCCs, and a new partnership in Vietnam produced a cheaper paper version. Since 2001, approximately 405,000 paper LCCs have been produced and distributed.

The delivery of site-specific nutrient management (SSNM) progressed with the promotion of suitable technologies in the more than 20 pilot villages in six

Asian countries, including the development of delivery strategies and promotional materials. The SSNM approach is now part of regional and nationwide initiatives in Bangladesh, Vietnam, Indonesia, India, and the Philippines.

Output 3. Develop human capital of NARES

IRRI offered a range of courses—including at least six high-demand courses delivered to targeted participants at Los Baños—on genetic engineering and nutrition improvement in rice, integrated nutrient management, integrated pest management, statistics, leadership for Asian women in agriculture R&D, rice breeding, rice breeding for better nutrition, rodent management, scientific writing and presentation, seed health testing policy for safe germplasm movement, rice production training, ORYZA2000, and English language at various levels. In addition, IRRI ran special courses in direct response to requests from NARES and established training partnerships in Myanmar and Korea to deliver high-demand knowledge to intermediaries and farmers.

Our courses facilitate learning through an approach that combines the Rice Knowledge Bank and classroom group discussions. Participant feedback has been excellent. IRRI training increasingly emphasizes not just presenting courses but actively engaging participants to make training more enjoyable and effective. Course evaluations submitted by participants indicate high course quality and relevance and an effective learning environment.

SUMMARY OF NEXT STEP ACTIVITIES IN 2004

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

- Further develop the Rice Knowledge Bank country sites by building the in-country capacity to convert relevant Bank core content into localized training materials.
- With Rice Knowledge Bank gaps identified, efforts are under way to build learning materials that are available anywhere and anytime to provide users and instructors with all the tools and formats required to learn and teach high-demand topics.

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

- In studying farmers' benefits from the adoption of and response to tested technologies at collaborative sites, continue pilot site implementation and documentation of process, impact, and lessons learned in Bangladesh, Indonesia, and Vietnam.
- In Indonesia and Vietnam, further test distilled farmer-preferred technologies and make them further available for broader testing and modification.

Output 3. Develop human capital of NARES

- Continue with high-demand courses (e.g., genetic engineering and nutrition improvement in rice, integrated nutrient management, integrated pest management, statistics, etc.) delivered to targeted participants at Los Baños.
- Continue training partnerships established in Myanmar and Korea to deliver high-demand knowledge to intermediaries and farmers and develop the local capacity to deliver the courses.
- Organize special in-country or headquarters courses as per actual demand from time to time.

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MEMORANDA OF AGREEMENT: PARTNER INSTITUTIONS IRRI ENTERED INTO AGREEMENTS WITH IN 2003

Australia

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Austria

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Bangladesh

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China

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- Institute of Soil Sciences (ISS), Chinese Academy of Sciences, China. Memorandum of Agreement between ISS and IRRI for the BMZ-funded

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France

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Germany

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India

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Indonesia

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Japan

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- Foundation for Advanced Studies on International Development (FASID). Memorandum of Understanding between IRRI and FASID for addressing poverty alleviation, technological changes in agriculture, natural resource management, and other major issues of development economics. 23-10-2003 – open.

Kenya

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Korea

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Mexico

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Myanmar

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Netherlands

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Philippines

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- Central Luzon State University (CLSU). Memorandum of Understanding for the establishment and operation of an Open Academy for Philippine Agriculture. 28-07-2003-open.
- Pampanga Agricultural College (PAC). Memorandum of Understanding for the establishment and operation of an Open Academy for Philippine Agriculture. 28-07-2003-open.
- University of Southern Mindanao (USM). Memorandum of Understanding for the establishment and operation of an Open Academy for Philippine Agriculture. 28-07-2003-open.

Singapore

- International Development Research Centre (IDRC) Regional Office for Southeast and East Asia. Consultancy contract between IDRC, Singapore, and IRRI for the project *Enhancing productivity through integrated natural resources management* (EPINARM) *in Bhutan* (DPPC2000-22). 01-07-2002 – 30-06-2003.
- IDRC Regional Office for Southeast and East Asia. Consultancy Contract between IDRC, Singapore, and IRRI for the project *Enhancing productivity through integrated natural resources management* (EPINARM) *in Bhutan* (DPPC2000-22). 01-07-2003 – 31-12-2003.

Switzerland

- Swiss Agency for Development and Cooperation (SDC). Memorandum of Agreement between SDC and IRRI (7F-03364.05) for the project *Lao PDR-IRRI Rice Research and Training Project, Phase V* (DPPC2003-06). 01-07-2003 – 31-12-2005.

UK

- Natural Resources Institute (NRI). Contract between NRI and IRRI for the DfID / NRI-funded project *Development of sustainable weed system in direct seeded irrigated rice (Publication)* (DPPC2002-59). 01-12-2002 – 31-12-2002.
- NRI. Agreement between NRI and IRRI for the DfID / NRI-funded project *Promotion of integrated weed management for direct seeding of rice in the Gangetic Plains of India* (Contract No. A1083x1) (DPPC2002-60). 01-01-2003 – 31-03-2005.
- NRI. Amendment to Contract No. A1083x1 changing the project coordinator (from Dr. Martin Mortimer to Dr. David Johnson) and amending the terms of reference and financial details of the DfID / NRI-funded project *Promotion of integrated weed management for direct seeding of rice in the Gangetic Plains of India* (DPPC2002-60).
- NRI. Agreement between NRI and IRRI for the DfID / NRI-funded project *Promotion of improved weed management in Bangladesh* (Contract No. A1075x3) (DPPC2002-61). 01-01-2003 – 31-03-2005.
- NRI. Amendment to Agreement A1975x3 providing an additional fund for the purchase of motorcycle for the project *Promotion of improved weed management in Bangladesh* (DPPC2002-61).
- International Fund for Agricultural Development (IFAD). Technical Assistance Grant Agreement between IFAD and IRRI for the project *Accelerating the adoption of technologies for improving the rural livelihoods in the rainfed eastern Gangetic Plains* (DPPC2002-27). 01-01-2003 – 31-12-2005.

USA

- International Food Policy Research Institute (IFPRI). Amendment No. 2 to contract 2001X078IRR increasing the contract by $17,000 to cover costs of organizing and participating at the workshop Breeding, Grain Quality and Nutrition under the project *Breeding for iron-dense rice: a low-cost sustainable approach to reduce anemia in Asia* (DPPC2001-54).
- IFPRI. Amendment No. 1 to contract 2001X077IRR increasing the contract by $40,000 to cover additional costs to be incurred by the project *Breeding for iron-dense rice: a low cost sustainable approach to reduce anemia in Asia* (DPPC2001-54). 02-06-2002 – 31-12-2004.
- Kansas State University (KSU). Memorandum of Understanding between KSU and IRRI (DPPC2003-02). 20-02-2003 – open.
- KSU. Memorandum of Agreement between KSU and IRRI for the joint sponsorship and management of the Cereals Genomics Initiative (CCGI) (DPPC2003-02). 01-03-2003 – 30-09-2004.
- KSU. Sub-award Agreement between KSU and IRRI for the USDA-funded project *Contribution of three defense response genes in quantitative disease resistance* (DPPC2002-43). 01-07-2003 – 30-06-2006.
- Ohio State University Research Foundation (OSURF). Amendment No. 1 to the Memorandum of Agreement between OSURF and IRRI which extends the collaborative project *Predicting the environmental impact of transgene outcrossing to wild and weedy rices in Asia* to August 31, 2003 (DPPC1997-12).
- Pennsylvania State University (PSU). Amendment No. 3 to the Memorandum of Agreement between PSU and IRRI for the USAID-

funded project *The IPM implementation of Vietnamese farms in the Mekong Delta Project* (DPPC1997-12). 01-01-2001 – 31-12-2003.

- Research Corporation of the University of Hawaii (RCUH). Agreement between RCUH and IRRI for the USAID-funded collaborative project *Testing, comparing, and adapting NuMass: the nutrient management support system* (DPPC2003-72). 01-09-2003 – 30-09-2007.
- Rockefeller Foundation (RF). Research Agreement between RF and IRRI for the RF-funded project *Tilling of rice* (2003 FS 081), a collaborative project between IRRI and the University of Washington, Seattle, Washington, USA (DPPC2002-48). 01-09-2003 – 31-08-2006.
- The Regents of the University of California. Amendment No. 3 to Research Agreement No. 980770 between IRRI and the Regents of the University of California relative to the no-cost extension of the IRRI / UC Davis collaborative weed research project funded from the USAID Land Grant Program (DPPC1997-12).
- University of Utah, Salt Lake City, Utah. Amendment No. 2 to the Memorandum of Agreement between the University of Utah and IRRI renewing the agreement until 31 Dec 2003, relative to the USAID-funded project *Xylem cavitation in rice and effects on productivity* (DPPC1997-12).

Vietnam

- Department of Plant Protection, Ministry of Agriculture and Rural Development (MARD). Agreement between IRRI and MARD for the project *Enhancing farmers' income and livelihood through integrated crop management (ICM) expansion in southern Vietnam* under IRRC Phase 2 (DPPC2001-03). 01-07-2003 – 31-12-2004.

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SPECIAL-FUNDED PROJECTS: PROPOSALS APPROVED BY DONOR AGENCIES IN 2003

- Australian Centre for International Agricultural Research (ACIAR)
  - Fertilization-independent formation of embryo, endosperm, and pericarp for apomictic hybrid rice (DPPC 2001-07), AUD1,500,000, 01-07-2003 – 30-06-2008.
  - Assessment of the ACIAR-supported rodent control project in Vietnam: adoption and impacts (DPPC 2003-79), USD17,687, 17-11-2003 – 06-02-2004.

- Asian Development Bank (ADB)
  - Development of a training course on water-saving technologies in rice production (DPPC 2002-39), USD46,000, 01-11-2003 – 31-10-2004.
  - International workshop on strategies for sustainable development of agricultural production systems in the highlands of the greater Mekong subregion countries (DPPC 2003-04), USD20,000, 12-09-2003 – 16-09-2004.
  - 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 (DPPC2003-42), USD900,000, 01-01-2004 – 31-12-2006.
  - Increasing rice returns through postharvest management: linking farmers to markets (DPPC 2002-37), USD750,000 (start date TBD).

- Challenge Program on Water and Food (CPWF)
  - Development of technologies to harness the productivity potential of salt-affected areas of the Indo-Gangetic, Mekong, and Nile river basins (DPPC 2003-21), (start date TBD).
  - Managing water and land resources for sustainable livelihoods at the interface between fresh and saline water environments (DPPC 2003-29) (start date TBD).

- Commonwealth Scientific and Industrial Research Organisation (CSIRO) / Crawford Fund
  - CSIRO-IRRI collaborative research and training on rodent management and ecology research (DPPC2003-48), AUD26,000, 20-05-2003 – 19-05-2004.

- Comprehensive Assessment–Systemwide Initiative on Water Management (CA-SWIM)
  - Increasing water productivity by managing land-water interface: effective water control for solving conflicts (DPPC2002-55), USD199,590, 01-02-2003 – 31-01-2005.

- Department of Agriculture – Sri Lanka (DOASL)
  - Improving the productivity of the Sri-Lankan rice granaries through effective technology promotion and delivery using information and communications technology (DPPC 2003-80), USD50,000 (start date TBD).

- Department for International Development–Natural Resources Institute (DfID-NRI)
  - Promotion of cost-effective weed management practices for lowland rice in Bangladesh (DPPC2002-61), GBP87,941, 01-01-2003 – 31-03-2005.
  - Promotion of integrated weed management for direct seeded rice in the Gangetic Plains of India, (DPPC 2002-60), GBP44,585, 01-01-2003 – 31 03-2005.

- Development of sustainable weed system in direct seeded irrigated rice (publication), (DPPC2002-59), GBP3,000, 01-01-2003 – 01-04-2003.

- Food and Agriculture Organization (FAO)
  - Poverty and food insecurity mapping in Bangladesh (DPPC2001-63), USD99,500, 01-04-2003 – 31-03-2004.

- German Federal Ministry for Economic Cooperation and Development (BMZ)
  - Food security and commercialization in uplands of northern Vietnam (DPPC 2003-62), 01-10-2003 – 30-09-2004.
  - From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments (DPPC2002-45), EUR700,000 (start date TBD).
  - Applying genetic diversity and genomic tools to benefit rice farmers at risk from drought (DPPC2003-41), EUR500,000 (start date TBD).

- International Atomic Energy Association (IAEA)
  - Selection for greater agronomic water-use efficiency in wheat and rice using carbon isotope discrimination (DPPC2002-51), 01-11-2003 up to the end of IAEA's coordinated research project in "Selection for greater agronomic water-use efficiency in wheat and rice using carbon isotope discrimination."
  - Simulating water and nitrogen interaction in the rice-wheat cropping system (DPPC2003-03), USD10,000, 15-04-2003 – 14-04-2004.

- International Development Research Centre (IDRC)
  - Efficiency improvement and environment sustainability: exploring the economy of fertilizer-nitrogen use of irrigated rice in China (DPPC2002-47), 01-01-2003 – 31-12-2005.

- National Graduate Institute for Policy Studies (GRIPS)
  - Household-level research project in the Philippines-Central Luzon Loop Survey: a joint research between GRIPS and IRRI (DPPC2003-81), USD15,000, 01-11-2003 – 01-03-2004.

- Philippine Rice Research Institute (PhilRice)
  - Hybrid nucleus and breeder seed production (DPPC2003-73) (start date TBD).

- Rural Development Administration (RDA)
  - Analysis of virus resistance mechanism in rice plants using disease-related gene expression profiles (DPPC2003-13), USD60,000, 01-02-2003 – 31-12-2005.
  - RDA-IRRI collaborative project on rice functional genomics and wide hybridization and gene introgression for rice (DPPC2003-07), USD300,000, 01-07-2003 – 30-06-2006.

- Rockefeller Foundation (RF)
  - Impact assessment of wide hybridization in rice research and technology development (DPPC2003-38), USD35,057, 01-06-2003 – 31-01-2005.
  - Tilling of rice project (DPPC2002-48), USD124,992, 01-09-2003 – 30-08-2006.

- Swiss Agency for Development and Cooperation (SDC)
  - Lao PDR-IRRI rice research and training project phase V (DPPC2003-06), USD2,093,000, 01-07-2003 – 31-12-2005.

- United States Agency for International Development (USAID)
  - A network of golden rice in Asia (DPPC2002-41), USD300,000, 01-01-2003 – 31-12-2005.
  - Testing, comparing and adapting NuMass: the nutrient management support system- IRRI-University of Hawaii collaborative project (DPPC2003-72), USD45,000, 01-09-2003 – 30-09-2007.
  - Challenge program on biofortified crops for improved human nutrition (DPPC2003-70), USD101,000, 09-09-2003 – 31-12-2003.
  - Comparative genetics, isolation and pyramiding of genes for aluminum tolerance in rice and wheat (DPPC2003-15), (start date TBD).

- United States Department of Agriculture (USDA)
  - Contribution of three defense response genes in quantitative disease resistance (DPPC2002-43), USD134,001, 01-07-2003 – 30-06-2006.
  - Tilling and eco-tilling resources for japonica and indica rice (DPPC2003-50), USD90,200 (start date TBD).

- World Bank (WB)
  - Upgrading of the International Rice Genebank Collection at IRRI (DPPC2003-05), USD1,175,899, 01-01-2003 – 31-12-2005.

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HONORS AND AWARDS RECEIVED BY IRS, NRS, AND BOT IN 2003

- **Fazle Hasan Abed**, BOT member
  1) Awarded the Gleitsman Foundation International Activist Award for 2003 on Eradication of Poverty, Harvard University, April.
  2) Received an honorary doctorate degree (education) from the University of Manchester, UK, May.

- **Remegio Aguilar, Adelaida Alcantara, Bernardino Almazan, Ma. Socorro Almazan, Lydia Angeles, Vicente Arcillas, Noel Banzuela, Imelda Boncajes, Flora de Guzman, Isabelita de Mesa, Minerva Eloria, Arnold Gonzales, Emerlinda Hernandez, Amita Juliano, Melencio Lalap, Alicia Lapis, Felix Llanes, Wilma Lumaybay, Minerva Macatangay, Yolanda Malatag, Veronica Mangubat, Jacqueline Manuel, Bernardo Mercado, Gregorio Mercado, Ma. Elizabeth Naredo, Maridee Pontipedra, Romulo Quilantang, Renato Reaño, Nelia Resurreccion, Mario Rodriguez, Digna Salisi, Teresita Santos,** and **Florencio Villegas**, national support staff, GRC
  Won the CGIAR Science Award for Outstanding Scientific Support Team, Nairobi, Kenya, October.

- **V. Balasubramanian**, agronomist, IPMO
  Received the 2003 International Fertilizer Association (IFA) International Award for his research relevant to fertilizer use in developing countries, Philadelphia, PA, USA, May.

- **V. Balasubramanian, R. Buresh, M.M. Escalada, and K.L. Heong** (with Nguyen Huu Huan of the Plant Protection Department; Pham Sy Tan and Pham Van Du of the Cuu Long Delta Rice Research Institute; and Pham van Quynh and Nguyen Van Ngau of Cantho Province)
  Won the 2003 Golden Rice Award for Best Agricultural Innovation from Vietnam's Ministry of Agriculture and Rural Development (MARD), December.

- **Bas Bouman**, water scientist, CSWS
  Elected honorary member of the Philippine Society of Agricultural Engineers for his research and extension work on water-saving irrigation technologies in the Philippines, Davao City, Philippines, April.

- **Ronald Cantrell,** director general
  Presented an honorary doctorate degree by the Sardar Vallabh Bhai Patel University of Agriculture and technology, Uttar Pradesh, India, November.

- **Charlene F. Dalmacio**, accountant, Property and Assets
  Named recipient of the 2003 National Young Achiever Award for Commerce and Industry, Legaspi City, Philippines, November.

- **David Dawe**, economist, SSD
  Nominated by *Time* Magazine as one of 20 Asian heroes. April.

- **Peter Fredenburg,** editor / writer, VIS
  Won a Gold Award in writing for magazines from the Agricultural Communicators in Education (ACE) for feature article, *Lost horizons restored,* which appeared in *Rice Today*, April.

- **K.L. Heong**, entomologist and deputy head, EPPD
  1) Recipient of the 2003 Charles A. Black Award from the Council for Agricultural Science and Technology for his outstanding contributions to the advancement of science in the public policy arena, Arlington, Virginia, March.
  2) Received the Malaysian Plant Protection Society's Inaugural Award of Excellence in Plant Protection, Kuala Lumpur, Malaysia, August.

- **K.L. Heong** and **Monina Escalada,** entomologist and deputy head, EPPD, and international research fellow, IPMO (with Nguyen Huu Huan and Vo Mai)
  Received the International Green Apple Environment Award from the Green Organization, House of Parliament, London, UK, November.

- **Gurdev S. Khush**, consultant, PBGB
  Received a Doctor of Science degree (*honoris causa*) from the N.D. University of Agriculture and Technology, Faizabad, India, March.

