Report of the Director General, 2002-03

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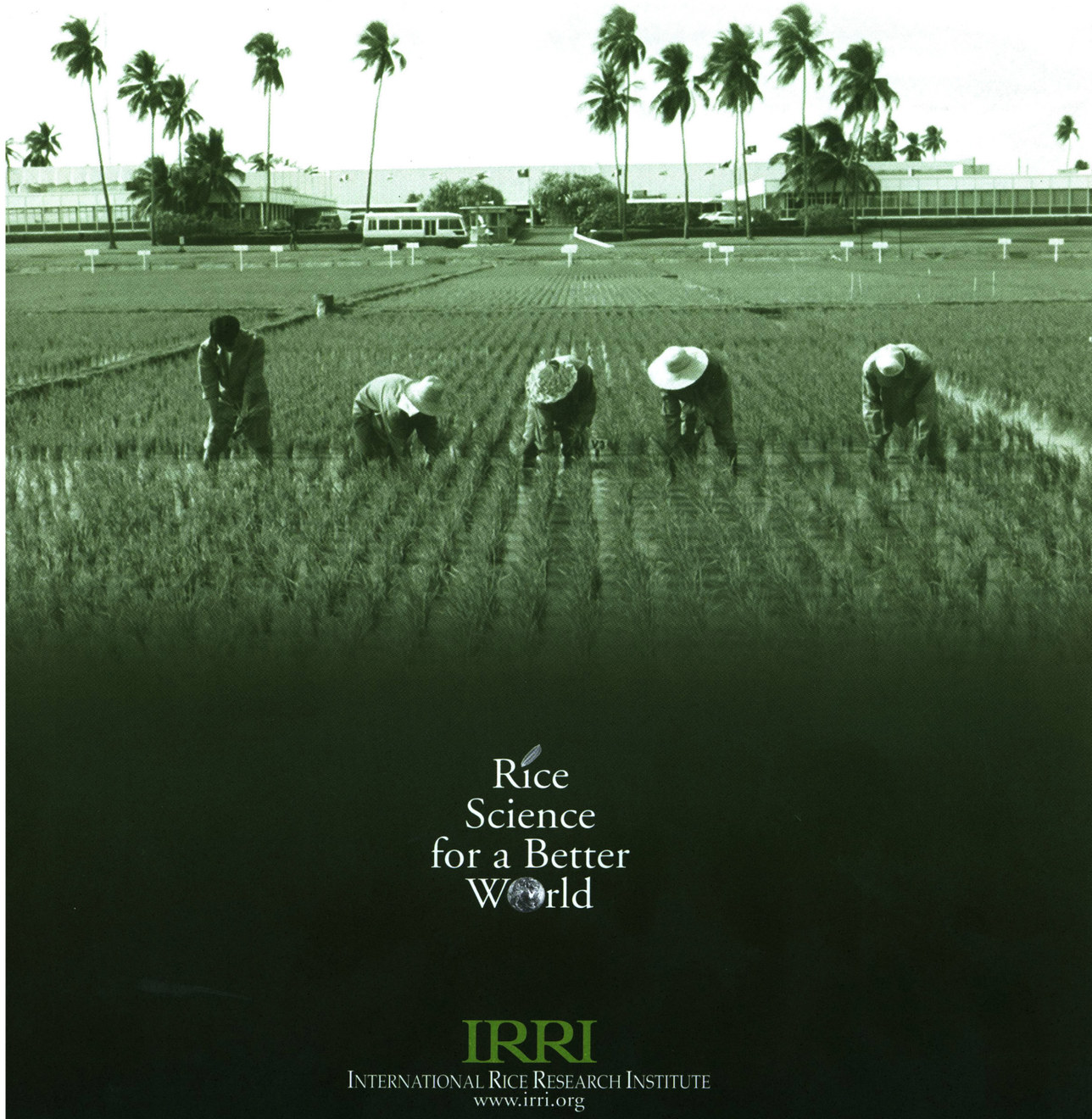

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IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE
DAPO Box 7777, Metro Manila, Philippines

Report of the Director General 2002–03 Volume 13

Contents

A message from the director general's office

IRRI retrenchment program 2002

Following official confirmation of a substantial core-funding cut of 48.8% in early 2002 by Japan—IRRI's biggest and most important donor—the IRRI BOT in April 2002 approved a nationally recruited staff (NRS) retrenchment program as part of a comprehensive remedial strategy aimed at restoring the Institute's financial equilibrium and a balanced budget by 2004.