- **Ruben Lampayan, Bas Bouman, Domingo Tabbal,** and **Lizzida Llorca,** CSWS (with collaborators from the National Irrigation Administration and the Philippine Rice Research Institute)
  Received the Best Technical Paper Award in the Energy Systems, Water Management and Environmental Management Category during the 53rd Annual National Convention of the Philippine Society of Agricultural Engineers, Davao City, Philippines, April.

- **Juan Lazaro IV** and **Gene Hettel,** graphic designer and head, respectively, CPS
  Won a Silver Award in graphic design from the Agricultural Communicators in Education (ACE) for the cover of the third edition of the *Rice Almanac*, April.

- **Hei Leung**, plant pathologist, EPPD
  Named Fellow of the American Phytopathological Society (APS), North Carolina, August.

- **Hei Leung** and **Casiana Vera Cruz**, plant pathologists, EPPD (with Lucia Borines of Leyte State University, Edilberto Redoña of Philippine Rice Research Institute, Marina Natural of the University of the Philippines Los Banos, and Brad Porter and Frank White of Kansas State University)
  Won the M.S. Swaminathan Outstanding Research Award during the celebration of National Science and Technology Week, Manila, Philippines, July.

- **Bio Liu** (EPPD), **Ramil Mauleon** (EPPD), **Marichu Bernardo** (PBGB), **Violeta Bartolome** and **Alexander Casico** (BBU), and **Hei Leung** (EPPD)
  Won second prize in the best poster category during the conference of the Federation of Crop Science Societies of the Philippines (FCSSP), Aklan State University, Aklan, Philippines, April.

- **David J. Mackill**, head, PBGB
  Named Fellow of the Crop Science Society of America (CSSA), Denver, November.

- **David Mackill, Glenn Gregorio, Parminder Virk, Edwin Javier, Seiji Yanagihara, Alvaro Pamplona, Julio Chavez, Rodolfo Toledo, Neil Monroy, Rhulyx Mendoza, Benito Romena, Vitaliano Lopena, Jose Roxas, Marcelino Laza, Modesto Amante,** and **Roger Cabunagan,** PBGB and EPPD
  Received a plaque of appreciation from the National Seed Industry Council, Philippine Rice Research Institute, and the Rice Technical Working Group for their contribution toward the release of five rice varieties in the Philippines, Tarlac, Philippines, April.

- **T.W. Mew**, plant pathologist and head, EPPD
  Received the Philippine Phytopathological Society Achievement Award, Cebu City, Philippines, May.

- **Harold John Nesbitt**, former head of Cambodia-IRRI-Australia Project and IRRI representative to Cambodia
  Appointed Member of the Order of Australia on the Queen's Birthday 2003 Honours List, 9 June 2003 for "Service to agriculture as project manager and agronomist for the Cambodia-International Rice Research Institute-Australia Project and, through this project, to the community of Cambodia," Perth, Australia.

- **Keijiro Otsuka**, BOT member (and Prabhu Pingali, former IRRI economist)
  Elected officers of the International Association of Agricultural Economists [vice president for programs and president, respectively] Durban, South Africa, August.

- **Domingo Tabbal, Sr.**, associate scientist, CSWS
  Named a PSAE Fellow for his exemplary professional distinction and his outstanding and extraordinary qualifications and experience in the field of agricultural engineering during the 53rd Annual National Convention of the Philippine Society of Agricultural Engineers (PSAE), Davao City, Philippines, April.

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Publications and seminars in 2003

Journal papers

Plant breeding, genetics, and transgenics

Andaya VC, Mackill DJ. 2003. Mapping of QTLs associated with cold tolerance during the vegetative stage in rice. J. Exp. Bot. 54:2579-2585.

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Krishnan S, Datta K, Baisakh N, de Vasconcelos M, Datta SK. 2003. Tissue-specific localization of b-carotene and iron in transgenic indica rice (*Oryza sativa* L). Curr. Sci. 84:101-104.

Mei HW, Luo LJ, Ying CS, Wang YP, Yu XQ, Guo LB, Paterson AH, Li ZK. 2003 Gene actions of QTLs affecting several agronomic traits resolved in a recombinant inbred population and two testcross populations. Theor. Appl. Genet. 107:89-101.

Moumeni A, Samadi BY, Wu J, Leung H. 2003. Genetic diversity and relatedness of selected Iranian rice cultivars and disease resistance donors assayed by simple sequence repeats and candidate defense gene markers. Euphytica 131:275-284.

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Nguyen BD, Brar DS, Bui BC, Nguyen TV, Pham LN, Nguyen HT. 2003. Identification and mapping of the QTL for aluminum tolerance introgressed from the new source, *Oryza rufipogon* Griff, into indica rice (*Oryza sativa* L). Theor. Appl. Genet. 106(4):583-593.

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Diseases and their management

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Soils and nutrient management

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Participatory agricultural research and technology transfer: concept, complexity, and confusions. Dr. M. Zainul Abedin.

Emergence of insect pests in agricultural ecosystems: ecological and evolutionary factors. Dr. Y. Chen, candidate for entomologist position.

Postharvest technology in action! Mr. J. Rickman.

One big mistake and one lucky break: progress in upland and aerobic rice breeding. Dr. G. Atlin.

Pathways from poverty. Dr. N. Fuwa.

IRRI as an international organization and workers' rights. Atty. W. Gloria.

Is rice research important for poverty reduction? Dr. M. Hossain.

Get to know your neighbor—CIAT's experiences of working with farmers and forages in Southeast Asia. Dr. R. Roothaert, CIAT.

Putting it together: integrating NRM research for rice. Dr. S.P. Kam.

(Im)proving the quality assurance of IRRI's laboratories: quo vadis? Ms. L. Revilla-Molina.

At the speed of a click! CPS, VIS, and ITS staffs.

Ricefield fisheries. Mr. R. Gregory, DFID Aquaculture Project, Uganda.

Measuring quality: Australian rice tries hard to reach high quality. Dr. M. Fitzgerald.

An alternative enterprise for rice farmers: goat raising. Dr. G. Hood, ILRI.

Impact assessment of Indonesia's research-extension system: lessons for other developing countries. Dr. F. Bernardo, IRRI's former deputy director general.

Ecology after 100 years. Dr. C. Krebs, author of *Ecological methodology*.

Allele mining the IRGC. Dr. K. McNally.

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Why do we need to worry about IPRs if we only deal with international public goods? Dr. T. Wai.

IRRI and biodiversity: the good, the bad, and the scientific. Dr. R. Sackville Hamilton.

The Philippine biodiversity crisis: a time bomb waiting to explode. Dr. P. Ong, associate professor, University of the Philippines Diliman.

Data assimilation using remote sensing and genetic algorithms: applications to agriculture and water management. Dr. A.V.M. Ines, Asian Institute of Technology, Pathumthani, Thailand.

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Rice water weevil, *Lissorhoptrus oryzophilus*, on California rice: refined management and improved understanding of pest biology. Dr. L. Godfrey, visiting scientist from University of California Davis.

The Biofortification Challenge Program. Dr. H. Bouis, senior research fellow, IFPRI.

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IRRI as the center of the world's fish information? FishBase—the model species information system and CGIAR global public good. Dr. B. Fabres, WorldFish Center.

Go bananas for food and income: prospects and challenges. Dr. A. Molina, regional coordinator for Asia and the Pacific, INIBAP.

Host plant resistance for disease management: dream or reality? Dr. C. Vera Cruz.

Growth-inhibiting factors originating in paddy soil. Dr. T. Nozoe.

Rice improvement based on genome research targeting high yield and disease resistance. Dr. Y. Fukuta.

SSNM reloaded: the evolution, the beauty, and the future of site-specific nutrient management. Dr. C. Witt.

Division seminars

Crop, Soil, and Water Sciences

Does vigorous root of irrigated rice contribute fertilizer N recovery? Dr. K. Kakuda, postdoctoral fellow.

Research on land and water resources in South and Southeast Asia: an ACIAR viewpoint.
Dr. I. Willett, research program manager for land and water resources, ACIAR, Australia.

Using GIS-linked hydraulic model to manage conflicting demands on water quality for shrimp and rice production. Dr. C.T. Hoanh, international research fellow.

Tug-of-war on a hydraulic rope: water transport in plants with emphasis on rice.

Dr. Volker Stiller, visitor / collaborator, University of Utah, Salt Lake City, USA.
Identification of mutants for drought tolerance in rice. Dr. Tina Botwright, postdoctoral fellow.
Growing rice with less water: alternate wetting-and-drying and aerobic rice. Paul Belder, PhD scholar.
Carbohydrate remobilization in main stem and tiller of wheat under post-anthesis water deficit. Dr. Elizabeth A. Conocono, assistant professor, Institute of Biological Sciences, UPLB.
Towards improving rice productivity in the saline coastal areas of Bangladesh. Dr. Z. Seraj, Department of Biochemistry and Molecular Biology,University of Dhaka, Bangladesh.
Water management research and training programs at IRRI: a personal journey. Engr. Domingo F. Tabbal.
Towards cloning of the *Pup1* gene—a major locus for phosphorus uptake under P deficiency. Dr. M. Wissuwa, international research fellow.
Correlative inhibition of spikelet development in rice panicle. Prof. P.K. Mohapatra, School of Life Science, Sambalpur University, India.
Will complex farms adopt complex innovations? The approach proposed by SAM project for the northern mountains of Vietnam. Dr. F. Affholder, cropping systems analyst, CIRAD, IRRI-Vietnam.
How to screen and evaluate the rice line for rainfed areas. Dr. Shi Yan, postdoctoral fellow.
Canopy characteristics related to sheath blight development in rice. Dr. X. Zhong, postdoctoral fellow.

Entomology and Plant Pathology

Farmers' decision-making framework. Dr. K.L. Heong.
Brown spot of rice. S. Banu
Methods of working with farmers in LITE. N.I. Kadry, M. Rahman, and S.M. Ashaduddowla.
Role of molecular biology in plant pathology. Dr. H. Leung.
Yield loss assessment. Dr. Z. Islam.
The CURE: an introduction of the Consortium through the CURE Web site. Ms. V. Casumpang.
INRM in Bangladesh. Dr. G. Jahn.
Mapping blast resistance genes. Dr. E. Araki.
Stellaria longipes (Caryophyllaceae)—a model system to study phenotypic plasticity, population differentiation, and polyploidy evolution. C.C. Chinnappa.
Deployment of BB resistance. K. Linholm.

Plant Breeding, Genetics, and Biochemistry

Accelerating salinity breeding program of japonica rice in Korea. Dr. K.-S. Lee, director, Kyehwa Substation, NHAES, RDA, Korea.
Transposable elements and genomic differentiation in *Oryza*. Dr. O. Panaud, visiting research fellow.
Use of wild species in japonica rice improvement in Korea. Dr. K.-H. Kang, rice breeder, National Crop Experiment Station, RDA, Suweon, Korea.
Current status of rice processing complex in Akorea. Dr. K.-J. Kim, National Crop Experiment Station, RDA, Suweon, Korea.
Research for enhancing blast resistance to japonica rice cultivar in Korea. Dr. Y. Chan, National Crop Experiment Station, RDA, Suweon, Korea.
Amylose synthesis: factors controlling it and factors it controls. Dr. M. Fitzgerald, cereal chemist, Yanco Agricultural Institute, Australia.
Molecular tagging of genes for thermosensitive genetic male sterility in rice. Dr. J. Hussain, visiting research fellow.
Use of high-throughput representational difference analysis (RDA) to detect alien introgression in rice. Ms. C. Vitte, visitor / collaborator.
Towards improving rice productivity in the saline coastal areas of Bangladesh. Dr. Z. Seraj, Department of Biochemistry and Molecular Biology, University of Dhaka, Bangladesh.
Improving some management practices of hybrid rice seed production in the tropics. Truong Quoc Can, MS scholar.
Breeding for abiotic stress tolerance in rice. Dr. D. J. Mackill.
Sensory evaluation and QTL analysis about eating quality in japonica rice. Dr. J.S. Lee, collaborative research fellow.
Map-based cloning of restorer of fertility (*RF* and *Fr*) genes in plants. Dr. A.A. Alfonso, supervising science research specialist, Plant Breeding and Biochemistry Division, PhilRice, Nueva Ecija.
Gene identification using DNA marker and chromosome segment substitution line–ex. blast resistance gene, *Pish*. Dr. E. Araki, postdoctoral fellow, IRRI-Japan Collaborative Research Project.
Isolation and characterization of genes for aluminum tolerance in cereals. Dr. J.P. Gustafson, USDA-ARS, University of Missouri, Columbia, USA.
Stellaria longipes (Caryophyllaceae)–a model system to study phenotypic plasticity , population differentiation and polyploidy evolution. Dr. C.C. Chinnappa, professor of Plant Biology, University of Calgary, Calgary, Alberta, Canada.

Social Sciences

Technology adoption and constraints in rice production: impact on social and cultural life in drought and wet zones of West Bengal. Mr. A. Samadar.
What use statistics? Ms. J. Narciso.

GIS-IP Lab: beyond maps. Mr. A. Rala. Comparing different technologies using a farm household model for Batac, Ilocos Norte. Ms. A. Prins, intern (GIS) from Wageningen University.

Guidelines for the creation of an efficient credit scheme. N. Tofighian and T. Ekstrand, Stockholm School of Economics.

Pattern of male labor out-migration: its impact on rice farming and shifting gender roles (a study in West Bengal, India). N.K. Saha, additional director of agriculture, Government of West Bengal.

Integration of GIS and crop modeling for estimation of soil nutrient supply. Bui Tan Yen, VRF.

Iron supplementation compliance among pregnant women in Bicol, Philippines. Ms. P. Schipull, US Fullbright scholar.

Groundwater development and agricultural production: a comparative study of eastern Uttar Pradesh, Bihar, and West Bengal. V. Ballabh, professor, Institute of Rural Management.

Analyzing and mapping physical accessibility. Ms. L. Villano.

Adding spatial dimension to data analysis: an example from Myanmar and QLPH (Vietnam). Ms. A. Maunahan.

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Staff changes in 2003

January

Dr. Stephan M. Haefele joined as soil scientist / agronomist, Crop, Soil, and Water Sciences Division.

Dr. Mohammed Zainul Abedin joined as international research fellow, Social Sciences Division.

Dr. Hiroyuki Hibino, liaison scientist, IRRI Office-Japan, left after completion of his assignment.

Mr. Bart Cottyn, affiliate scientist, Entomology and Plant Pathology Division, left after completion of his assignment.

Dr. Xuhua Zhong joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Abubacker Jauhar Ali, postdoctoral fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Dr. A. Jakir Hussain joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Gouri S. Laha joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Shawn Golinowski, consultant, Training Center, resigned.

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

Dr. K.S. Lee joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Ms. Jenny Edwards joined as consultant, International Programs Management Office.

Dr. Edwin Shanks joined as consultant, International Programs Management Office.

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

February

Mr. Kyung-Ho Kang joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Young-Chan Cho joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Kee-Jong Kim joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Hong-Yul Seo joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Md. Abdus Salam joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

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

Dr. Edwin Shanks, consultant, International Programs Management Office, left after completion of his assignment.

Dr. Xuan Zengpei joined as consultant, Office of the Deputy Director General for Research; left after completion of his assignment on the same month.

Dr. G.S. Khush joined as consultant, Entomology and Plant Pathology Division.

Dr. K.S. Lee, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

Ms. Mika Takita, collaborative research fellow, Crop, Soil, and Water Sciences Division, left after completion of her assignment.

Dr. You-Chun Song joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

March

Dr.Ken-ichi Kakuda, postdoctoral fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Dr. G.S. Khush, consultant, Entomology and Plant Pathology Division, left after completion of his assignment.

Dr. Olivier Panaud, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. A.R.A.S. Sastri joined as visiting research fellow, Social Sciences Division.
Dr. Bhuban Barah joined as consultant, Social Sciences Division.
Dr. James Hill joined as consultant, Crop, Soil, and Water Sciences Division.
Ms. Gyung-Mee Gim joined as collaborative research fellow, Social Sciences Division.
Dr. Young Kim joined as collaborative research fellow, Social Sciences Division.
Ms. Hyun-Soon Kim joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Charmian Sackville joined as consultant, International Programs Management Office.
Dr. Ki-Young Kim, collaborative research fellow, left after completion of his assignment.

April

Dr.Chu Thai Hoanh, international research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Mr. Kyung-Ho Kang, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Young-Chan Cho, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Kee-Jong Kim, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. A.R.A.S. Sastri, visiting research fellow, Social Sciences Division, left after completion of his assignment.
Dr. James Hill, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Dr. Bhuban Barah, consultant, Social Sciences Division, left after completion of his assignment.
Dr. Fu Binying, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Gouri S. Laha, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Md. Abdus Salam, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Satish Verulkar, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Ms. Jenny Edwards, consultant, International Programs Management Office, left after completion of her assignment.
Mr. Robert Hill, consultant, Visitors and Information Services, left after completion of his assignment.
Ms. Hendrika van Laar joined as consultant, Crop, Soil, and Water Sciences Division.
Ms. Gyung-Mee Gim, collaborative research fellow, Social Sciences Division, left after completion of her assignment.
Dr. Young Kim, collaborative research fellow, Social Sciences Division, left after completion of his assignment.
Ms. Hyun-Soon Kim, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of her assignment.
Mr. Fazle Elahi Chowdhury joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Grant Singleton joined as consultant, Entomology and Plant Pathology Division.
Dr. R.C. Chaudhary joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Appa Rao joined as consultant, International Programs Management Office.
Dr. Jeom-Sig Lee joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Charmian Sackville, consultant, International Programs Management Office, left after completion of her assignment.

May

Dr. Francois Affholder joined as IRS seconded from CIRAD, Social Sciences Division.
Dr. Gloria Cabuslay, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of her assignment. She later rejoined as consultant in the same division on the same month.
Dr. R.C. Chaudhary joined as consultant, Plant Breeding, Genetics, and Biochemistry Division, and left after completion of his assignment on the same month.
Dr. Peter G. Malvicini joined as consultant, Office of the Director for Program Planning and Coordination, and left after completion of his assignment on the same month.
Dr. M. Mahadevappa joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. V.P. Singh joined as consultant, International Programs Management Office, and left after completion of his assignment on the same month.
Dr. You-Chun Song joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Mr. Ki-Yong Ha, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

Ms. Xing Zhang, collaborative research fellow, Crop, Soil, and Water Sciences Division, left after completion of her assignment.

June

Mr. Jianliang Huang joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Mr. Xiang Zhang joined as collaborative research fellow, Crop, Soil, and Water Sciences Division.

Dr. Tina Botwright, postdoctoral fellow, Crop, Soil, and Water Sciences Division, left after completion of her assignment.

Dr. Ramasamy Rajendran joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Zeba I. Seraj joined as visiting research fellow, Crop, Soil, and Water Sciences Division; left after completion of her assignment on the same month.

Mr. Rico Pamplona joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Tin Htut joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Ms. Hendrika van Laar, consultant, Crop, Soil, and Water Sciences Division, left after completion of her assignment.

Dr. M. Mahadevappa, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

July

Dr. Liping Feng joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Prof. Ramesh Sharan joined as visiting research fellow, Social Sciences Division.

Dr. Gloria Cabuslay, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completion of her assignment.

Dr. Peter Malvicini rejoined as consultant, Office of the Director for Program Planning and Coordination, and left after completion of his assignment on the same month.

Mr. Rico Pamplona, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Dr. Sigrid Heuer joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Tim Medhurst joined as consultant, International Programs Management Office, and left after completion of his assignment on the same month.

Mr. Jianliang Huang, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Dr. Grant Singleton joined as consultant, Entomology and Plant Pathology Division.

Dr. Tin Htut, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

August

Dr. Andrew Martin Mortimer, weed scientist, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Dr. Robin Graham rejoined as consultant, Plant Breeding, Genetics and Biochemistry Division.

Mr. Jianliang Huang, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.

Prof. Ramesh Sharan, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Dr. Muthurajan Raveendran joined as visiting research fellow, Biometrics and Bioinformatics Unit.

Dr. Melissa Fitzgerald joined as consultant, Office of the Director for Research, and left after completion of her assignment on the same month.

Ms. Kimberly Marie Linholm joined as collaborative research fellow, Entomology and Plant Pathology Division.

Mr. Fazle Elahi Chowdhury, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

September

Dr. David E. Johnson joined as weed scientist, Crop, Soil, and Water Sciences Division.

Mr. David Shires was appointed as part-time international research fellow, Training Center.

Dr. Shengxiang Tang, liaison scientist for China, IRRI Office-China, left after completion of his assignment.

Dr. Jill Cairns joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Jeom-Sig Lee, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

Dr. Do-Yeon Kwak joined as visiting research fellow, Entomology and Plant Pathology Division.

Dr. Yongming Gao, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.

Mr. Bui Tan Yen, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Dr. Jatinder Kaur joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Dr. David Shires, consultant, Training Center, left after completion of his assignment.

Dr. Martin Mortimer joined as consultant, Crop, Soil, and Water Sciences Division, and left after completion of his assignment on the same month.

Dr. Kuk-Hyun Jung joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Prof. Indira Hirway joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Robert Hill joined as consultant, Visitors and Information Services.

October
Mr. Isaiah Mukema joined as international research fellow, Genetic Resources Center.
Dr. Zhao Kaijun joined as liaison scientist for China, IRRI Office-China.
Dr. Robin Graham, consultant, Plant Breeding, Genetics and Biochemistry Division, left after completion of his assignment.
Ms. Hendrika van Laar rejoined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Oh-Young Jeong joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, and left after completion of his assignment.
Dr. Mohapatra K. Pravat joined as visiting research fellow, Crop, Soil, and Water Sciences Division.
Mr. Armin Kerstan joined as consultant, Crop, Soil, and Water Sciences Division.

November
Dr. Gerard Barry joined as coordinator, Golden Rice Network, Deputy Director General for Partnerships Office.
Dr. Do-Yeon Kwak, visiting research fellow, Entomology and Plant Pathology Division, left after completion of his assignment.
Dr. Kuk-Hyun Jung, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Mohapatra K. Pravat, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Dr. Nirmal K. Saha joined as visiting research fellow, Social Sciences Division.
Dr. Abdul Bayes joined as consultant, Social Sciences Division.
Dr. Jianxiang Liu joined as postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Liu Bin joined as postdoctoral fellow, Entomology and Plant Pathology Division.
Dr. Bazlul A.A. Mustafi joined as visiting research fellow, Social Sciences Division.
Dr. Euan James joined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Melissa Fitzgerald rejoined as consultant, Office of the Director for Research; left after completion of her assignment on the same month.
Mr. Ha-Cheol Hong joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Len Wade joined as consultant, Crop, Soil, and Water Sciences Division.
Prof. Ramesh Sharan rejoined as visiting research fellow, Social Sciences Division.
Mr. M.V. Ramana Rao, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completion of his assignment.
Dr. Zenaida M. Sumalde joined as consultant, Social Sciences Division.

December
Mr. Martin Gummert joined as international research fellow, Agricultural Engineering Unit.
Dr. Mercedita A. Sombilla, policy economist, Social Sciences Division, left after completion of her assignment.
Dr. Christian Witt, international research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Ms. Kimberly Marie Linholm, collaborative research fellow, Entomology and Plant Pathology Division, left after completion of her assignment.
Prof. Indira Hirway, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completion of her assignment.
Ms. Hendrika van Laar, consultant, Crop, Soil, and Water Sciences Division, left after completion of her assignment.
Dr. Nirmal K. Saha, visiting research fellow, Social Sciences Division, left after completion of his assignment.
Dr. Bazlul A.A. Mustafi, visiting research fellow, Social Sciences Division, left after completion of his assignment.
Dr. Euan James, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Dr. Zahirul Islam, postdoctoral fellow, Training Center, left after completion of his assignment.
Dr. Len Wade, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Dr. Mohapatra K. Pravat, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Dr. Nirmal Saha, visiting research fellow, Social Sciences Division, left after completion of his assignment.
Dr. Maria Fay Rola-Rubzen joined as consultant, Social Sciences Division.
Mr. Armin Kerstan, consultant, Crop, Soil, and Water Sciences Division, left after completion of his assignment.
Prof. Ramesh Sharan, visiting research fellow, Social Sciences Division, left after completion of his assignment.

Dr. Jahawar Thakur joined as visiting research fellow, Social Sciences Division.

Dr. Alberto Barrion joined as consultant, Entomology and Plant Pathology Division, and left after completion of his assignment on the same month.

Dr. Min-Kyu Choi joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Arvind Singhal joined as consultant, Entomology and Plant Pathology Division, and left after completion of his assignment on the same month.

Dr. K. Nyogu joined as consultant, Entomology and Plant Pathology Division, and left after completion of his assignment on the same month.

Ms. Kimberly Marie Linholm, collaborative research fellow, Entomology and Plant Pathology Division, left after completion of her assignment.

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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 facilities and services to projects involving use of radionuclides and offers use of equipment and facilities for organic extraction and chromatography.

Analytical services

ASL completed 37,862 routine analyses for plant, soil, water, and nonstandard samples (Table 1). The most requested analyses—plant N, P, and K constitute 54% of its total analyses. Of the total samples received, about 90% came from the Crop, Soil, and Water Sciences Division (CSWS); the rest were from Plant Breeding, Genetics, and Biochemistry Division (PBGB); Entomology and Plant Pathology Division; International Programs Management Office; International Livestock Research Institute; and University of the Philippines Los Baños.

Table 1. Analyses completed in ASL, IRRI, 2003.

Type of analysis	ASL section		Total
	PSL[a]	MSL[b]	
Plant analysis	24,755	1,067	25,822
Soil analysis	7,891	494	8,385
Water analysis	3,644		3,644
Others		11	11
Total	36,292	1,572	37,862

[a]PSL=Plant and Soil Lab. [b]MSL=Mass Spectrometry Lab.

Quality assurance

A major concern at ASL is continuous improvement of its quality assurance program. Its analytical procedures must produce high-quality analytical data. For this purpose, ASL is a participating laboratory in the Wageningen Evaluating Program for Analytical Laboratories-International Plant Exchange (WEPAL-IPE) proficiency testing for plant analysis. The ASL is also involved in other international proficiency testing programs for soil and water analysis. ASL received exchange soil samples from the Australasian Soil and Plant Analysis Council (ASPAC) and water samples from the North American Proficiency Testing (NAPT) programs. These samples were analyzed using ASL standard methods and results were submitted to ASPAC and NAPT for evaluation of analytical data. ASL was able to meet ASPAC's proficiency test criteria in the 2003 Soil Proficiency Testing Program for the following analyses: total carbon, organic carbon, total nitrogen, total Kjeldahl nitrogen, total phosphorus, extractable phosphorus, exchangeable calcium, magnesium, sodium, potassium, and aluminum using recommended methods from Rayment and Higginson (1992). ASL methods for water analysis of EC, NH_4-N, total Kjeldahl nitrogen, PO_4-P, and multi-element analysis using inductively coupled argon plasma (ICP) were found to comply with the NAPT requirements. Through these programs, ASL was able to identify weaknesses in specific soil and water analytical methods and apply necessary measures such as using / validating other recommended procedures, standardizing sample preparation, preparing wider concentration range of standards, calibrating instruments with the National Institute of Standards and Technology (NIST) traceable standards, and using certified NIST standards for quality control checks.

New equipment and upgrades

ASL acquired a replacement for a 20-year-old stable isotope ratio-mass spectrometer (IRMS) unit for analysis of stable isotopes such as ^{15}N and ^{13}C. The new PDZ Europa 20-20 IRMS was purchased in December. This IRMS unit will be coupled to the total carbon / nitrogen analyzer employing the Dumas principle. This will allow simultaneous measurement of total nitrogen and carbon in a sample and also ^{15}N or ^{13}C levels in a wide range of biological and chemical

analyses of samples. It can also be set up for pyrolysis applications for ^{18}O, ^{2}H, and ^{34}S analyses. The startup and commissioning of the new unit will commence in 2004.

Existing autoanalyzers and accessories were improved to achieve a more stable system. Electromechanical parts such as precision timers and roller bearings were replaced and improved. An in-house software program for the colorimeter system was altered to work with its high-end Y2K compliant computer. Optical alignment was optimized to ensure enhanced signal selectivity and stability.

A new 18-KVA capacity uninterrupted power supply (UPS) was installed to support uninterrupted analysis using the ICP, atomic absorption spectrometer, and autoanalyzer. The existing 7-KVA UPS was relocated to the Chromatography Room to provide extended power supply to the GCMS, K. Hemmi server, and manager's room. Equipment runtime during power failure has increased to about 2 h of usage. With these upgrades, continuous operation of all highly sensitive equipment is now assured.

Radioisotope Laboratory

The ASL provided liaison with the Philippine Nuclear Research Institute (PNRI) on matters related to the use of radioactive materials. The following projects have benefited from these services:

- Genotyping of material used in experiments involving molecular dissection of introgression lines for the molecular breeding program.
- Identification of drought tolerance and salt-responsive genes.
- Expression of invertase and choline monooxygenase genes.
- DNA labeling and protein phosphorylation with ^{32}P.
- Molecular evaluation of transgenic rice plants.
- Tagging salinity tolerance genes in rice using amplified fragment length polymorphism analysis.

Mass Spectrometry Laboratory

This year, plant total N and C, and stable isotope ^{15}N and ^{13}C analyses have been included in the International Plant Exchange proficiency testing program by WEPAL. Sample preparation protocols were improved, which resulted in better agreement of analyses results with that of other participating laboratories.

In line with ASL's continuing effort to improve and upgrade its services, a new IRMS was acquired to replace two outmoded units, VG Micromass 622 and Isogas 903 ES. The VG Micromass 622 has been used extensively to analyze ^{15}N in more than 20,000 plant and soil samples and these analyses benefited the following research projects:

- Biological nitrogen fixation.
- N cycling in rice-based systems.
- N use efficiency.
- Fate of inorganic and organic (green manure) N incorporated in rice soils.
- Translocation of absorbed N to the rice grain.
- Soil organic matter characterization.

The VG Isogas 903 IRMS was used to analyze ^{13}C in more than 3,000 plant and soil samples for studies involving

- C dynamics in rice and rice-based systems.
- Physiological basis for drought tolerance.
- Screening of wild rices for C4 vs C3 plant attributes.

These units, though reliable, had limited applications and were too costly to maintain.

On the other hand, the replacement PDZ Europa 20-20 IRMS is supplied with an electromagnet, which makes it capable of analyzing deuterium (^{2}H) and stable isotopes of oxygen (^{17}O, ^{18}O), in addition to the routine ^{15}N and ^{13}C analyses. Water isotopic composition (^{2}H, ^{18}O) studies can be used to

- Identify sources of origin.
- Trace water use, uptake, and transport by plants.
- Determine water evaporation from paddies and reservoirs (hydrological applications).

Moreover, the 20-20 bench-top IRMS is equipped with two turbo-molecular pumps for faster and more efficient pumping, resulting in higher sensitivity. The state-of-the-art design also eliminates the need for accessories, such as chillers and water pumps that supported the old mass spectrometers and facilitates simple operation, troubleshooting, and maintenance.

Organic Analysis Laboratory

ASL provided run-ready rotary evaporators and gas chromatography facilities to CSWS researchers and students to:

- Extract and concentrate phytohormone abscisic acid (ABA) from rice plants.
- Quantify ethylene production of rice previously treated with an ethylene-releasing compound.

Training

A 5-d training on Safe Handling of Radioactive Materials was arranged for 12 PBGB staff who will use radioactive isotopes in their research work. Lecturers from PNRI conducted the training; the topics included a review of the principles of radioactivity, handling procedures during normal and emergency conditions, radioactivity and dose measurements, radiation protection, radiation monitoring in relation to contamination and decontamination, safe transport, radiowaste management, applications in agricultural

research, and licensing rules and regulations. Practical aspects centered on monitoring, decontamination, and waste management. A visit to the PNRI research facilities, an examination, and the awarding of certificates of completion capped the 5-d training.

BIOMETRICS AND BIOINFORMATICS UNIT

Consulting

Statistical consultations involving data analysis and experimental design were provided to several IRRI staff, trainees, and collaborators examples of which are spatial analysis for uneven layout of alpha designs and analysis of microarray data.

Statistical research

- G×E database was prepared for characterization and G×E studies between 2001 and 2002.
- Analysis of Phase II G×E data for site characterization and QTL mapping is ongoing with visits of Dr. Len Wade and Dome Harnpichitvitaya in November.
- IRRISTAT version 4.4 was released in July 2003 with a much enhanced help system as well as improved functions to generate experimental designs for plant variety trials.
- Research on the use of pedigree information in the analysis of breeding and evaluation is continuing.

Biometrics training

BBU delivered four in-house training courses within the year and served as trainors in short-term courses in collaboration with the Training Center. There were also in-country training courses where BBU staff expertise was availed of. Details of the training courses are summarized in the following tables:

BBU in-house training course	Date	Participants (no.)
Introduction to SAS for Windows	2–6 Feb	21
Introduction to IRRISTAT	31 Mar–4 Apr	19
IRIS for Rice Breeding	22– Apr	25

Short-term course	Date	Participants (no.)
Plant Breeder's Course	11–22 Aug	25

In-country training course	Country	Date	Participants (no.)
Internship and training for ICARDA scientists on ICIS	Syria	7–11 Sep	29
Training of trainers in statistics	Vientiane, Lao PDR	13-17 Oct	16

Database development and deployment

International Rice Information System (ICIS)

- Versions 4.0 and 4.1 of ICIS DLL and application were released during 2003. These versions incorporate the design changes for DMS developed through 2002 and are now in use in most ICIS implementations.
- A new application for inventory management and an interactive study interface, IRIS FORMS, has been developed for IRIS and will be available for any ICIS implementation.
- The IRIS Web interface has been stabilized and generalized so that the open source MySQL database program can be used. Any ICIS database can be enabled in a few hours.
- Development of the ICIS Breeders' Interface continued under the IRRI-NUNZA Project with a review and planning workshop at Nunhems in May to develop a workplan to enhance SETGEN, develop a more general and user-friendly Field Book Application, and improve Retriever with a SWITCHBOARD menu system for running stored queries and producing periodic reports of breeding data.
- A paper describing IRIS was published in *Bioinformatics* and presented at the ISMB international meeting in Brisbane in July.
- Following 2002 IPR, the decision was made to merge IRRI's three main germplasm databases IRGCIS, INGER, and IRIS. INGER and IRIS were already partially merged so work was started on IRGCIS with a design workshop held in February. The transfer and management of passport data was planned and a new tool, ICIS FORMS, was designed and prototyped as a user interface to any ICIS study; but in particular, it will replicate the Oracle Interface for passport data in IRGCIS.
- The second component started was a general Inventory Management System (IMS). A workshop on the design of IMS was held in June at the University of Queensland in Brisbane. Design is at an advanced stage and the data access functions are being programmed.
- A system for capturing all details of incoming and outgoing seeds for IRRI has been designed. This is now being implemented. Automation of assignment of MTAs is being designed.
- IRIS data curation
  - Pedigree and nomenclature information in IRIS on all Japanese Released Cultivars was corrected and updated from New Japanese publications.
  - Information on isozyme analysis of 25,000 accessions was obtained from PBGB and is being transferred to IRIS.

Bioinformatics

The year 2003 was highlighted by the following bioinformatics-driven activities:

- *Training*
  Five MS, PhD, and postdoctoral scholars funded by the Rockefeller Foundation from China, India, Thailand, and the Philippines underwent training with focus on the drought tolerance trait. One of the trainees has already obtained an MS degree (and has one journal publication for submission).

  One MS scholar from the Philippines, funded by the SDC, completed some upgrade development work on the IRRI IR64 Rice Mutant Database.

  One Canadian MS scholar funded by the CIDA Canada-CGIAR Linkage Fund (CCLF) completed a 1-year activity of IRRI-hosted bioinformatics research on rice transposable elements. Midway through this activity, IRRI's bioinformatics specialist, the Canadian scholar (N. Juretic), and her McGill University faculty supervisor (Dr. T. Bureau) were invited to participate in transposable element annotation for the IRGSP rice genome draft sequence. This activity will directly result in two publications.

- *Research*
  The bioinformatics specialist collaborated with Dr. M. Wissuwa in continuing positional cloning work for the phosphorus uptake locus, Pup1.

- *Infrastructure*
  The Bioinformatics team continued their work on extending the IRIS to manage functional genomics information. As part of this effort, a next-generation system exploiting Java language technologies is being built to provide a more powerful and highly integrated state-of-the-art research environment for rice scientists who wish to use genomic information.

- *External activities*
  The informatics subprogram of the Genetic Resources Challenge Program continued to be a major focal point of bioinformatics engagement for the Institute.

COMMUNICATION AND PUBLICATIONS SERVICES

Publications

Through CPS, IRRI produced and distributed 10 titles, including five scientific books; the *Annual Report of the Plant Breeding, Genetics, and Biochemistry Division*; the 2004 International Year of Rice Desk Calendar; *Report of the Director General, 2002-03*; and *Graindell*, the first book produced by IRRI aimed at children. Two issues each of IRRI's popular magazine, *Rice Today*, and the *International Rice Research Notes* were also produced.

In 2003, IRRI forged a number of successful copublishing arrangements to produce

- A Chinese version of the 3rd edition of the *Rice Almanac* (with Fujian Science and Technology Publishing House in Fuzhou, Fujian, China);
- *Improving the Productivity and Sustainability of Rice-Wheat Systems: Issues and Impacts*, (with CIMMYT and the American Society of Agronomy);
- *Rice Science Innovations and Impact for Livelihood*, the 1,022-page proceedings of the 24th International Rice Research Conference held in Beijing during the International Rice Congress (with the Chinese Academy of Engineering and the Chinese Academy of Agricultural Sciences);
- *Increasing Productivity of Intensive Rice Systems through Site-specific Nutrient Management* (with Science Publishers, Inc., Enfield, New Hampshire)
- *Rice-feeding Insects and Selected Natural Enemies in West Africa: Biology, Ecology, Identification* (with the Africa Rice Center or WARDA); and
- A reprint of the popular *The Practical Guide to Nutrient Management* (with the Potash and Phosphate Institute, Singapore).
- A reprint of IRRI's most popular book ever, *Statistical Procedures for Agricultural Research* (with John Wiley & Sons, Singapore).