Before proceeding to implement the retrenchment program, IRRI obtained the appropriate legal advice to ensure that it strictly complied with all the requirements of the Philippine labor laws by (1) approving a multiplier (a factor times the number of months' salary paid as separation per year of service) higher than the legal requirement of 0.5 month for every year of service; and (2) implementing a grievance procedure that included the creation of an appeals committee although no such mechanism is legally required.

On 30 September 2002, 165 NRS in Los Baños and eight NRS in Thailand officially were separated from IRRI. The Institute spent a total of Php 194,335,843 to retrench these 173 NRS. This amount includes payouts corresponding to the accumulated retirement fund share and the unused vacation/sick leave credits of the retrenched staff. The implementation of the retrenchment program brought the total number of remaining NRS at IRRI down to 688.

In addition, up to 15 internationally recruited staff (IRS) positions were eliminated as part of the budget reduction measures. Eight of these positions had become vacant in 2002, and the remainder will have been abolished by the end of 2003. Unlike for the NRS, there is no separation payment for the IRS. IRS positions, including scientists, postdoctoral fellows, and graduate students, will have dropped from 150 to 135 by the end of 2003.

A detailed document on the *IRRI retrenchment program 2002* is available. It provides an overview as well as information on the rationale, the process and related issues, the retrenchment package, financial and human resource profiles, and employee assistance programs that were provided.

International Rice Congress

Delegates to the International Rice Congress (16–20 September 2002) in Beijing were universal in their praise for the event, which has been described by many as one of the most important and influential in IRRI's 42-year history. The President of China, His Excellency Mr. Jiang Zemin, graced the opening ceremony of the Congress on 16 September, giving a powerful speech on the importance of international collaboration and agricultural research. More than 1,000 delegates from more than 20 countries attended the Congress's three main events: the International Rice Research Conference (800 delegates), the World Rice Commerce Conference (200 delegates), and the International Rice Technology and Cultural Exhibition (40 exhibitors). The annual meeting of the Council of Partnerships for Rice Research in Asia (CORRA) and the Program Committee meeting of the IRRI BOT were also held.

In addition to this, the ministers of agriculture (or their representatives) from 13 rice-producing nations attended the first-ever International Roundtable on Rice on 15 September. During this historic meeting, they endorsed a draft of the *Beijing Declaration on Rice*. The ministers unanimously called for the

The Beijing Declaration on Rice

The following statements on rice were discussed at the 1st Ministerial Roundtable on Rice held on Sunday, 15 September 2002 as part of the International Rice Congress in Beijing, China. The Roundtable was chaired by His Excellency, Mr. Du Qinglin, the Chinese Minister of Agriculture and was attended by 12 other ministers and national representatives. The following statements are considered non-binding and for general agreement only:

- Rice production is the foundation of food security and social stability for almost half the world's population (2.6 billion people). It is essential to the national stability of the 13 nations represented at the roundtable.
- Rice production and consumption are national characteristics uniting the 13 countries represented at the Roundtable, which include three of the world's largest nations: China, India, and Indonesia.
- The 13 nations represented at the Roundtable all seek economically strong and sustainable rural communities with diversified rice production playing a key role. Such communities are also recognized as the foundation of each nation and essential to their continued national development
- Rice research and access to new technologies are essential to the livelihoods and improved well-being of more than half the world's rural families, as well as the development of economically strong rice-based communities.
- The public sector must have a major role in such research and the development of new, freely available rice technologies. It is also essential that the public sector—in both national and international research—be guaranteed the resources it needs to play this vital role. While the private sector must also play a role, the poverty of most rice producers and consumers make it essential that any new technologies are made easily accessible to all those who need them.
- More must be done to make the citizens—especially the young people—of the 13 nations represented at the Roundtable more aware of the importance of rice to their lives and their cultures.

Declaration to be further developed and strengthened by IRRI (see final wording in box at left) and then sent to them for official endorsement. To date, Indonesia, Laos, Myanmar, and the Republic of Korea have officially endorsed the Declaration. Official endorsement by the remaining nine countries (Bangladesh, Cambodia, China, India, Iran, Malaysia, Sri Lanka, Thailand, and Vietnam) is expected soon, not to mention endorsement by rice-growing countries that did not represented during the roundtable, such as the Philippines, which has already endorsed the Declaration.