IRRI also provided some content and review for two commercial books on rice in time for the International Year of Rice 2004: *The Art of Rice: Spirit and Sustenance in Asia*, published by the UCLA Fowler Museum of Cultural History; and *Rice Trails: A Journey through the Ricelands of Asia and Australia*, published by Lonely Planet.

The IRRI Rice Publications Archive (http://rice-publications.irri.org), available on the Intranet and to trainees outside of IRRI identified by the Training Center, now contains a wide range of rice research topics found in more than 480 historical scientific books (approximately 90,000 pages in searchable pdf format) published by IRRI over the last 43 years. IRRI staff members have full access to these files from anywhere in the world using their network account.

IRRI on the Web

In early 2003, the IRRI mother site (www.irri.org) underwent a major revamping, which included a new branded appearance. Similar revamping is scheduled for www.riceweb.org and www.riceworld.org in 2004.

During 2003, CPS staff members worked closely

with other OU webmasters at the Institute to enhance the external site with special sites for

- The Irrigated Rice Research Consortium (IRRC);
- The International Platform for Saving Water in Rice (IPSWA);
- The Council for Partnerships on Rice Research in Asia (CORRA);
- The International Rice Functional Genomics Consortium (IRFGC);
- Poverty Elimination Through Rice Research Assistance (PETRRA); and
- The Consortium for Unfavorable Rice Environments (CURE).

IRRI's scientific publications can now be ordered online via the Institute's Intranet by OUs and IRRI staff members and paid for using an appropriate account number. This facility is the prototype for establishing an external online shopping cart for IRRI book customers with credit cards.

Rice photo bank, AsianGrain, and photography by staff

More than 1,200 educators, students, photographers, graphic designers, and others worldwide have 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.

The Rice Photo Bank was conceived primarily for IRRI staff members, trainees, and NARES partners as a common resource for finding images for Powerpoint and other types of presentations. To accommodate the income-generating potential of IRRI images, a commercial arm of the Bank, called AsianGrain (www.asiangrain.com), is being set up and scheduled to go online during the first quarter of 2004.

To fill gaps in subject matter of the images currently in the Rice Photo Bank, CPS is urging all IRRI staff members who take digital—or traditional—photos in the field to begin contributing their best images to the Bank. The Intranet now has a facility that provides easy instructions on how to do this.

Related to photography done by IRRI staff members, Management asked CPS to compile an inventory of all old and/or underutilized cameras (both traditional film and digital) and to study the possibility of auctioning them off to help subsidize the acquisition of a standard set of digital cameras and accessories, which can be checked out by staff. Management has also asked CPS to organize training sessions for all staff using digital cameras so that they will know how to use their equipment properly—and fully. From 2004 on, CPS will manage still and video cameras (purchases, maintenance, and disposal) at IRRI in the same manner that ITS manages computers.

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 2003, the OU printed 1,041,650 pages of text, not including IRRI books, which were outsourced to printers in Manila. Only 684 original slides were produced when, in past years, thousands of these were processed, indicating a dramatic switch over to Powerpoint for this type of presentation. Approximately 930 photographs were printed. Graphic artists produced 200 illustrations, laid out 3,826 pages for publications, and prepared 60 posters.

IRRI editors worked on more than 700 pages appearing in 29 refereed journal articles, 2,100 pages appearing in IRRI's scientific books, and 1,460 pages of additional conference papers, abstracts, proposals, and others.

EXPERIMENT STATION

The Experiment Station (ES) provided support services to 187 field experiments. A total of 278 ha of land were prepared and planted to rice during the year. PBGB remained the biggest user of the farm, utilizing some 123 ha for its various field trials and varietal development programs. ES, the second biggest user, planted a total of 98 ha of rice crop for production and seed increase activities of the unit. Overall, land use increased by about 33% compared with the 10-year average (1992-2001) utilization of the IRRI farm and by 2% compared with the 2002 level. Average utilization from 1992 to 2001 was 208 ha/year; 2002 utilization was 272 ha.

Division	Dry season (ha)	Wet season (ha)
PBGB	61.46	61.61
ES	39.10	59.38
GRC	15.28	3.59
CSWS	11.61	10.21
EPPD	1.48	6.09
CIAT	4.00	4.00
TC		0.25
Total	**132.93**	**145.13**

To meet the field nursery requirements of various users from the different research divisions, 15.75 ha have been utilized for centralized seedling production. Of this, dry bed and wet bed nurseries accounted for 9.75 ha and 6.0 ha, respectively. Compared with 2002 levels, this reflected a 63% increase in seedling nursery requirements, 69% increase in the use of dry beds, and 50% increase in the use of wet beds. Another 400 m^2 of concrete space at the back of the ES administration building was utilized for the modified *dapog* nurseries.

Crop establishment methods used by ES have mainly been mechanized drill seeding during the dry season and drum seeding during the wet season. More than 85% of the plantings were established this way. Depending on weather and soil conditions, manual and mechanical transplanting methods were used occasionally. Production plots were established right after all field requirements of the research divisions have been met. About 87 t of fertilizers in the form of ammonium sulfate, complete, muriate of potash, solophos, urea, zinc oxide, and zinc sulfate were used at the farm during the year. From 98 ha of production and seed increase plots, ES harvested a total of 350 t of paddy. Harvesting was mainly done with the use of the combine harvesters. Another 234 t of mixed varieties that were either harvested from researchers' fields or turned over to the Materials Management Unit from old seed stocks were sold through the standard bidding process. The highest yield noted in the ES-managed seed increase plots was 5.3 t in blocks 314-316 planted to Rc110. The overall average yield from all the ES plots was computed at 3.6 t / ha. The lower average yield, compared with the previous year's average of 3.9 t / ha, was partly attributed to the lower solar radiation levels during the dry season as well as the reduced amount of rainfall during the later part of the wet season. These conditions coincided with the late vegetative, flowering, and maturation stages of majority of the dry- and wet-season production crops. Other major constraints noted include weed and bird problems as well as irrigation.

Integrated pest management (IPM) was practiced in ES-managed fields as a standard. This resulted in zero insecticide applications in majority of the seed increase and seed production plots. Pesticide use in the whole farm decreased by 35% compared with the previous year. This may be attributed to lower incidence of insect pests and diseases during the year as well as to larger areas planted to resistant materials and significant changes in fallow management systems. Tillage of the fields immediately after harvest apparently deprives the pests of their alternate hosts and provides long periods of starvation, thereby causing significant reductions in pest populations. Herbicide use, on the other hand, went up by 4% compared with the previous year. Weed control efforts were sustained in the experimental fields, on the levees, in fallow areas, and along the perimeter fences. Manual weeding was noted to be the single most labor-intensive operation in the farm. Use of herbicides remains to be the most cost-effective method of weed control at the farm. While most weeding in experimental fields is done manually, the application of sublethal doses of nonselective herbicides is being done in the maintenance of fallow areas, levees, and perimeter fences to reduce the cost of weed control. To further cut costs on chemical applications, treatments are commonly done using machines. Whenever possible, the four-wheel drive mud master spray applicator was used for preplant applications of molluscicides to control snails and for preemergence herbicide applications in production plots. Tractor boom sprayers were used in herbicide applications in fallow areas. ES also provided rat control services through the installation of 600 baiting stations and 112 ha of active barrier system (ABS). Flame throwing and destruction of rat burrows were periodically done on an as-needed basis. Some 1,334 live traps were installed and a total of 5,548 rats were caught during the year. For bird control, about 0.2 ha of bird net was also installed. There is a current need for an integrated approach to the management of avian pests in the farm.

Land development operations covered about 10 ha during the year. This includes the conversion of upland blocks UN1-3 and UM3-4 into lowland fields and land redevelopment in blocks D2-8, E20-25, and UV3. Rehabilitation and repair works were carried out for some 1,500 m of main road in the lowland and upland areas. Road patching and back-filling were also done on about 2 km of farm access roads along the ES main building. For this, some 1,000 m^3 of soil were extracted from the IPB site, hauled, and then mixed with gravel and cinder using heavy equipment. Dumpsite improvements included regular earthwork on a 2-ha composting area and weekly bulldozing of garbage into excavated pits. Routine heavy equipment jobs, which include rice straw collection, roadside maintenance, and road rehabilitation works were part of the regular operations conducted by the civil maintenance group during the year.

Repair, maintenance services, and fabrication jobs for farm equipment, machinery, and reservoir pumps were continuously provided during the year. Five hundred and thirty requests for repair and maintenance of light and heavy equipment and reservoir pumps were completed. Pump extraction and repair works were done in blocks C1, C26, and UW. Two vertical pump motors at C26 and 2000 series reservoir were also repaired. Modification in the location of discharge pipe from UW pump to UX reservoir was done to increase the water flow and irrigation delivery in the upland area. About 50 units of different types of threshers and 32 dryers were also repaired and maintained. Structure modifications and repair and maintenance services were also provided for the new rice mill. Another unit of seeder and cultivator was also fabricated and modified for use in the aerobic rice project of CSWS in Tarlac and Nueva Ecija.

Supply of irrigation water through the underground piping system was provided to some 244 ha of lowland fields. Sprinkler irrigation services were also provided to some 34 ha of upland setups

though the installation of irrigation pipes at blocks B, D, 833, the 900 series, UD, UJ, UL, UM, UO, UP, UQ, UW, and UN / UX seedbeds. Fifteen manholes were constructed and 20 manholes were repaired at the farm. An additional gate valve was also installed at the upland area to improve water distribution system in the area. About 40 units of drainage outlets were also developed and constructed. Two units of trailers were converted for use as transportable carrier for irrigation pipes. PVC pipes were installed to improve the water discharge system from the UW pump to the UX reservoir and CSWS experiment in Block 912. Repropping of the water discharge base in block UT was also completed during the year. There is an apparent need to improve the supply of irrigation water in the upland area. A steadily increasing trend in the utilization of the upland farm brought about by the expansion of research work on upland rice was noted over the last 3 years.

The Rice Mill Unit started its operation during the middle of 2003. Some 302 t of paddy were milled, of which 243 t came from ES harvest and 59 t were bought from outside suppliers. Average milling recovery was computed at 65%. A total of 141.6 t were supplied to qualified NRS during the months of June, July, August, and December. The rest of all the milled rice produced by the mill were either sold to the highest bidder or provided to other units. Thirty-five and a half tons of small and large brokens were also sold to the highest bidder as well as some 26.6 t of rice bran. Most of the bran produced from the milling operations was used as feed for fish. About 1.5 t of brown rice were also produced and distributed to IRRI staff as part of the institute-wide survey on brown rice preferences. Improvements include the concrete pavement of passage areas, installation of canvass curtains for the stopgap control of dusts from the husk bin, and the acquisition and deployment of a new self-dumping trailer, which was specifically designed for use in the regular and efficient hauling of rice husks from the mill. A new, high-capacity precleaner and a 10-t capacity recirculating drier were also incorporated in the overall mill design.

The Controlled Growth Facilities and Grounds Unit (CGFG) of the ES supported a total of 29 experiments in the phytotron, 83 experiments in the greenhouses, and 23 experiments in the CL4 transgenic greenhouses. A total of 458 maintenance service requests were served. About 515 t of ground soil were provided mainly for use in the phytotron, CL4, and greenhouse experiments and partly for use as covering material for newly planted seeds in some field experiments.

Basic research support services were provided to all experiments conducted in the phytotron and CL4 facilities. Repainting was done on all air handling units (AHU) of the CL4 transgenic greenhouses. Major structural improvement done during the year included the replacement of the double-glazed glass roof panels of the phytotron glasshouse bays with industry-standard UV-resistant twin-wall polycarbonate sheets. A total of 23,287 gallons of reverse-osmosis-grade water were served to phytotron researchers. Staggered 1-mo shutdown was done on the eight bays of the CL4. Preventive maintenance shutdown for all of the phytotron facilities was done in November. Normal operations immediately resumed thereafter. During the shutdown period, the mechanical control system of Chiller No. 1 was converted into an electronic control system to improve power use efficiency, lengthen the useful life of the compressors, and reduce maintenance costs. Modification of Chiller no. 2 was also initiated in preparation for future conversion into a compatible electronic system. All defective HS-2 solenoid valves were repaired and improved. Protective canopies for the actuator valves were fabricated to improve reliability of the cooling system. The old and dilapidated water demineralizer unit was dismantled and disposed. Cleaning and repainting work was done on the catwalk at the solar panel area and all trenches at the chiller area. Various spare parts, tools, and gadgets, one unit of Walton humidifier and six condenser fan motors were acquired during the year. Energy-saving features incorporated into the control systems, as well as simple power-saving strategies led to further reductions in phytotron power consumption by 15% from 1,373,600 kwh in 2002 to 1,157,600 kwh in 2003.

The Greenhouse Unit provided basic research support services to all experiments conducted in all greenhouse and screenhouse facilities. Construction of a screenhouse extension area was initiated during the later part of 2003 in the upland area for use by the Genetic Resources Center's gene bank materials and wild rice accessions. Other maintenance services done during the year included the interior and exterior repainting of two screenhouses; roof replacement of two work areas; replacement of the glass roof of two greenhouses with UV-resistant polycarbonate sheets; dwarf wall extensions of four trash bin areas; screen clad replacement of two screenhouses; concrete wall construction for one screenhouse; and concrete pavement of the soil bins and pot storage areas. Routine services included the regular hauling and grinding of soil, regular collection of trash from all concrete waste segregation bins in the greenhouse area, as well as lawn mowing and brush cutting operations to maintain the landscape in the greenhouse area. Manpower pooling operations were also organized to meet the labor requirements of the labor-intensive patch-up and screen repair works of six screenhouses in cluster C. One-month preventive

maintenance shutdown operations were carried out for all greenhouses on a staggered schedule. At least two greenhouses per month underwent shutdown operations. Major renovation works started in PBGB headhouse AH01 in December.

Regular mowing operations, road sweeping, brush cutting, and garbage collection remained as the main bulk of the daily activities of the Grounds Unit. The use of blowers in the staff housing for cleaning the roads was stopped in response to the request of residents noting the noise pollution the machines generate. Plant decoration support services were provided during seminars, workshops, and all other special events conducted in IRRI. Indoor plant services were also continuously provided in some administration building offices and the auditorium display areas. Trimming of trees was done both at the IRRI Staff Housing and the IRRI farm to rejuvenate old branches, improve light penetration, help reduce the frequency of leaf sweeping operations, and more importantly, to increase the margin of safety from falling tree branches and twigs during typhoon months. Mowing frequency was increased in some high-profile areas in response to fast grass growth rates during the rainy season. Two push mowers, two brush cutters, and two power saws were acquired during the year to replace old units. As part of the new projects of the Grounds Unit, the irrigation reservoirs in blocks J, K, and L were developed and planted with new improved stocks of fish fingerlings. Regular maintenance schedule for the ponds and the fishes was established as part of routine operations. Harvest and sale of fish produce started in May. Approximately 780 kg have been sold to employees during the year. Landscaping and plant decoration services were provided to the new Book and Coffee Shop. Other improvements include re-landscaping and addition of more ornamental fishes to the pond. The entrance to the ISLB building was also landscaped to improve the aesthetic appeal of the area. The Grounds Unit also installed traps for stray animals in some strategic locations within the institute premises in view of safety and health concerns and also in some field experiments to protect experimental plants from damage.

A monitoring and user-feedback mechanism was established to regularly evaluate the performance of the current service provider for *kabesilya* services. Monthly meetings were held between division coordinators, kabesilya leaders, and ES management to discuss performance measures and user feedback, as well as focus on areas for improvement. Utilization of kabesilya services by the various research divisions and support units totaled 666,211 man-hours. This represents a 14% reduction in utilization compared with the previous year's 774,538 man-hours. Manual bird-scaring services also went down by 22% from 155,028 man-hours in 2002 to 120,278 man-hours in 2003. Considering the increased acreage in cropped areas, this labor use data can be taken as a result of improved kabesilya labor use efficiency as well as increased mechanization in some areas of farm operations. Another important factor could be the improved kabesilya administration procedures and systems that were put in place in previous years.

As part of its role in maintaining harmonious relationships with nearby communities and other organizations and institutions, ES continued to serve external requests for equipment and services following established protocols and guidelines. The various groups included the different departments of the University of the Philippines Los Banos, the UP Open University, a number of nongovernment organizations, and the municipalities and barangays of Los Baños and Bay, among others. Three plaques of appreciation were received by IRRI from the Mayor of Los Baños in recognition of the institute's substantial contributions and support to the municipal government's Clean and Green Program.

As a whole, the ES generally had a smooth transition period after the staff reduction. 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. The unit has been able to meet new challenges and additional responsibilities despite the 25% reduction in its workforce. For instance, ES-managed crop production areas have been increased by 345% from an average of 22 ha / year to a new annual target of at least 90 ha / year. Another significant change has been the establishment and operation of the new rice mill and the supply of monthly rice ration to the nationally recruited staff. Other additional responsibilities included ES staff involvement in the training activities of the Training Center; year-round field tours and field demonstrations for visitors of the VIS, orientation program for newcomers, and collaborative work with research units on a number of experiments and new projects.

LIBRARY AND DOCUMENTATION SERVICE

The Library and Documentation Service (LDS), through its state-of-the art computerized library system, continued to assume an active role in linking electronic and conventional knowledge sources with local and worldwide clients.

The Library's home page (http://ricelib.irri.org) was redesigned with minimal use of colors and graphics, allowing faster connection to the site. Also, the contents were improved with the addition of more links to relevant information sources. A notable new feature is the button for access to the list of current journal articles published by IRRI staff. Some entries have links to the full text documents or to abstracts. The web site now carries 831 links to current electronic journals and 845 links to web sites, documents, and databases.

A profile of the IRRI Library, with illustrations, was published in the December 2002 issue of *Asia Library News*, which came out in early 2003. The IRRI Library is one of the three Philippine libraries entered in the *LAP (Libraries of Asia and the Pacific) Directory*. This online directory, which is developed and maintained by the National Library of Australia, covers more than 400 libraries in the region. Also, a photograph of the staff appeared in the August 2003 issue of *Gateways*, the electronic newsletter of the National Library of Australia.

With the Library staff's increasing familiarity with the Millennium (Web-based library system) and the frequent use of the Z39.50 broadcast software, data input in the online public catalog and the rice bibliography was highly facilitated. Import of data from catalogs of other libraries abroad is easily done with a few keystrokes.

The retrospective conversion of the old card catalog and the kardex file was finished in August. With this, all journal holdings and monographic sources can now be searched online.

Added to the Online Public Access Catalog (OPAC) were 2,050 bibliographic records, bringing the total to 72,760 entries. There were 188 rice dissertations acquired and these represent 74 universities and 18 countries worldwide.

The rice bibliography database now has 226,183 records, with the addition of 20,314 new and retrospective rice literature citations. Links to full text articles or abstracts were added to many entries. Two issues of the *Rice Literature Update* were published in 2003. The *International Bibliography of Rice Research CD-ROM* continued to be distributed to libraries and institutions worldwide. The retrospective conversion of the rice bibliography supplement started in June.

Accessibility of electronic resources, which are widely preferred by scientists nowadays, was a major concern. The LDS worked toward increased access to electronic journals and electronic documents on the Web. Searching freely downloadable sources and creating links to free sources were given top priority. Free trial access to databases and electronic journals was arranged for local clients.

Streamlining the journal subscription list is a very complicated process. Early this year, a survey was conducted to determine the top 10 electronic journals preferred by IRRI scientists. The results show that all 15 top titles selected are already available through the Library's Web site.

As a member of the CGIAR Libraries and Information Services Consortium (CGIARLISC), the Library collaborated actively with other libraries in the CGIAR system in the sharing of knowledge and resources. Joint electronic (only) subscriptions to many titles were arranged.

A sizable number of electronic journals are now within the reach of researchers in the IRRI campus.

Electronic journals made available in 2003

Mode of access	Titles (no.)
Full text access through Paid Subscriptions	131
Full text access (free with print or through the Internet)	371
Full text access (through CGIARLISC)	20
Table of Contents access only (free)	309
Total	**831**

The CGIARLISC also facilitated procurement of individual articles in journals not held by the Library. Free electronic document delivery service was rendered promptly by each center library, resulting in considerable savings. In many instances, the LDS was a provider rather than a receiver of this service, as it received only 35 documents from the various center libraries as compared with 738 papers that it provided.

Electronic documents delivered to CGIAR centers

Center	Articles delivered (no.)
CIAT	48
CIFOR	15
CIMMYT	63
CIP	46
ICARDA	7
ICRAF	62
ICRISAT	244
IFPRI	39
IITA	8
ILRI	6
ISNAR	2
IWMI	88
WARDA	90
WorldFish	20
Total	**738**

Information requests, literature searches, and conventional and electronic document delivery were provided to researchers from 37 countries, including those from the CGIAR system.

Information requests, literature searches, and documents delivered, by country.

Country	Literature search requests (no.)	Requests for documents (no.)	Documents delivered (no.)
Australia	2	14	16
Bangladesh	2	12	37
Belarus		3	3
Belgium		1	1
Brazil		1	1
Canada	2	3	11
China	1	8	15
Colombia	1	36	48
Cuba	1		
Egypt		9	38
Ethiopia	1	2	6
Germany	1	2	10
Ghana	1	2	15
India	11	202	471
Indonesia	2	19	50
Iran		1	7
Iraq	1		
Italy		4	4
Ivory Coast	1	34	95
Kenya		25	71
Korea		4	5
Lao PDR	1	3	7
Malaysia	2	23	33
Mexico		47	68
Nepal		3	8
Netherlands		8	9
New Zealand		2	4
Nigeria		6	8
Norway		1	1
Pakistan	4	9	35
Peru		45	58
Philippines	8	97	170
Singapore		4	12
Sri Lanka	2	32	87
Syria		7	14
Thailand	1	6	17
Uganda		1	13
UK	1	8	15
USA		30	52
IRRI staff	2	42	114
Total	**48**	**756**	**1,629**

Through the *International Directory of Rice Workers*, an active database of rice scientists with 1,190 names posted on the Library's web site, the LDS provided data to the CGIAR Gender and Diversity Program in expanding its database of women scientists.

Current awareness was strengthened through circulation of significant news / journal articles, table of contents alerts, updated list of conferences, list of new acquisitions, and regular announcements in the electronic *IRRI Bulletin* and the Public Announcements Folder.

In addition to providing access to information and resources, preservation also was a major concern. Rice reprints constitute a major portion of the world's biggest collection of technical rice literature stored in the LDS. Most of these are irreplaceable and, ironically, they are printed on acid paper, which will deteriorate in time. The conversion of rare rice reprints to electronic format was started in June. These are now stored as pdf files on CD-ROM.

The LDS collaborated proactively with institutions outside the CGIAR system. The Libraries of the UPLB System and the Philippine Rice Research Institute availed of interlibrary loan services. Students and faculty from nearby and remote colleges and universities also made use of IRRI LDS facilities.

The Library organized two capacity-building workshops for the Food and Agriculture Organization (FAO) at the IRRI campus in August and November. This was done in cooperation with the Agricultural Librarians Association of the Philippines (ALAP). The WebAGRIS, a free software developed by FAO, was introduced to agricultural librarians in the Philippines. Three IRRI librarians and a library assistant acted as resource persons and / or facilitators. After the workshops, librarians and other staff of the UPLB and the Bureau of Agricultural Research (BAR) were given tutorials on the use of the WebAGRIS software.

A key result of these workshops is the creation of the Philippine Agricultural Libraries and Information Services Network *(PhilAgriNet*), by virtue of a Memorandum of Agreement among 14 major agricultural institutions on the Philippines. IRRI is one of the first signatories. PhilAgriNet will link agricultural scientists with Philippine agricultural knowledge through a central electronic database to be maintained by the BAR. It will also provide national inputs to the AGRIS database in Rome.

The *FAO InfoFinder Project* was fully supported by adding metadata with links to full text IRRI information resources to the database as soon as they become available.

The LDS became a member of the *LibraryLink Project* with the signing of a Memorandum of Agreement with the Ayala Foundation, Inc. Participation in this project enabled the Library to search and to contribute to the *LibraryLink* database of Filipiniana materials available in the collection of major universities and other institutions in the Philippines.

Duplicate and superseded publications were donated to interested local libraries. Some of the beneficiaries are the Department of Agriculture (Lipa City), Mindoro State College of Agriculture and Technology (Victoria, Oriental Mindoro), Don Mariano Marcos State University (Bacnotan, La Union), Palawan State College (Aborlan Palawan), Camarines Sur State Agricultural College, Isabela State University, Lasam Institute of Technology (Cagayan), Benguet State University, and the Leyte State University.

The Library Staff attended in-house and off-campus training activities to improve their skills and to render better service to clients.

VISITORS AND INFORMATION SERVICES

The Institute welcomed and hosted some 86,550 visitors as compared with last year's 55,909, indicating an increase of 30,641 visitors (Table 1). This included distinguished visitors comprising 3,515 government officials, three ambassadors, members of the diplomatic community, and representatives of various donor and international organizations such as the Asian Development Bank and the United States Agency for International Development. The increase in number of visitors was due to organized, professional, and extensive promotion.

During the year, IRRI hosted or co-hosted 17 regional and international conferences, workshops, and symposia (Table 2) on top of the regular- and special in-house seminars, workshops, and meeting reviews. The regional and international conferences and workshops were participated in by more than 683 representative delegates from at least 35 countries.

At Riceworld Museum and Learning Center, the Training Center's Section was improved by the addition of two interactive displays and one computer kiosk for visitors to surf Training Center's Web site. Also, the Leaf Color Chart (LCC) Exhibit was finally completed. The Ifugao Section was also improved by the addition of a continuous video portraying an Ifugao rice ritual.

Other improvements included replacement of the IRRI donors exhibit signages, refurbishing existing exhibits and the donation box corner, and rotation of other artifacts. The Biotechnology Section was also dismantled to make way for a special exhibition room.

Further renovations are planned in 2004 after the completion of a new interactive museum design geared toward a younger audience. Targeted for renovations are the Rice History, Agricultural Engineering, Biotechnology , and IPM sections and the Riceworld Ecopark to be set up near the bus parking spaces.

In November, artifact identification and cataloguing under the International Artifact Cataloguing System was implemented. Organization and restoration of the Archive Room was also concluded. Several artifacts were catalogued and sent to Rome for the International Year of Rice exhibit at the FAO office.

Last December, the new Riceworld Bookstore and Coffee Shop at the old Public Awareness Office was opened to the public.

Table 1. IRRI visitors in 2003.

Visitor group	Philippines	Asia	Africa	Australasia	Europe	Latin America	North America	Total
Students	71,977	137			2		31	72,147
Conference participants	701	191						892
Nongovernment organizations	1,271	128		4	12	1	15	1,431
Donors		1			1			2
Government officials/politicians	3,291	189	1	6	28			3,515
Farmers	2,776	61					10	2,847
Faculty members/parents	2,351	21			3		7	2,382
Scientists, university staff	247	254	7	2	6		9	525
Private sector	1,815	15		4	12	2	10	1,858
UN agencies, CGIAR, TAC, etc.	22	8					4	34
Diplomatic corps	3	13	2		6		82	106
Media	30	17		1	23		2	73
Tourists	448	272	272	6	2		8	738
Total	**84,932**	**1,307**	**12**	**23**	**95**	**3**	**178**	**86,550**

Table 2. International and regional conferences, workshops, symposia, and meetings hosted or co-hosted by IRRI in 2003.

Date	Title	Venue	Number of	
			Participants	Countries represented
18-21 Feb	CURE Working Groups 1 and 5 Planning Meetings	IRRI	20	6
2-3 Apr	BOT Program Committee Meeting	Dhaka	30	14
5-6 May	Sustainable Food-Feed Systems and Improved Livelihoods of the Poor in Rainfed Lowland Areas: Socioeconomic Component	Thailand	22	5
12-13 May	Second Steering Committee Meeting of the Consortium for Unfavorable Environments (CURE)	Philippines	38	12
28-29 May	IRRI Strategic Planning Workshop (Phase I)	IRRI	57	1
2-3 Jul	Strategic Planning Workshop (Phase II)	IRRI	49	1
23-25 Jul	Capacity Building for Automation of Philippine Libraries and for Broadening the Base of FAO Agris	IRRI	41	2
12 Aug	IRRI Strategy Integration Workshop	IRRI	21	1
1-2 Sep	Philippines-IRRI Collaborative Workplan 2004-06	PhilRice	120	1
12-16 Sep	Strategies for Sustainable Development of Agricultural Production Systems in the Highlands of the Greater Mekong Subregion	China	42	11
18-19 Sep	Vietnam-IRRI Collaborative Workplan Meeting	Indonesia	67	3
29-30 Sep	Indonesia-IRRI Collaborative Workplan Meeting	Indonesia	68	5
6-8 Oct	Biofortification Challenge Program Rice Crop Meeting	IRRI	49	14
5-7 Nov	Seed Health Testing Policy for Safe and Efficient Germplasm Movement	IRRI	17	14
18-20 Nov	Improving Water and Food Productivity at Different Scales in Drought-prone and Saline Areas	IRRI	24	17
27 Nov	IRRI Representatives, Liaison Scientists, and National Coordinators Meeting	IRRI	18	9
27 Nov	Capacity Building for the PhilAgriNet: Refresher cum Intensive Training Course on Web AGRIS	IRRI	30	1
Total			**683**	

INFORMATION TECHNOLOGY SERVICES

Telecommunications

- New PBX installed: a Nortel Meridian1 Option 61c.
- Software phones deployed with new laptops.
- Internet phone technology introduced (Makati office).
- Voicemail and CallPilot integrated messaging software deployed.
- New IRRI phone book, quick reference card, and web site produced.
- Fax server (for electronic faxing of attachments) installed; incoming faxes now received electronically and delivered by email.
- Dozens of direct dial Manila numbers allocated to OUs with high volumes of incoming calls (HR, Shipping, Purchasing) and to one hosted center (WorldFish).
- Operator hours extended to 7PM.
- New call billing system deployed, with ITS-developed web interface.

The most important development of the year on the telecommunications front was the replacement of IRRI's 13-year-old Siemen's analog telephone system with a modern "Internet Protocol (IP) Enabled" digital system. This entailed the installation of a 30-channel (line) digital connection and the adoption of an additional and now preferred range of phone numbers. Call quality on the new digital lines is much improved in most cases. Older analog numbers remain in use for backup and for use with a very few countries with which call quality has declined.

Video conferencing

This year saw the first intercenter video conferences (with IPGRI). A Sony PCS 1600 video conferencing system and a dedicated two-channel digital line (ISDN basic rate interface circuit) were installed in the IRRI Boardroom and these may be booked by staff.

Asset management

This year, ITS completed implementation of a commercial asset management solution: Track-It. Track-It can report on all of the hardware on a LAN and on what software has been installed. For this to be useful, new asset tags were required. New tags were created by ITS and application of these TS tags was completed in February. Since then, ITS has had continually updated information about what hardware and software are installed on IRRI's network.

Currently, asset data exist in three sources: Track-It, spreadsheet (items that cannot be inventoried over the network), and Property and Assets (P&A)

database. With an upgrade from Track-It 5.0 to 6.0 (in progress), it is planned to merge the first two items listed, creating one database. Afterwards, ITS will review how P&A data may best be presented to the user.

During the year, an IT plantilla was completed, showing an approved total of almost 700 computers. An interface has been written to enable annotation of the underlying data and it is planned that this will be used in future for planning and budgeting annual replacements of IT assets.

Visitor services

- Charges for phone calls by guests in IRRI guesthouse now appear on their bills.
- Guesthouse rooms now have direct dial Manila numbers, voice mail, wake up call, and other "hospitality features."
- Hardware registration is no longer required for guests to use their own computers in their rooms in the IRRI guesthouse (they are not connected to IRRI's network and we are not exposed to security risks); wireless access in the guesthouse is also unrestricted.
- Network printing is now available in the guesthouse.
- Modem access points were provided downstairs for guests with modem capability only (access code needed).
- Revised visitor brochures, including *How to get Connected to the Internet* were prepared in color and distributed to FHS for distribution to new guests.
- We now issue a receipt for equipment given to ITS for repair or configuration that includes a disclaimer of liability for loss or damage of data resulting from such action or from connection to IRRI's network (e.g., by virus infection).

Data communications

- 2nd Internet connection (from 1 × 2Mb to 2 × 1Mb with 20% cost saving):
  - Redundant links with separate local loops.
  - Failover + traffic load balancing.
  - Internet Address portability.
- New carrier for 64k international leased line to US (for Voice over IP).
- DSL service for IRRI Makati office; enables voice and data communications: office on IRRI network and phone on IRRI PBX.

The most significant development in the area of connectivity during the year was the installation of a 2nd Internet connection with an independent local loop. We now have independent links to each two on campus data centers (PLDT to CPS and Capwire to Umali). This was not too difficult to achieve. Much more important was the opportunity having two such connections provided to have true redundancy with automatic and completely transparent failover. We achieved this using a special hardware device from Radware.

Remote connectivity

- VPN software deployed on new laptops to provide secure access to internal information systems via the Internet.
- Firewall software procured for use with laptops (not deployed yet).
- IRRI's Makati office and the ICRAF office in Forestry are connected over the Internet by VPN and have full access to internal applications incl. financial systems *and* direct access to IRRI's telephone system.
- Problems: Outlook unreliable because of port blocking following MSBlaster worm (VPN will often provide a workaround).
- Desktop Authority remote control software licensed from Scriptlogic Inc. in partnership with CIP (total 1,400 seat license).
- IRRIhelpdesk@cgiar.org address is now online for instant messaging with Microsoft Messenger—for coordinating helpdesk support.

Infrastructure and systems

- New firewalls (CPS, Umali, and guesthouse).
- Fiber interconnection of CPS and Umali (for above + communications links).
- FTP server set up for high-volume data transfer.
- Network storage expanded; redundant network attached storage (NAS) on order to mirror data between CPS and Umali (tape backup for 2nd level backup in future).
- Fire suppression system installed in CPS data center.
- New UPS installed in CPS; old one moved to Umali; run time more than doubled.
- Remotely controlled power management equipment installed in Guesthouse equipment room.
- New Ethernet infrastructure installed in: Library, Experiment station, Umali (Biometrics and Bioinformatics).

Additional servers were purchased for HR application, SQL Server, Asset management, Sharepoint, ISA Proxy server plus replacements for two mail servers. One of the highlights of the year was the installation of new firewall equipment. A pair of Netscreen NS208 firewalls was installed (one each for CPS and Umali data centers, respectively). The previously installed Netscree NS100 firewall was moved to the IRRI guesthouse where it provides direct Internet access to computers not registered on IRRI's network and protects IRRI's internal network. The

NS208s are installed in a high-availability configuration that enables either to continue the job of the other, serving all network zones and both Internet connections in the event of a firewall hardware failure.

Training

The ITS Learning Center opened for classroom training in May. The classroom training became so popular that our main problem with IT training is excess demand for it.

Our NETg e-learning materials were renewed at a concessionary rate. We paid for 200 seats and have the right to make unlimited use of them next year. We cannot usefully begin this until we start deploying Office 2003 fairly widely. In the meantime, we have been granted the right to keep Office 2000 materials on the network and these are also available to all who would like to use them.

In September, ITS made an IT training needs assessment survey, interviewing organization unit heads and IRRI staff. The result was circulated to IRRI management. Several useful ways of promoting training were identified. Management support for IT skills development, as reflected in HR policy changes, continues to be strong.

Our main challenge in 2004 will be ensuring that as many IRRI staff as possible get both updated Office software and classroom training on how to make good use of it. In addition, we have to further stimulate use of e-learning, demand for which continues to be weak.

Course	Classes (no.)	Participants (no.)
Basic Outlook	7	61
Advanced Outlook	6	55
Basic Word	7	62
Intermediate Word	6	54
Basic Excel	7	69
Intermediate Excel	7	65
Basic PowerPoint	4	39
Basic Access	5	50
Outlook Tips	8	67
Word Tips	8	64
Excel Tips	8	75
PowerPoint Tips	8	70
Total	81	731
Av no. of participants per class		9

SEED HEALTH UNIT

Phytosanitary certification

The Seed Health Unit issued 341 phytosanitary certificates covering 60,056 seedlots (1.42 t) and sent to 41 countries worldwide. By region, East Asia received 71 rice seed shipments (23,963 seedlots); Europe, 39 shipments (818 seedlots); Latin America, 6 shipments (614 seedlots); North America, 24 shipments (14,285 seedlots); Oceania, 27 shipments (6,208 seedlots); South Asia, 56 shipments (5,952 seedlots); Southeast Asia, 104 shipments (3,797 seedlots); sub-Sahara Africa, 5 shipments (580 seedlots); West Africa, 1 shipment (13 seedlots); and West Asia and North Africa, 8 shipments (3,826 seedlots). The rice seed export originated from different organizational units: INGER—1,008 seedlots; CSWS—2,752 seedlots; EPPD—16,040 seedlots; Genetic Resources Center—3,492 seedlots; and PBGB, 36,764 seedlots.

Different kinds of fungi were detected. Routine seed health testing of 583 nontreated, outgoing seedlots revealed that *Trichoconis padwickii* affected 91.6% of the seedlots; followed by *Curvularia* sp., 90.9%; *Sarocladium oryzae*, 66.0%; *Bipolaris oryzae*, 34.7%; *Fusarium moniliforme*, 29.3%; *Microdochium oryzae*, 13.7%; *Aphelenchoides besseyi*, 10.5%; *Tilletia barclayana*, 3.1%; and *Pyricularia oryzae*, 0.7%. All exported rice seeds were cleaned for objects of quarantine importance, tested for health, and treated with prescribed ASEAN standard seed treatment for rice-hot-water 52-57 °C / 15 min. This was followed by fungicide slurry treatment with benomyl and mancozeb both at 0.1% by seed weight, except for countries that do not allow seed treatment. Fumigation with phosphine was also administered to all outgoing seeds.