Clearly, the Congress was a great success and provided IRRI with many excellent opportunities to further develop and expand its already strong relationships across Asia. Most of all, it greatly boosted international recognition and support for rice research. Activities and statements during the Congress were covered heavily in the international media.

CGIAR AGM in Manila

Manila was the venue for the 2002 annual general meeting of the CGIAR, marking the first time this gathering of 500 movers and shakers in publicly funded agricultural research has taken place outside of Washington, D.C. The AGM was held at the Makati Shangri-la Hotel, 30 October–1 November, with the theme "Agriculture for growth and development."

IRRI and its partners in the Los Baños Science Community seized the chance to invite delegates to journey south from Manila on 28 October for a Philippine Day program and again on 29 October for IRRI Day. More than 280 visitors braved heavy rains to board buses for IRRI Day and were rewarded by gloriously fresh weather upon arrival at the Institute's 252-ha experimental farm. Many visitors stated that IRRI Day was the best field day they had ever attended. Visitors spoke of the guides' and presenters' enthusiasm and good humor and of the focused presentations. Truly, this was one of the biggest events in IRRI's recent history!

Key changes for IRRI staff and BOT

Since the last *DG Report*, a number of key IRRI international staff members have arrived or departed. In June, **Tanguy Lafarge**, joined Crop, Soil, and Water Sciences (CSWS) as an IRS seconded from CIRAD (Centre de coopération internationale en recherche agronomique pour le développement). In August, **Nigel Ruaraidh Sackville Hamilton** assumed his duties as head of the Genetic Resources Center. In September **Kwame Akuffo-Akoto** arrived as the new director of finance, replacing **Gordon MacNeil** (1998–2002) who resigned in July. Mr. Akuffo-Akoto had served as ICRISAT's director for finance and administration since 1996. In February 2003, **Stephan Haefele** joined CSWS as soil scientist-agronomist.

In addition to Mr. MacNeil, other departing staff members included **Virendra Pal Singh**, agronomist in CSWS (1989–2002); **Thomas George**, IRS seconded from NifTAL in CSWS (1989–2002); **Surapong Sarkarung**, plant breeder in PBGB (1991–2002); **Leonard John Wade**, crop physiologist/agronomist in CSWS (1993–2002); **Stephen Robert Morin**, anthropologist in the Social Sciences Division (1997–2002); **Hiroyuki Hibino**, liaison scientist for Japan (1999–2003); **Madduma P. Dhanapala**, affiliate scientist in PBGB (2000–02); and **Barney Caton**, affiliate scientist in CSWS (2000–02).

Also, we welcome to the IRRI BOT **Luis P. Lorenzo, Jr.**, who as the new secretary of agriculture in the Philippines, replaced **Leonardo Q. Montemayor** (2001–02) as an ex officio member.

For a complete listing of staff arrivals and departures for 2002, which includes postdoctoral fellows and international research fellows, see page 77.

GRC transfers to DDG-R

In 2002, IRRI management approved and announced the transfer of the Genetic Resources Center (GRC) from the office of the Deputy Director General for

Partnerships (DDG-P) to the office of the Deputy Director General for Research (DDG-R). This move has enhanced the interaction of the GRC with other research staff and streamline the management of germplasm-related activities with breeding, resource management, and informatics research. Edwin Javier, who assumed (as of 1 July 2002) the position of upland rice breeder in PBGB, has continued as the INGER coordinator.

Institute environmental agenda being developed

In line with making sure that the new doubly green revolution in Asia will have an environmental emphasis on the "green," IRRI is developing an environmental agenda (IEA) that covers both its research and its local community relations. Few issues attract more public attention or resources than the environment. However, despite the enormous potential for both positive and negative impacts on the environment, few people make any connection between the environment and rice production and research. Clearly, there is a wide range of very important international issues closely connected to rice and the environment. The IEA spells out the problem, current progress, and future strategy for each of six issues (poverty and human health, land use and degradation, water, biodiversity, farm chemicals, and climate change). In addition, the IEA will not only heighten the awareness of these international issues among the Institute's staff, but it will also promote community spirit through environment-friendly initiatives at the local level.