A total of 60 phytosanitary certificate werer also issued to INGER for their nursery seed distribution covering 25,830 seedlots (1.26 t) and sent to 32 countries.

Twenty-nine incoming seed shipments (2,574 seedlots) from 16 countries were also processed for post-entry clearance. PBGB received 17 shipments (2,223 seedlots weighing 98.6 kg); INGER received 7 shipments (120 seedlots weighing 15.2 kg); EPPD received 3 shipments (112 seedlots weighing 86.25 kg); CSWS got 1 shipment (108 seedlots weighing .48 kg); and IPMO received 1 shipment (11 seedlots weighing .22 kg).

Subjected to post-entry examination were 771 seedlots. Of the seedlots visually inspected, 21.7% have seeds with soil, while 6.74% were affected by insects, mainly by *Sitophilus* spp. (9.73%) and *Cryptolestes ferrugineus* (0.52%). Contamination with weed seeds was only 0.91%, mainly *Echinochloa* spp. Seed health tests showed that *T. padwickii* and *Curvularia* sp. affected 87.5% seedlots, followed by *S. oryzae* (56%) and *B. oryzae* (56%), *T. barclayana* (37.5%), *F. moniliforme* (28%), *M. oryzae* (18.8%), *A. besseyi* (9.4%), and *P. oryzae* (3.1%) The prescribed ASEAN standard treatments were applied to all incoming seeds.

Crop inspection

Post-entry and pre-export crop health inspections were conducted on GRC, EPPD, PBGB, and TC multiplication plots during the dry season and wet season. For post entry, crop health inspections were

conducted on 5,151 entries during dry season and 425 entries during wet season. The most prevalent disease observed during the dry and wet seasons was tungro (20% and 7.0%, respectively). Pre-export crop health inspection was also done on 4,877 entries during dry season and 1,766 entries during wet season. The most prevalent disease during dry season was sheath rot (5.0%), followed by tungro (2.32%); during wet season, the most prevalent disease was narrow brown leaf spot (17.89%), followed by tungro (10.65%).

Advanced testing for GRC seeds

A total of 5,677 GRC seedlots for long-term storage were processed for seed health status. Seed health tests of 2,764 nontreated seedlots showed that *Curvularia* spp. affected 99.9% of the seedlots, followed by *S. oryzae* (70.8%), *F. moniliforme* (47.4%), *T. padwickii* (40.1%), *B. oryzae* (15.9%), and *M. oryzae* (2.7%). *Aphelenchoides besseyi* affected only 0.62% of the seedlots.

Workshops, training courses, and visitors

SHU, in coordination with the Bureau of Plant Industry Plant Quarantine Service (BPI-PQS) conducted a workshop entitled *Seed Health Testing Policy on Safe and Efficient Germplasm Movement*. The workshop was attended by 14 plant quarantine officers from 11 major Asian rice-producing countries and scientists working on seedborne pathogens. During the 3-day workshop, the participants reviewed current knowledge of rice seedborne pathogens, reviewed policies related to seed health testing for phytosanitary certification, and came up with feasible recommendations and biology-sound approach to rice phytosanitary requirements.

SHU also participated in various training / workshops: *Workshop on General Plant Quarantine* conducted by BPI-PQS in coordination with the UPLB National Crop Protection Center with 33 plant quarantine officers from different Philippine regions; *Rice Production Course* (1st offering with 9 participants from 6 countries and 9 participants from IRRI and 2nd offering with 26 participants from 7 countries and 8 participants from IRRI); *Integrated Pest Management Course* with 23 participants from 12 countries; and *Hybrid Rice Seed Production* with 9 researchers from Bangladesh.

Other visitors included UPLB students: 10 Plant Pathology 121 (Postharvest Pathology) students and 27 Agronomy 170 (Fundamentals of Seed Technology) students. During these visits, lectures and hands-on exercises on routine seed health testing activities and identification of seedborne pathogens and other quarantine objects were conducted.

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Degree and postdegree training in 2003

1. Number of on-the-job trainees for 2003.

Trainees (no.)	Length of stay	Days (no.)	Person days (no.)
3	1 wk	5	15
5	2 wk	10	50
3	3 wk	15	45
2	1 mo	22	44
1	4 mo	88	88
1	10.5 mo	231	231
			473
Total: 15			

2. Number of interns for 2003.

Interns (no.)	Length of stay	Days (no.)	Person days (no.)
2	1 mo	22	44
5	2 mo	44	220
1	2.5 mo	55	55
1	3 mo	66	66
1	4 mo	88	88
1	4.5 mo	99	99
3	5 mo	110	330
1	7 mo	154	154
		1056	
Total: 15			
14 bachelor level; 1 MS			

3. Number of degree scholars (MS and PhD) who started their program at IRRI in 2003.

Category	Scholars starting in 2003 (no.)	Scholars continuing in 2003 (no.)	Degree scholars in 2003 (total no.)
MS			
MS	2	4	6
MS-thesis	4	1	5
Affiliate MS-thesis	6	9	15
PhD			
PhD	5	11	16
PhD-thesis	11	12	23
Affiliate PhD-thesis	4	10	14
Total	**32**	**47**	**79**

4. Number of degree scholars at IRRI in 2003.

Category	Scholars on board (no.)	Scholars (no.)	Length of stay (mo)
MS	6		
		2	12
		1	8
		1	7.5
		1	6
		1	2.5
MS-thesis	5		
		1	12
		1	8.5
		1	5
		1	3
		1	1.75
Affiliate MS-thesis	15		
		4	12
		1	11
		1	9.75
		2	8
		1	6.5
		1	6
		1	5.5
		1	3
		1	1.25
		2	1
PhD	16		
		11	12
		1	8.75
		1	7.5
		1	7
		1	4
		1	2.25
PhD-thesis	23		
		12	12
		1	11
		1	10.25
		1	9.5
		1	8.25
		1	4.75
		1	4
		1	3.5
		1	2.5
		1	2
		1	1.25
		1	1
Affiliate PhD-thesis	14		
		9	12
		1	10.5
		1	9
		1	5
		1	4
		1	2
Total	**79**		

5. Group training courses conducted in 2003.

Course title	Participants (no.)	Duration
Regular courses		
English for Conversation	22	10–21 Feb
Two-week Rice Production Training Course	19	17–28 Feb
Developing Integrated Nutrient Management Options	32	24 Feb–7 Mar
Basic and Conversational English	24	3 Mar–25 Apr
Integrated Pest Management (IPM)	24	24 Mar–11 Apr
Introduction to IRISTAT Statistical Software	7	31 Mar–4 Apr
ORYZA 2000	21	28 Apr–2 May
Master Class on Rodent Management	17	19 May–6 Jun
Intensive English 1	17	7 Jul–26 Sep
Planning Rice Breeding for Impact	25	11–29 Aug
Two-week Rice Production Training Course	22	1–12 Sep
Genetic Engineering and Nutrition Improvement in Rice	9	23–27 Sep
Scientific Writing and Presentation Skills Course	21	20–25 Oct
Workshop on Rice Seed Health and Testing Policy for Safe and Efficient Germplasm Movement		
Leadership Course for Asian Women in Agriculture R&D	17	3–14 Nov
Intensive English 2	23	10–28 Nov
Special courses		
Hybrid Rice Seed Production Course	8	6–17 Oct
Designing Computer-based Publications and Communications	3	7–14 Dec
Total	**311**	

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Finances

Summary of financial support to IRRI research agenda, 2003 (in US$'000).

Asian Development Bank	272
Australia	638
Belgium	106
Canada	
Canadian International Development Agency	824
CGIAR Challenge Programs	310
China	130
Denmark	597
European Commission	1,937
Food and Agricultural Organization	23
France	748
Germany	
Federal Ministry for Economic Cooperation	292
Federal Ministry for Economic Cooperation/German Agency for Technical Cooperation	789
India	150
International Fund for Agricultural Development	298
Iran	100
Japan	4,058
Korea	545
Netherlands	374
Norway	208
Philippines	110
Portugal	6
Rockefeller Foundation	715
Spain	50
Sweden	460
Switzerland	2,380
Thailand	26
United Kingdom	5,043
United States of America	
United States Agency for International Development	3,578
United States Department of Agriculture	84
Vietnam	15
World Bank	2,083
Others	176
TOTAL	**27,125**

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Weather summary

Annual rainfall for year 2003 was 1,774 mm for the IRRI dryland (upland) site and 1,582 mm for the wetland (lowland) site. These values were 326 mm lower than the long-term average rainfall for the upland site and 450 mm lower than that for the lowland site. Los Baños experienced twice more rainfall in May and less rainfall in October this year, compared with the long-term amount (Fig. 1). The wettest day at IRRI occurred 19 Jul with more than 105 mm rainfall per day. The longest recorded continuous wet spell was 13 d at the upland site (22 May–3 Jun) and 12 d at the lowland site (22 May–2 Jun). The longest continuous dry spell was 20 d at the upland site (12 Feb–3 Mar) and 26 d at the lowland sites (27 Mar–21 Apr).

Mean monthly solar radiation reached a peak in April (more than 24 MJ m^2 / d) and gradually declined to 12.9 MJ m^2 / d in December (Fig. 2). Solar radiation was relatively low during the second decade of December. The highest recorded cumulated solar radiation (28.9 MJ m^2 / d) occurred 6 Jul. The average duration of bright sunshine was about 10 h / d in April and declined to a low value of 4.4 h / d in December. The longest record of sunshine at Los Baños was on 1 May with 12.0 h of bright sunshine.

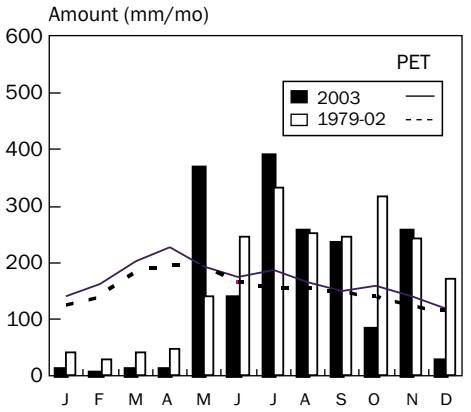
Maximum temperature reached its highest monthly mean value in April (35.2 °C at the upland site and 33.0 °C at the lowland site). It gradually dropped to its lowest monthly mean value in December (28.4 °C at the upland site and 27.9 °C at the lowland site) (Fig. 3). Except for the months of July and December, the recorded averages of maximum temperature for 2003 were higher than the long-term average. The hottest day in Los Baños was on 8 May with 37.0 °C of recorded maximum temperature at the upland site. The distribution of minimum temperatures was more stable than the distribution of maximum temperatures. The coldest day for 2003 was on 24 Feb, registering 19.4 °C in the upland site and 20.0 °C in the lowland site.

Mean early morning relative humidity ranged from 77 to 89% in the upland site and 81 to 87% in the lowland site. Midday vapor pressure deficit was consistently higher in the upland site than in the lowland site (Fig. 4).

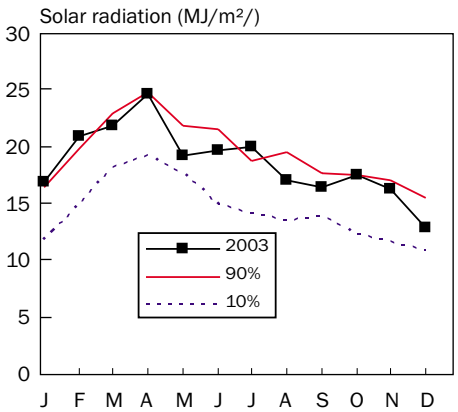
Daily mean windspeed, measured at 2-m height, was 1.7 m / s for the upland site and 1.5 m / s in the lowland site. Windspeed was generally low (<2.2 m / s), except during the passage of tropical disturbances. Maximum 24-h average windspeed was 5.3 m / s at the upland site on 27 May.

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 that at the lowland site. Open-pan evaporation totals were 1,894 mm at the upland site and 1,723 mm at the lowland site. These values were higher than the long-term evaporation total at the upland (57 mm higher) and lowland site (49 mm higher).

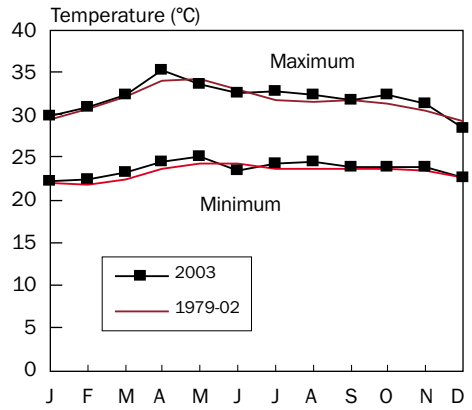
Twenty-five disturbances passed through the Philippines area of responsibility. Six of these disturbances occurred in August.



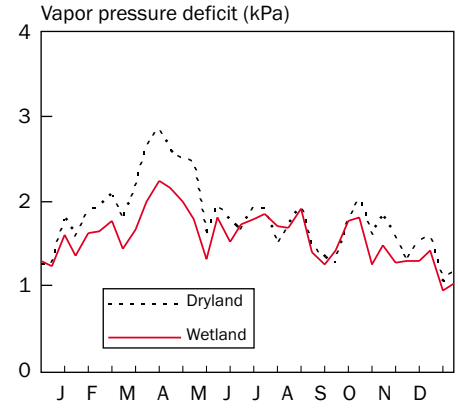
1. Rainfall and potential evapotranspiration pattern at Los Baños. IRRI, 2003.



2. Mean monthly solar radiation with 10 and 90% probability of occurrence. IRRI, 2003.



3. Maximum and minimum air temperature at the dryland site. IRRI, 1979-2002.



4. Midday vapor pressure deficit at the dryland and wetland sites. IRRI, 2003.

Table 1. Monthly weather data for IRRI and cooperating weather stations in the Philippines, 2003.

Site		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total or daily average
Rainfall (mm/mo)														
IRRI, dryland site (14°13' N, 121°15' E)		10	4	10	10	366	136	387	255	233	81	255	26	1774
IRRI, wetland site (14°11' N, 121°15' E)		8	4	13	20	328	137	359	186	193	94	215	25	1582
Solar radiation (MJ/m²/d)														
IRRI, dryland site		16.8	20.9	21.8	24.6	19.2	19.6	20.0	17.0	16.4	17.4	16.2	12.9	18.6
IRRI, wetland site		16.2	20.1	21.3	24.2	18.6	19.1	19.6	16.6	16.2	17.1	15.8	12.4	18.1
Relative humidity (%)														
IRRI, dryland site		83	82	80	77	82	85	85	85	89	83	85	83	83
IRRI, wetland site		84	84	83	81	86	84	85	87	89	83	84	84	85
Temperature (°C)														
IRRI, dryland site	Max	29.8	30.9	32.4	35.2	33.5	32.6	32.8	32.4	31.6	32.3	31.3	28.4	31.9
	Min	22.2	22.4	23.2	24.4	25.0	23.4	24.2	24.4	23.9	23.9	23.9	22.5	23.6
IRRI, wetland site	Max	28.5	29.4	30.5	33.0	32.2	31.8	31.8	31.4	31.0	31.2	30.7	27.9	30.8
	Min	22.2	22.0	22.9	24.3	25.2	24.0	24.8	24.8	24.4	24.1	24.0	22.6	23.8
Windspeed (m/s)														
IRRI, dryland site		1.6	2.1	2.1	1.9	2.1	1.4	1.4	1.5	1.2	1.2	1.5	1.9	1.7
IRRI, wetland site		1.9	1.9	1.8	1.6	1.8	1.3	1.2	1.1	0.9	1.1	1.3	2.1	1.5
Evaporation (mm/mo)														
IRRI, dryland site		139	176	216	250	190	144	157	140	119	134	115	114	1894
IRRI, wetland site		130	150	185	210	168	143	155	129	112	123	110	108	1723

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Jose L. Angeles, *research technician III*
Danilo B. Balagtas, *research technician III*
Socorro Carandang, *research technician III*
Danilo C. de Ocampo, *research technician III*
Rollin V. Deocampo, *research technician III*
Mario M. Escote, *research technician III*[5]
Angelito S. Francisco, *research technician III*
Reynaldo P. Garcia, *research technician III*
Virgilio P. Magat, *research technician III*
Inofra I. Sandoval, *BS, research technician III*
Eloisa B. Suiton, *research technician III*
Ernesto C. Sumague, *research technician III*
Jonathan R. Abengania, *BS, research technician I1*[1]
Emmanuel R. Adique, *research technician II*[5]
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Virgilio M. Angeles, *research technician II*
Renel C. Aventurado, *research technician II*[5]
Victor P. Banasihan, *research technician II*[5]
Ma. Gina L. Borja, *research technician II*[5]
Joselito M. Calibo, *research technician II*[5]
Luisito L. Caracuel, *research technician II*
Ronaldo L.Cornista, *research technician II*
Marifa L. Corral, *BS, research technician II*
Reynaldo J. dela Cueva, *research technician II*
Mario A. Garcia, *research technician II*
Oscar A. Gonzales, *research technician II*
Francisco V. Gulay, *research technician II*
Juvy A. Gutierrez, *research technician II*[5]
Rommel V. Javier, *research technician II*[5]
Cenon L. Lanao, *research technician II*
Nestor P. Leron, *research technician II*
Noel P. Llanza, *research technician II*[5]
Evelyn A. Liwanag, *research technician II*[5]
Orlando T. Lucero, *research technician II*
Carmela D. Malabanan, *research technician II*[5]
Noel S. Malabanan, *research technician II*[4,5]
Apolonio N. Mamiit, *research technicianII*[4]
Eduardo T. Managat, *research technician II*
Eleazar O. Manalaysay, *research technician II*[5]
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Marina C. Manzanilla, *BS, research technician II* [1,5]
Jose M. Marasigan, *research technician II*
Josefina G. Mendoza, *research technician II*
Virginia P. Meulio, *research technician II*[5]
Florencia A. Montecillo, *research technician II*[5]
Arsenio R. Morales, *research technician II*
Honorio M. Oboza, *research technician II*
Daniel L. Pasuquin, *research technician II*
Juanito M. Pasuquin, *research technician II*[5]
Macario S. Perez, Sr. *research technician II*
Renato T. Pizon, *research technician II*
Norberto T. Quilloy, *research technician II*[5]
Nestor D. Ramos, *research technician II*
Julito P. Talay, *research technician II*
Irma R. Tamisin, *research technician II*[5]
Teodoro L. Atienza, *research technician I*
Wilfredo Cabauatan, *research technician I*[5]
Patricio Carandang, *research technician I*[5]
Rodante Nuevo, *research technician I*[5]
Janice A. Sapin, *research technician I*
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Social Sciences

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Sushil Pandey, *PhD, deputy head and senior scientist, agricultural economics*
David Dawe , *PhD, senior scientist, agricultural economics*
Suan Pheng Kam, *PhD, senior scientist, GIS specialist*
Mercedita A. Sombilla, *PhD, policy economist*[1]
Thelma R. Paris, *PhD, senior scientist, gender specialist*
Guy Trebuil, *PhD, IRS seconded from CIRAD*
Francois Bousquet, *PhD, IRS seconded from CIRAD*
Mohammed Zainul Abedin, *PhD, international research fellow*
Nobuhiko Fuwa, *PhD, international research fellow*
Manik Lal Bose, *PhD, postdoctoral fellow*[4]
Hum Nath Bhandari, *PhD, postdoctoral fellow*
Aldas Janaiah, *PhD, postdoctoral fellow*[1]
Piedad F. Moya, *MS, senior associate scientist*
Arnel Rala, *MS, senior assistant scientist*
Fe B. Gascon, *MS, senior assistant scientist*[4,5]
Lolita Garcia, *MS*, *senior assistant scientist*[4,5]
Imelda Revilla, *MS, senior assistant scientist*[1]
Catalina P. Diaz, *MS, senior assistant scientist*
Nestor G. Fabellar, *BS, senior assistant scientist*
Florencia G. Palis, *PhD, senior assistant scientist*
Amelia de los Reyes, *MS, senior assistant scientist*[4,5]
Sidky Macatangay, *MS, systems analyst/programmer*[4]
Alice Laborte, *MS, assistant scientist*
Joyce S. Luis, *MS, assistant scientist*
Lourdes E. Velasco, *MS, assistant scientist*
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Ma. Romilee Bool, *BS, researcher*[4,5]
Aileen Alvaran, *BS, researcher*
Ellanie R. Cabrera, *BS, researcher*
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Aileen Lapitan, *BS, researcher*[4]
Esther B. Marciano, *BS, researcher*
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Lorena Villano, *BS, researcher*
Mirla Domingo, *BS, administrative coordinator*
Lydia Damian, *BS, senior secretary*

Jocelyn Go, *BS, secretary*
Angelina Malabrigo, *BS, senior secretary*
Ramil Gutierrez, *BS, secretary*
Frederick Lagasca, *BS, statistical assistant*
Teodora Malabanan, *BS, statistical assistant*
Joel Reaño, *BS, statistical assistant*
Cornelia Garcia, *BS, graphics assistant*

Experiment Station

Joseph Frederick Rickman, *PhD, head*
Arnold R. Manza, *MS, senior manager*
Tomas P. Clemeno, *MS, manager*
Bienvenido B. Manimtim, *BS, ES supervisor II*
Myra L. Collado, *BS, programmer*
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Celso L. Varron, *lead research technician*
Sulpicio J. Malabanan, *lead research technician*
Nazario B. Timbol, *lead research technician*
Jesse C. Banasihan, *lead research technician*
Francisco G. Calibo, *equipment operator I*
Rolando G. Guevarra, *mechanic II*
Rogelio R. Pamulaklakin, *mechanic II*
Juanito M. Rosario, *mechanic II*
Efren E. Viquiera, *mechanic II*
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Cecilio L. Villamayor, *secretary I*
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Romeo T. Llamas, *welder*
Abraham G. Dalid, *AB, research technician III*
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Luis M. Calma, *research technician II*
Aurelio M. Catangay, *research technician II*
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Rogelio M. Elbo, *research technician II*
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Ramiro C. Panting, *research technician II*
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Roberto B. Revilleza, *research technician II*
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Benjamin C. Garcia, *research technician II*
Andres M. Mercado, *research technician II*
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Nestor M. Angeles, *research technician II*
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Virgilio T. Lalap, *research technician II*
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Danilo O. Gonzaga, *research technician II*
Nestor L. Ilaw, *research technician II*
Fidel G. Lanorio, *research technician II*
Carlos P. Alforja, *research technician II*
Mateo F. Manzanilla, *research technician II*
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Efren P. Bautista, *research technician II*
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Seed Health Unit

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Florencio I. Lapiz, *research technician II*
Jose F. Banasihan, *research technician I*
Aurelio A. Gamba, *research technician I*
Salome Palmones-Bulaquina, *data encoder*

Analytical Service Laboratories

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Rosario R. Jimenez, *BS, assistant scientist I*
Lilia R. Molina, *BS, assistant scientist I*
Marnol Santos, *BS*, *instrumentation specialist*
Ma. Carmela Ong, *BS, researcher*
Ruben G. Chavez, *ASL supervisor I*
Aniceto B. Boncajes, *BS, research technician III*
Rufino D. Manuel, *research technician III*
Jose G. Rosales, *research technician III*
Edgar O. Amoloza, *research technician III*
Jesus S. Belen, *research technician III*

Biometrics and Bioinformatics Unit

Christopher Graham McLaren, *PhD, senior scientist, biometrics and head*
Richard Bruskiewich, *PhD, senior scientist, bioinformatics specialist*

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Arllet Portugal, *MS, database administrator II*
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Luralyn Ramos, *BS, database administrator I1*[1]
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Genetic Resources Center

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Ma. Socorro R. Almazan, *BS, assistant scientist I*
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Ma. Elizabeth B. Naredo, *MS, assistant scientist I*
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Bernardino T. Almazan, *research technician III*
Vicente M. Arcillas, *research technician III*
Emerlinda E. Hernandez, *research technician III*
Felix R. Llanes, *research technician III*
Gregorio M. Mercado, *research technician III*
Mario A. Rodriguez, *research technician III*
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Teresita C. Santos, *AB, secretary II*
Remegio L. Aguilar, *research technician II*
Noel R. Banzuela, *research technician II*
Arnold B. Gonzales, *research technician II*
Florencio F. Villegas, *research technician II*
Melencio R. Lalap, *GRC assistant*
Lydia G. Angeles, *BSBA, research technician I*[5]
Imelda P. Boncajes, *research technician I*[5]
Isabelita P. de Mesa, *BSBA, research technician I*[5]
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Alicia A. Lapis, *BSFEd, research technician I*[5]
Wilma L. Lumaybay, *research technician I*[5]
Yolanda P. Malatag, *AB, research technician I*[5]
Veronica V. Mangubat, *research technician I*[5]
Jacqueline D. Manuel, *research technician I*[5]
Maridee Pontipedra, *research technician I*[5]

Communication and Publications Services

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Bill Hardy, *PhD, science editor*
Albert A. Borrero, *CPS manager*
Sylvia Katherine S. Lopez, *MS, CPS assistant manager II*
Teresita V. Rola, *MPS, CPS assistant manager I*
Ginalyn H. Santos, *BS, web developer and multimedia designer*
Victor Alarcon, *BS, multimedia developer*
Ma. Guadalupe Yandoc, *BS, technical writer/editor for multimedia*
Antonette Abigail E. Caballero, *MBA, administrative coordinator*
Rogelio M. Alfonso, *CPS supervisor I*
Anna Arsenal, *BS, marketing specialist*[4]
Krisna Pinero, *BS, marketing assistant*[4]
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Juan V. Lazaro IV, *graphics designer*
Emmanuel A. Panisales, *BS, graphics designer*
George R. Reyes, *BS, graphics designer*
Ariel Javellana, *BS, photography supervisor*
Aileen del Rosario-Rondilla, *BS, photography assistant*
Reynaldo L. Stevens, *printer*
Rogelio R. Quintos, *BS, secretary II*
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Library and Documentation Service

Mila M. Ramos, *MLS, head librarian*
Carmelita S. Austria, *MLS, assistant librarian (bibliographer)*
Iris Marigold P. Operario, *BLS, collections development librarian*
Allan Crispulo R.Vallarta, *BLS, catalog librarian*
Natalia V. delos Reyes, *BS, electronic resources and serials librarian*
Ma. Consuelo S. Parducho, *BS, library assistant*
Guido O. Talabis, *library assistant*
Mauro T. Malabrigo, Jr., *library assistant*
Emmanuel Mendoza, *BS, library assistant*
Isagani P. Garcia, *library assistant*
Corvette M. Apolinario, *library assistant*
Francisco A. Jaraplasan, *library assistant*
Marilyn O. Bonador, *BS, library assistant*
Ma. Aisa M. Atienza, *BS, library assistant*

Information Technology Services

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Wilbert Almoro, *BS, assistant manager*
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Visitors and Information Services

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Johnny S. Goloyugo, *MM, public awareness specialist*
Joselito A. Platon, *BS, community project officer*
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Frances Tesoro, *BS, secretary II*
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Training Center

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Albert Dean Atkinson, *PhD, training and courseware specialist*
Zahirul Islam, *PhD, project scientist*
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Macario B. Montecillo, *training logistics assistant*
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Priscilla P. Comia, *BS, secretary I*
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International Programs Management Office

Headquarters-based

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Shaila Arifa Nabi, *BS, researcher, PETRRA*
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Fauzia Sultana, *BS, secretary II*
Mohammad Samad, *office assistant*[1]
S.M. Suzat, *office attendant*[4]
Ruhul Amin, *office attendant*[4]
Jopinath Bazi, *driver*
Md. Nazmul Huda, *driver*[4]
Mohammad Jamal, *driver*[1]
Mohammad Ahsanullah, *driver*
Nuruzzaman Badal, *driver*
Mohammad Naseem, *driver*[1]
M. Jashim, *driver*
Babul Kumar Das, *driver*
M. Mazid, *guard*[1]
Fazlu Miah, *office guard*
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India
R.K. Singh, *PhD, liaison scientist for India*
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Savita Sharma, *BA*, *steno-typist*
Nikhil Juneja, *BA*, *office clerk (travel)*
Chander Mohan, *BCom*, *office clerk/messenger*
Vinod Kumar Singh, *driver/utilityman*
Ayodha Lodhi*, driver/utilityman*

Indonesia/Malaysia/Brunei Darussalam
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Bouchanh Keopha, *administrator*
Sansai Samounty, *accountant*
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Bounmy Sengthong, *JPO project assistant*
Kham Souk Mosky, *BS, driver/general services*
Khamphay Onesanga, *driver*
Khamchanh Joutdala, *guard*
Chanh Sommaniphone, *guard*
Oudone Srithirath, *guard*
Samien Luanglath, *guard/cleaner*

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Nanda Soe Myint, *driver/office aide*

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Chaiporn Soising, *field technician*
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Office of the Director for Program Planning and Coordination

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Finance

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Office of the Director for Administration and Human Resources

Nida E. Reyes, *BS, HR coordinator*
Selene M. Ocampo, *BS, administrative coordinator*
Ma. Liza R. Milante, *BS, secretary II*

Human Resources Services

Fe V. Aglipay, *BS, HRS national staff manager*
Lillian M. Mendoza, *MS, employee relations manager*
Sylvia P. Avance, *BS, HRS specialist*
Gladys Faith Tan, *BS, HRS specialist*
Kathryn Rose Victoria, *BS, employee relations coordinator*[4]
Alfredo R. Reyes, *BS, HRS benefits coordinator*
Larry Montermoso, *HRS assistant*
Iluminada B. Oleta, *BS, secretary II*

Materials Management Services

Frisco L. Guce, *MS, manager*
Felicisimo N. Kalaw, *BS, MM supervisor II*
Zenaida M. Belarmino, *BS, purchaser*
Lourdes A. Belison, *BS, purchaser*
Nerisa M. Gutierrez, *BS, purchaser*
Luzviminda G. Oleta, *BS, purchaser*
Conception Elybeth A. Alcantara, *MBA, MM assistant*
Anatolio A. Magampon, *BS, property disposal assistant*
Irineo B. Esguerra, *warehouseman*
William M. Estrellado, *warehouseman*
Ernesto L. Nimedez, Jr., *BS, warehouseman*
Jose L. Sibal, *warehouseman*
Priscilla T. Cabral, *BS, shipping assistant*
Francisco T. Quilloy, *materials expediter*
Delfin M. Lacandula, Jr., *MM attendant*
Fred B. Angeles, *fuel attendant*
Anicia R. Malabanan, *data encoder*
Maureen C. Pader, *data encoder*
Remedios E. Ballesfin, *BS, administrative coordinator*
Angelica P. Valintos, *BS, administrative coordinator*
Wilmer B. Jacob, *office clerk*
Louell R. Tanzo, *BS, central files assistant*
Felix C. Estipona, *Makati office assistant*

Legal Services

Walfrido E. Gloria, *MBA, manager*
Cherryl M. Cruz-Breva, *BS, secretary II*

Food and Housing Services

Ma. Obdulia B. Jolejole, *BS, FHS manager II*
Leody M. Genil, *BS, FHS supervisor II*
Melinda M. Cuyno, *BS, FHS supervisor I*
Erenita Gabriel, *MEd, FHS supervisor I*
Fe C. de Ocampo, *BS, food service assistant*
Ricardo L. Bejosano, Jr., *housing attendant*
Cristina E. Cauntay, *housing attendant*
Irene S. Escoses, *housing attendant*
Laureano M. Escuadra, *housing attendant*
Edgardo S. Estenor, *housing attendant*
Aurelio C. Garcia, *housing attendant*
Francisca O. Oro, *housing attendant*
Alfredo G. Regalado, *housing attendant*
Limberto S. Aldipollo, *AB, stock assistant*
Anselmo R. Reyes, *recreation assistant*
Jojo P. Cabutin, *BS, recreation assistant*

Security and Safety Services

Glenn A. Enriquez, *BS, SSO manager II*
Andres V. Mendoza, *BS, security supervisor I*
Bionico R. Malacad, *security investigator*
Salvador T. Zaragosa, Jr., *security investigator*
Crisanto P. Dawinan, *BS, nurse*
William G. Amador, *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*
Juanito C. Exconde, *BS, core guard*
Esteban C. Palis, *core guard*
Macario C. Punzalan, *BS, core guard*
Ernesto S. Regulacion, *core guard*

Transport Services

Manuel F. Vergara, *BS, senior manager*
John Arturo M. Aquino, *BS, supervisor II*
Reynaldo G. Elmido, *MPDS dispatcher*
Sesinando B. Guerta, *MPDS dispatcher*[6]
Bonifacio M. Palis, *MPDS dispatcher*
Perlita E. Malabayabas, *BS, secretary II*
Ariel B. Nuque, BS, *MVRS coordinator*
Carlito C. Cabral, BS, *MPDS assistant*
Danilo G. Abrenilla, *driver*
Jaime D. Atienza. *mechanic II*
Crisencio L. Balneg, *driver*
Edwin S. Cabarrubias, *mechanic I*
Rolando A. Cabrera, *driver*
Roger M. Cuevas, *mechanic I*
Amador L. de Jesus, *driver*
Rodrigo M. Fule, *driver*
Emilio R. Gonzalez, Jr., *AC mechanic*
Romeo L. Jarmin, *mechanic II*
Mabini M. Linatoc, *mechanic I*
Armando E. Malveda, *mechanic II*
Diosdado D. Mamaril, *driver*
Hernani M. Moreno, *driver*
Eduardo L. Pua, *driver*
Angelito C. Quijano, *driver*
Roduardo S. Quintos, *mechanic II*
Rolando L. Santos, *mechanic II*
Oscar A. Templanza, *driver*
Ronilo M. Villanueva, *mechanic I*
Renato C. Vivas, *driver*

Physical Plant Services

Douglas Avila, *BS, manager*
Alfredo Mazaredo, *MS, manager*
Enrique delos Reyes, *BS, manager*
Jaime Fojas, *BS, PP supervisor II*
Fernando Madriaga, *BS, PP supervisor II*
Nestor Malabuyoc, *BS, PP supervisor II*
Teodoro Carreon, *PP supervisor I*
Rodolfo Calibo, *lead PP technician*
Fidel Alvarez, *carpenter*

Levi Malijan, *carpenter*
Virgilio Verano, *carpenter*
Danilo Banasihan, *instrument and telephone technician*
Marcelino Navasero, Jr., *instrument and telephone technician*
Domingo Ortiz, *telephone technician*
Alex Alumaga, *plumber*
Regalado Alcachupas, *plumber*
Melencio Tapia, *plumber*
Leonardo Mangubat, *refrigeration technician*[4]
Manolo de Guia, *refrigeration and AC mechanic*
Dionisio Ng, *refrigeration and AC mechanic*
Juancho Petrasanta, *refrigeration and AC mechanic*
Enrique Baterina, *electrician*[4]
Ricardo Tabilangon, *refrigeration and AC mechanic*
Mario Garcia, *electrician*[4]
Roberto Escueta, *BS, electrician II*
Rufino Gibe, *electrician II*
Felix Halili, *electrician II*
Benjamin Libutan, *electrician II*
Cesar Padonan, *electrician II*
Ramon Suarez, *electronics and instrument technician*[4]
Rolando Simon, *electrician II*
Marissa Templanza, *BS, administrative coordinator*
Benita Pangan, *BS, office clerk*
Jennifer Jarlego, *AB, clerk-typist*[4]
Larry Salgado, *BS, drafting technician*
Apolinario Armia, *welder/tinsmith*
Anito Mabalhin, *welder/tinsmith*
Roberto Tamio, *mason*
Almario Pinero, *painter*[4]
Luisito Vitan, *painter*
Fermin Junsay, *BS, stock assistant*

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[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]Died during the year.
[7]Effective 1 March 2004.
[8]Transferred to ILRI.

IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE
DAPO Box 7777, Metro Manila, Philippines

Appendix. IRRI's research partners.