Research highlights

This *DG report* highlights achievements for the 12 projects in IRRI's MTP for 2003–05. Although more detailed summaries, by project, begin on page 9, some items of particular interest include

- ***Project 1:*** We identified a core collection of 10,159 accessions using a semi-stratified selection scheme. The collection contains 9,559 *Oryza sativa* samples and includes special-purpose sets. Strictly random selection has identified 157 accessions of the *O. glaberrima* species of African cultivated rice and 443 accessions of wild *Oryza* species. To date, more than 4,000 accessions have been processed, establishing a "tissue bank" of freeze-dried leaves for high-throughput genomic DNA production.
- ***Project 2:*** We identified novel mutations that provide new opportunities for the genetic manipulation of agronomic traits. Screening knockout mutants for tolerance of multiple stresses (disease, drought, and submergence) revealed a considerable number of "gain-of-function" mutations, suggesting that suppressor genes may commonly play a role in regulating complex traits. Identifying these genes will open up opportunities for enhancing the performance of plants regarding target traits by, for example, neutralizing suppressor genes.
- ***Project 3:*** We improved the agronomic management package of hybrid rice and demonstrated that hybrid rice provides a better opportunity than the new plant type (NPT) to break the yield barrier. Among five hybrids grown in the dry and wet seasons, IR73868H achieved a maximum yield of 10.5 t/ha, which was 7% greater than the maximum yield attained by an NPT line.
- ***Project 4:*** In China, we identified new N management strategies, with considerable promise in reducing loss of N fertilizer to the environment, and are now ready for wider scale on-farm evaluation. Also, through on-farm evaluation of the leaf color chart (LCC) for four seasons in Bangladesh, we confirmed that it was ready for wider scale evaluation and promotion through the country's extension program.
- ***Project 5:*** We released ORYZA model software and data files for potential, water-limited, and nitrogen-limited rice production.

Welcomed by many scientists, the model supports the analysis of field experiments and extrapolates the results to other environments.

- ***Project 6:*** Our Nutrient Management or Reaching Toward Optimal Productivity (RTOP) and Water Savings workgroups conducted needs-and-opportunities assessments (NOAs), with assistance from the Achieving Impact workgroup. This resulted in modifications of research and extension activities in the work plans. The NOAs improved the ability of the workgroups to (1) focus demand-driven research on emerging problems, (2) strengthen extension strategies for promoting successful technologies in target areas, and (3) examine policy interventions that enhance technology adoption. Also, the Irrigated Rice Research Consortium (IRRC) launched its new Web site (www.irri.org/irrc) during the International Rice Congress in Beijing. IRRC success stories are posted on the site to demonstrate how research in irrigated rice leads to technologies that benefit Asian rice farmers.
- ***Project 7:*** Rice lines developed through the Rainfed Lowland Shuttle Breeding Network in eastern India are now a major source of material in advanced trials. Many of the lines have been evaluated on-farm in IRRI-led participatory varietal selection (PVS) trials and they are highly preferred by farmers and are likely to be widely accepted by them over the next 3–5 years.
- ***Project 8:*** In Bangladesh, we applied participatory approaches to earlier research findings on seed health, thereby increasing farmers' awareness that using clean seeds can fortify crops against disease and boost yields by 12–14%. Farmers, including women, can easily manage this simple intervention. We established procedures of seed selection prior to harvest, trained key farmers during the wet season, and are now assessing the quality of harvested seed. Meanwhile, we are testing farmers' indigenous knowledge on seed storage and comparing this with inputs from scientists.
- ***Project 9:*** We restructured the former Rainfed Lowland Rice Research Consortium (RLRRC) and Upland Rice Research Consortium (URRC) into a single consortium called the Consortium for Unfavorable Rice Environments (CURE). Hosted by the Indian Council of Agricultural Research, members of the CURE steering committee conducted their first meeting in June and are now set to (1) provide focus on identifying and prioritizing research in unfavorable environments that will have impact in farmers' fields; (2) enhance strategic IRRI-NARES research collaboration, resource-sharing, and information exchange; and (3) encourage participatory development and testing of technologies in partnership with farmers.
- ***Project 10:*** In 2002, we developed key policy recommendations to facilitate wider adoption and commercialization of hybrid rice technology. These included (1) continued adoption of hybrid rice development as a national policy within a country's food security agenda, (2) budget support for research to overcome technical problems and for extension to increase public awareness on hybrid rice, and (3) fomenting a policy environment that encourages strong participation by the private sector and other stakeholders and interest among farmers to cultivate hybrid rice. Successful dissemination and adoption of hybrid rice on a wider scale will result in not only more rice production but also more employment and improved welfare, especially among rice farmers and seed growers in rural areas.
- ***Project 11:*** In the Red River Basin, our project there contributed actively to events tied to the International Year of the Mountain (IYM2002) convened by the FAO in Vietnam. Our achievements were published in a compendium, *Success stories from the mountains of Vietnam*: *a collection of lessons learned and case studies of successful rural development*. In the