Australia

Australian Council for International Agricultural Research (ACIAR)
Centre for Pest Information Technology and Transfer (CPITT)
Commonwealth Scientific & Industrial Research Organization (CSIRO)
CSIRO Horticulture (CSIROH)
CSIRO Land and Water Griffith Laboratory (CSIRO-LWGL)
CSIRO Plant Industry (CSIRO-PI)
Curtin University of Technology (CUT)
Macquarie University (MU)
University of Adelaide (UA)
University of Newcastle (UN)
University of Queensland (UQ)
University of Sydney (UoS)

Bangladesh

A Voluntary Organization of Community Development (APEX)
Agricultural Advisory Society (AAS)
Agro Business Corporation (ABC)
Association for Integrated Development, Inc. (AID-Comilla)
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)
Bangladesh Academy for Rural Development (BARD)
Bangladesh Agricultural Development Corporation (BADC)
Bangladesh Agricultural Research Council (BARC)
Bangladesh Agricultural Research Institute (BARI)
Bangladesh Agricultural University (BAU)
Bangladesh Bureau of Statistics (BBS)
Bangladesh Development Society (BDS)
Bangladesh Institute of Development Studies (BIDS)
Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEMD)
Bangladesh Rice Exporters Association (BREA)
Bangladesh Rice Research Institute (BRRI)
Bangladesh Rural Advancement Committee (BRAC)
CARE (CARE-Bangladesh)
Center for Policy Dialogue (CPD)
Coastal Development Partnership (CDP)
Department of Agricultural Extension (DAE)
Friends in Village Development Bangladesh (FIVDB)
Grameen Krishi Foundation (GKF)
HEED Bangladesh (HEED)
Integrated Action Research and Development (IARD)
International Development Enterprise (IDE)
Jahangirnagar University Dhaka (JU)
Local Government Engineering Department (LGED)
MARK Industries (pvt.) Ltd. (Mark)
National Rice Research and Extension Programs (NRREP)
PRA Promoters Society Bangladesh (PPS-BD)
Proshika- A Center for Human Development (Proshika)
RDRS Bangladesh (RDRS)
Rural Development Academy (RDA)
Shushilan (Shushilan)
Socioconsult Ltd. (SocioConsult)
University of Dhaka (UD)
Uttaran (Uttaran)

Belgium

University of Ghent (UG)

Bhutan

Council of Research and Extension (CORE)
Ministry of Agriculture (MOA-Bhutan)
Royal Government of Bhutan (RGOB)

Brazil

National Research Center for Rice and Beans (NRCRB)

Cambodia

Cambodian Agricultural Research and Development Institute (CARDI)
Ministry of Agriculture, Forestry and Fisheries (MAFF)
Cambodia Rice Millers Association (CRMA)

Canada

Agriculture and Agri-Food Canada (AAFC)
Commonwealth of Learning (CoL)
McGill University (McGill)
National Research Council - Plant Biotechnology Institute (NRC-PBI)
Potash & Phosphate Institute/Potash and Phosphate Institute of Canada (PPI/PPIC)
Simon Fraser University (SFU)
University of British Columbia (UBC)
University of Western Ontario (UWO)

China

Center for Chinese Agricultural Policy - Chinese Academy of Sciences (CCAP)
China National Rice Research Institute (CNRRI)
China Agricultural University (CAU)
China National Hybrid Rice Research and Development Center (CNHRRDC)
Chinese Academy of Agricultural Sciences (CAAS)
Fujian Science and Technology Publishing House (FSTPH)
Guangdong Academy of Agricultural Sciences (GAAS)
Guangxi Rice Research Institute (GRRI)
Huazhong Agricultural University (HAU)
Hunan Agricultural University (HAU)
Hunan Hybrid Rice Research Center (HHRRC)
Institute of Soil Sciences-Chinese Academy of Sciences (ISS-CAS)
Institute of Sub-Tropical Agriculture (ISA)
National Natural Science Foundation of China (NSFC)

Sichuan Academy of Agricultural Sciences (SAAS)
Wuhan University (WU)
Yangzhou University (YU)
Yunnan Academy of Agricultural Sciences (YAAS)
Yunnan Agricultural University (YAU)
Zhejiang University (ZU)

Denmark

Danish Institute of Agricultural Sciences (DIAS)
Royal Veterinary and Agricultural University (KLV)

Egypt

Assiut University (AU)
Ministry of Agriculture and Land Reclamation (MOA)

France

Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)
Institut de recherche pour le développement (IRD)
Institut National Agronomique Paris, Grignon (INA-PG)
Institut National de la Recherche Agronomique (INRA)
Montpellier II University Centre des Sciences Humaines (CSH)
Paris X University (PXU)
Research and Technology Exchange Group (GRET)
Réseaux de recherche et d'innovation technologique (RRIT)

Germany

Center for Environmental Research (UFZ)
Centre for Development Research (ZEF)
Martin Luther University Halle, Wittenberg (MLU)
Max-Planck Institut fur Zuchtungsforschung (MPI)
Universitaet Bayreuth (UB)
University of Freiburg3 (UF)
University of Hannover (UH)
University of Hohenheim (UH)
University of Leipzig (UL)

India

Acharya N.G. Ranga Agricultural University (ANGRAU)
Agricultural College & Research Institute, Trichy (ACRI)
Assam Agricultural University (AAU)
Bidhan Chandra Krishi Viswavidyalaya (BCKV)
Birsa Agricultural University (BAU)
CCS Haryana Agricultural University (HAU-India)
Center for Research and Development of Waste and Marginal Land , India (CRDWML)
Central Agricultural University (CAU)
Central Agricultural Research Institute (CARI)
Central Rainfed Upland Rice Research Station (Hazaribagh) (CRURRS)
Central Rice Research Institute (CRRI)
Central Soil Salinity Research Institute (CSSRI)
Chinsurah Rice Research Station (CRRS)
Department of Agricultural Extension-Tamil Nadu (DAE)
Department of Agriculture (DOA-India)
Directorate of Rice Research (DRR)
Energy Research Institute (TERI)
Goa University (GOAU)
Government of India, Ministry of Agriculture, Department of Agriculture and Cooperation, Dept of Plant Protection, Quarantine and Storage (GOI-MOA-DOAC-DPPQS)
Government of West Bengal (GWB)
Govind Ballabh Pant University of Agriculture and Technology (GBPUAT)
Himachal Pradesh Agricultural University (HPAU)
Holy Cross Vocational Training Institute (HCVTI)
Indian Agricultural Research Institute (IARI)
Indian Council of Agricultural Research (ICAR)
Indian Farmers Fertiliser Cooperative Ltd (IFFCO)
Indian Statistical Institute (ISI)
Indira Gandhi Agricultural University (IGAU)
Institut Français de Pondichéry (IFP)
Institute of Rural Management (IRMA)
Institutional Linkage Village Program (ILVP)
Krishi Vigyan Kendra (KVK)
MAHYCO Research Foundation (MRF)
MS Swaminathan Research Foundation (MSSRF)
Nand Educational Foundation for Rural Development (NEFORD)
Narendra Deva University of Agriculture and Technology (NDUAT)
National Bureau of Plant Genetic Resources (NBPGR)
National Center for Agricultural Economics Policy Research (NCAP)
Orissa Agricultural University (OAU)
Orissa University of Agricultural Technology (OUAT)
Punjab Agricultural University (PAU)
Rajendra Agricultural University (RAU)
Ram Krishna Mission (RKM)
Seed Wing of the Indian Council of Agricultural Research (SWICAR)
Soil and Water Management Research Institute (SWMRI)
Swaminathan Association (SA)
Tamil Nadu Agricultural University (TNAU)
Tamil Nadu Rice Research Institute (TNRRI)
University of Agricultural Sciences (UAS)
University of Calcutta (UC)
Water Technology Center (WTC)
West Bengal Directorate of Agriculture (WBDA)
West Bengal Rice Research Station (WBRRS)

Indonesia

Agricultural Service Center, Central Java (DINAS-CentralJava)
Agricultural Service Center, West Java (DINAS-WestJava)
Assesment Institute for Agricultural Technology, North Sumatra (AIAT-NorthSumatra)
Assessment Institute for Agricultural Technology West Java (AIAT-WestJava)
Assessment Institute for Agricultural Technology, Central Java (AIAT-CentralJava)
Assessment Institute for Agricultural Technology, National (AIAT2)
Bogor Agricultural University (Institut Pertanian Bogor) (IPB)
Center for Agro-Socioeconomic Research (CASER)
Central Research Institute for Animal Sciences (CRIAS)
Confederation of ASEAN Journalists (CAJ)
Hassanudin University (HU)
Indonesia Agricultural Post Harvest Research Institute (IAPHRI)
Indonesian Agency for Agricultural Research and Development (IAARD (formerlyAARD))
Indonesian Center for Food Crops R & D, Bogor (ICFORD (formerlyCRIFC))
Indonesian Institute for Rice Research (IIRR)
National Seed Company (NSC)
Provincial Agricultural Services (Dinas Pertanian Tanaman Pangan Propinsi) (DINAS-Indonesia)
Research Institute for Food Crops and Biotechnology (RIFCB)
Seed Wing of the Ministry of Agriculture (SWMA)
Sukamandi Research Institute of Rice (SRIR)

Iran

Government of Islamic Republic of Iran (GIRI)

Japan

Aoyama Gakuin University (AGU)
Chiba University (CU)
Foundation for Advanced Studies on International Development (FASID)
Hokkaido University (HU)

Hokuriku National Agricultural Experiment Station (HNAES)
Hokuriku Research Center (HRC-Japan)
Japan International Cooperation Agency (JICA)
Japan International Research Center for Agricultural Sciences (JIRCAS)
Japan Rice Genome Program (RGP)
Kagoshima University (KU)
Kyushu National Agricultural Experiment Station (KNAES)
Kyushu University (KU)
Nagoya University (NU)
National Agricultural Research Center (NARC-Japan)
National Agricultural Research Center for Tohoku Region (NARCT)
National Agricultural Research Center for Western Region (WeNARC)
National Agriculture and Bio-Oriented Research Organization (NARO-Japan)
National Graduate Institute for Policy Studies (GRIPS)
National Institute of Agricultural Sciences (NIAS)
National Institute of Agro-Environmental Sciences (NIAES)
National Institute of Crop Science (NICS)
Oklahoma State University (Okla.SU)
Tohoku University (TU)
Tropical Agriculture Research Center (TARC)
Tsukuba University (TU)
University of Kyoto (UK)
Waseda University (WU)
Yamagata University (YU)

Korea

Farm Management & Information Office (FM-Korea)
International Technical Cooperation Center (ITCC,Korea)
National Agricultural Science and Technology Institute (NASTI-Korea)
National Crop Experiment Station,Rural Development Administration (NCES-RDA)
National Honam Agricultural Experiment Station (NHAES)
National Yeongnam Agricultural Experiment Station (NYAES)
Rural Development Administration (RDA)

Lao PDR

DED-German Development Service (DED)
Department of Agricultural Extension (DOAE-LaoPDR)
GTZ Bokeo Project (GBP)
Huay Khot Research Station (HKST)
Lao People's Democratic Republic (LAO)
Luang Namtha Research Station (LNRS)
Ministry of Agriculture and Forestry (MAF-LAOPDR)
NARC Rice Research Station (NRRS)
National Agriculture and Forestry Research Institute (NAFRI)
Phakse Rice Research Station (PRRS)
Phone Ngam Research Station (PNRS)
Savannkhet Provincial Department of Agriculture (SPDA-Lao)
Thasano Rice Research Station (TRRS)
World Vision Laos, Savanaketh Project (WV-SP)

Malaysia

Malaysian Agricultural Research and Development Institute (MARDI)
Universiti Pertanian Malaysia (Malaysia) (UPM)

Myanmar

Agricultural Corporation, the Socialist Republic of the Union of Burma (Union of Myanmar) (AC-SRUB)
Myanma Agriculture Service (MAS)
Yezin Agriculture University (YAU)

Nepal

Department of Agriculture, Government of Nepal (DOA-NEPAL)
Nepal Agricultural Research Council (NARC-Nepal)

Netherlands

C.T. De Wit Graduate School of Production Ecology and Resource Conservation of Wageningen University and Research Center (PRC)
Gene-Mine Project (GMP)
Groningen University (GU)
Nunza B. V. (NBV)
Plant Research International (PRI)
Wageningen University (WU)

Norway

Agricultural University of Norway (NLH)
United Nations Environment Program, Environment Assessment and Reporting Sub-Programme, Global Resources Information Database Component (UNEP-GRID)

Pakistan

National Agricultural Research Center (NARC-Pakistan)
Pakistan Agricultural Research Council (PARC)

Philippines

Basic Technology and Management Corporation (BTMC)
Bureau of Agricultural Statistics (BAS)
Bureau of Plant Industry (BPI)
Bureau of Postharvest Research and Extension (BPRE)
Central Luzon State University (CLSU)
Department of Agriculture (DA-Philippines)
Department of Science and Technology (DOST-PHIL)
Ecosystem Research and Development Bureau (ERDB)
Forest Products Research and Development Institute (FPRD)
Infanta Integrated Community Development Assistance, Inc. (ICDAI)
Leyte State University (LSU)
Mariano Marcos State University (MMSU)
Metal Industries Association of the Philippines (MIAP)
National Food Authority (NFA)
National Irrigation Administration (NIA)
National Post-Harvest Institute for Research and Extension (NAPHIRE)
Pampanga Agricultural College (PAC)
Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD)
Philippine Council for Aquatic and Marine Research and Development (PCAMRD)
Philippine Rice Research Institute (PhilRice)
Process Foundation (PF)
Seed Wing of the Department of Agriculture (SWDA)
Southeast Asian Ministers of Education Organization Regional for Study and Research in Center Graduate Agriculture (SEAMEO-SEARCA)
University of Southern Mindanao (USM)
University of the Philippines at Los Baños (UPLB)

Portugal

Institute for Biological and Experimental Technology (IBET)

Sri Lanka

Department of Agriculture (DOA-SriLanka)
Ministry of Agriculture and Land of Sri Lanka (MOALSL)
Rice Research and Development Institute (RRDI)
Rice Research Institute (RRI-SriLanka)
Seed and Plant Materials Division (SPMD)

Sweden

Stockholm School of Economics (SSE)
University of Lund (UL)

Switzerland

CIBA-GEIGY Limited (CIBA)
Swiss Federal Institute of Technology (Eidgenössische Technische Hochschule Zürich) (ETH)
Syngenta Foundation for Sustainable Agriculture (Syngenta)

Thailand

Asian Institute of Technology (AIT)
Chiang Mai University (CMU)
Chulalongkorn University (CU)
Chumpae Rice Research Station (CRRS)
Department of Agricultural Extension (DOAE-Thailand)
Department of Agriculture (DA-Thailand)
Kasetsart University (KU)
Khon Kaen Rice Research Station (KKRRS)
Khon Kaen University (KKU)
Kuvempu University (KU)
Ministry of Agriculture and Cooperatives (MOAC)
Pathum Thani Rice Research Center (PTRRC)
Phimai Rice Research Station (PRRS)
Phitsanulok Rice Research Center (PRRC)
Population and Community Development Association (PCDA)
Population and Development Association (PDA)
Prae Rice Research Center (PRRC)
Rice Research Center, Prachin Buri (RRC)
Rice Research Institute (RRI-Thailand)
Surin Rice Research Station (SRRS)
Thai Nguyen University (TNU)
Thai Nguyen University of Agriculture and Forestry (TNUAF)
Ubon Ratchathani University (URU)
Ubon Rice Research Center (URRC)

Timor Leste

United Nations Transitional Administration in East Timor, East Timor Transitional Administration (UNTAET-ETTA)

United Kingdom

CABI Bioscience (CABI)
Center for Land Use and Water Resources Research, University of New Castle upon Tyne (CLUWRR-UNT)
De Montfort University, Norman Borlaug Institute for Plant Science Research (DMU-NBIPSR)
Horticulture Research International (HRI)
Imperial College, University of London (IC)
John Innes Centre (JIC)
LION Bioscience AG (LION)
Natural Resources Institute (NRI)
Natural Resources International Limited (NRIL)
Silsoe Research Institute (SRI)
University of Birmingham (UB)
University of East Anglia (UEA)
University of Liverpool (UoL)
University of Manchester (MU)
University of Reading (UR)
University of Sheffield (US)

USA

Clemson University (ClemU)
Cornell University (CU)
Economic Growth Center, Yale University (EGC)
Fred Hutchinson Cancer Research Center (FHCRC)
Gramene Database Project (Gramene)
International Benchmark Sites Network for Agrotechology Transfer Prject (IBSNAT)
International Service for the Acquisition of Agri-Biotech Applications (ISAAA)
Iowa State University (ISU)
Kansas State University (KSU)
National Center for Genetic Resources Preservation (NCGRP)
Nitrogen Fixation by Tropical Agricultural Legumes (NIFTAL)
North Carolina State University (NCSU)
Ohio State University (OSU)
Ohio State University Research Foundation (OSURF)
Pennsylvania State University (PSU)
Perlegen Sciences, Inc. (PERLEGEN)
Purdue University (PU)
Research Corporation of the University of Hawaii (RCUH)
Soil Management Collaborative Research Support Program, North Carolina State University (TROPSOILS-NCSU)
Texas Tech University (TTU)
University of Arizona (UA)
University of California - Davis (UC-Davis)
University of Florida - Gainesville (UF-Gainesville)
University of Georgia (UG)
University of Hawaii (UH)
University of South Florida (USF)
University of Utah (UU)
University of Washington (UW)
USDA Salinity Laboratory (USDA-SL)
Virginia Polytechnic Institute and State University (VirginiaUniversity)
Williams College (WC)
Yale University (YU)

Vietnam

Agricultural Breeding Center, Baclieu (ABC)
Agricultural Extension Center, Baclieu (AEC-BacLieu)
Agricultural Extension Center, Cantho Province (AEC-Cantho)
Agricultural Genetics Institute (AGI)
Ang Giang University (AGU)
Can Tho University (CTU)
College of Agriculture and Forestry , Vietnam National University of Ho Chi Minh City (CAF-VNU)
Cuu Long Delta Rice Research Institute (CLRRI)
Department of Agriculture and Rural Development, Bac Lieu Province (DARD-Vietnam)
Department of Agriculture, Cantho Province (DA-Cantho)
Department of Science, Technology and Product Quality (DSTPQ)
Farming Systems Research and Development Institute (FSRDI)
Hanoi Agricultural University (HAU-Vietnam)
Information Center for Agricultural and Rural Development (ICARD)
Institute of Agricultural Sciences (IAS)
Institute of Biotechnology, Hanoi (IB)
Integrated Resources Mapping Centre (IRMC)
Mekong Delta Farming System Research and Development Insitute , Can Tho University (MDFSRDI-CTU)
Ministry of Agriculture and Food Industries (MAFI)
Ministry of Agriculture and Rural Development (MARD-Vietnam)
National Institute for Soils and Fertilizers (NISF)
National Institute for Agricultural Projection and Planning (NIAPP)
National Institute of Plant Protection (NIPP)
Plant Protection Department (PPD)
Seed Wing of the Department of Agriculture and Rural Development (SWDARD)
Sub-Institute of Water Resources Planning (SWIRP)
University of Agriculture and Forestry (UAF-Vietnam)
Vietnam Agricultural Science Institute (VASI)
Vietnam National University (VNU)
Voice of Ho Chi Minh Radio Broadcasting (VoiceofHoChiMinh)

International and Regional Organizations

Africa Rice Center (WARDA)
Agent Links European Network (ALEN)
Asia and Pacific Seed Association (APSA)
Asia Rice Foundation (ARF)
Caribbean Agricultural Research and Development Institute (CARDI)
Center for International Forestry Research (CIFOR)
Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)
Fondo Latinoamericano de Arroz de Riego (FLAR)
Food and Agriculture Organization of the United Nations, Rome, Italy (FAO)
International Atomic Energy Agency (IAEA)
International Board for Soil Research and Management (IBSRAM)
International Center for Research in Agroforestry (World Agroforestry Center) (ICRAF)
International Center for Research in the Semi-Arid Tropics (ICRISAT)
International Center for Soil Fertility and Agricultural Development (IFDC)
International Centre for Insect Physiology and Ecology (ICIPE)
International Centre for Tropical Agriculture (CIAT)
International Fertilizer Association (IFA)
International Food Policy Research Institute (IFPRI)
International Institute for Rural Reconstruction (IIRR)
International Livestock Research Institute (ILRI)
International Plant Genetic Resources Institute (IPGRI)
International Potash Institute (IPI)
International Potato Center (CIP)
International Water Management Institute (IWMI)
Systemwide Genetic Resources Program , IPGRI (SGRP)
WorldFish Center (WorldFish)