Mekong River Delta, we updated the database on changes in agro-hydrology, land use, and farmer livelihood. We applied a hydraulic and salinity model, using 2002 water quality monitoring data, to help the provincial government of Bac Lieu identify sluice operation scenarios for managing a dual saline/freshwater regime. This will allow rice intensification in the eastern part of the study area and shrimp raising in the western part.

- ***Project 12:*** We developed the Rice Knowledge Bank (www.knowledgebank.irri.org) and officially launched it during the International Rice Congress in Beijing. This site's contents, which have grown to include 20 reference guides, 2 decision support tools, 2 e-learning courses, 5 knowledgebytes, and more than 450 learning materials, lay the benefits of more than four decades of IRRI research at the fingertips of users. We aim to make this dynamic Internet portal the world's central repository of rice knowledge and training materials.

Some significant events since last *DG Report* in 2002, early 2003

Collaboration with Lao PDR. IRRI and the Lao People's Democratic Republic reaffirmed their collaboration in rice research, production, and training during the visit of His Excellency Prime Minister Boun-nhang Vorachith to the Institute on 30 April. IRRI and Laos have had a long history of collaboration, particularly through the Lao PDR-IRRI Project. During 24–28 June, the IRRI director general made a reciprocal visit to the Lao-IRRI Project, where he saw firsthand research under way to identify farmer constraints and develop some technologies that could improve farmer livelihoods in the uplands. With the signing of an agreement between the Government of Switzerland and IRRI for a second phase of the Lao PDR Rice Biodiversity Project, work on rice biodiversity will be continuing in the country. Phase 2 aims to ensure that indigenous rice biodiversity and associated farmer knowledge are conserved, documented, and used by researchers, extension workers, and farmers. This will improve the livelihoods of Lao rice farmers and the sustainability of their rice-based farming systems.

Fourth hybrid rice symposium. One of the most valuable developments in the modern history of rice production was the focus of the *4th International Symposium on Hybrid Rice* held 14–17 May in Hanoi, Vietnam. With the theme *Hybrid vigor in rice for food security, poverty alleviation, and environmental protection*, the participants, including representatives from public, private, and NGO seed companies, discussed the current status and future prospects of developing and disseminating hybrid rice technology. The symposium also included a special session on public- and private-sector partnership for hybrid rice commercialization.

Thai trade delegation visits. IRRI-Thailand collaboration in rice research and production was improved and expanded with the visit to the Institute of a high-powered Thai trade delegation on 4–6 June led by Prachuab Chaiyasan, trade representative and former foreign minister of the Kingdom. Acting on specific instructions from Prime Minister Thaksin Shinawatra, Mr. Chaiyasan and his delegation took special interest in IRRI's current research agenda, the rice genome, the new plant type (NPT), and progress in biotechnology.

IRRI and RDA co-organize training on rice technology transfer. For the first time in 40 years of partnership, IRRI and Korea's Rural Development Administration (RDA) co-organized a training workshop on *Rice Technology Transfer Systems in Asia.* The workshop began on 30 September at RDA, Suwon, Republic of Korea. Nineteen participants from Bangladesh, Cambodia, China, Indonesia, Lao PDR, Myanmar, Philippines, Republic of Korea, Sri Lanka, Thailand, and Vietnam attended through 12 October. In his opening remarks, Dr. Kim Young-Wook, deputy administrator of RDA, said the workshop was organized in recognition of the common objective of RDA and IRRI to develop human capability in Asia to help alleviate poverty through increased rice productivity and profitability.

USAID and IRRI co-sponsor food security conference. During 29 September–5 October, the United States Agency for International Development (USAID) and IRRI co-sponsored an *Asia and the Near East Agriculture and Food Security Workshop* held at the Shangri-la Hotel in Manila and at IRRI. The workshop provided an opportunity for more than 70 USAID agriculture, environment, and food aid officers across Asia and the Near East to hear from leading experts in a variety of fields ranging from agricultural research to trade competitiveness. Discussions promoted further development and implementation of a new Asia/Near East strategy for USAID. The workshop participants spent one entire day at IRRI headquarters to hear presentations from scientists in the fields and laboratories.

Cross IR80000 made. Consecutive numbering of crosses is the odometer of the IRRI plant breeding program, and in 2002 it clicked over a whole bunch of zeros with the birth of cross number IR80000. The new F_1 cross, which reached maturity in early September, was seeded on 24 June and transplanted on 16 July. Plant breeders at the Institute began making crosses soon after IRRI's founding in 1960. It took until 1976 to clock up the first four-zero cross, IR10000. Breeders churned out the next four crosses numbered with four zeros at 2-year intervals, with IR50000 appearing in 1984. Then the pace slowed down again. It was 4 years before IR60000 saw the light of day in 1988. IR70000 was made in 1994, after a gap of 6 years, and then it took fully 8 years to reach IR80000. At the current pace, it will take at least a decade before we reach IR90000. Some observers blame the slowdown in crossing rate on successive staff reductions. The breeders insist, on the contrary, that it shows they are getting better at their job and reducing the number of unnecessary, dead-end crosses.

IRRI-NIAS partnership opens new chapter in gene discovery. IRRI entered into a landmark research and capacity-building agreement on 19 December with Japan's National Institute of Agrobiological Sciences (NIAS), paving the way for the next stage of discovery revealing the genetic makeup of rice. The partnership promises to unlock the secrets of functionality in the recently sequenced genome of the world's main food grain, determining which genes strengthen plants against drought, problem soils, diseases, and pests—and to do so for the benefit of the poor rice farmers and consumers. The memorandum of agreement came into force when it was signed in Tokyo by the IRRI Director General and NIAS President Masaki Iwabuchi. It sets the terms for a 5-year IRRI-NIAS collaboration designed, in the words of the agreement, "to apply genomics science and technologies to discover genes of agronomic interest, especially those involved in stress tolerance, and to build human resources that will enhance international partnerships in agricultural research and development in the developing world."

Office closure marks start of new era in IRRI-Japan relationship. February 2003 marked the start of a new era in IRRI-Japan ties with the refocusing of this important relationship not only on continued close research collaboration, but also on efforts to expand into other areas such as new resource mobilization opportunities and heightened public awareness. On 31 January 2003, IRRI's liaison scientist in Japan, Dr. Hiroyuki Hibino, formally retired from his position—the same time as the official closure of the old IRRI-Japan office in Tsukuba. The success and impact the office had achieved over the years in Japan showed clearly the important role that Dr. Hibino had played and for this IRRI is grateful. In the short term, IRRI's main contacts in Japan are the two Japanese members of the BOT, Drs. Keijiro Otsuka and Shigemi Akita.

Visitors to IRRI decrease somewhat

In 2002, we welcomed 55,909 visitors, a decline of 5,416, or 11% from the 61,325 in 2001. Among distinguished visitors were 17 high government officials, including His Excellency Prime Minister Boun-nhang Vorachit of the Lao People's Democratic Republic; the Australian and Bangladeshi ministers of agriculture; the Japanese minister of foreign affairs; a top Philippine

presidential adviser; seven members of the Philippine Congressional Committee on Agriculture, Food, and Fisheries; a provincial governor of Papua New Guinea; and a four-member delegation from the Federated States of Micronesia. Among diplomatic visitors were the ambassadors to the Philippines of India, Cuba, Japan, South Korea, and Bangladesh and a consul of Belize. See the table on page 91, which provides the details on 19 regional and international conferences, workshops, and symposia hosted or co-hosted by IRRI and attended by 1,159 representative delegates from 59 countries.

2004 declared International Year of Rice
On 16 December, the 57th Session of the UN General Assembly adopted the year 2004 as the International Year of Rice (IYR) and invited FAO to facilitate the implementation of the IYR. FAO has since hosted a global consultation meeting to discuss and develop a global program for the implementation of events throughout the IYR. IRRI, of course, will be heavily involved in these activities.

Awards and honors
IRRI received recognition as an institution twice in 2002:

- On 21 October during the first-ever International Conference on Wild Rice (ICWR) hosted by the Green Energy Mission (GEM) in Kathmandu, Nepal, a "felicitation" was presented to IRRI by the Honorable Badri Prasad Mandal, deputy prime minister of Nepal and minister for agriculture and cooperatives. A framed letter to IRRI from Dr. Gyan Shresta, chief executive of GEM/Nepal and chairman of the ICWR, congratulates IRRI for "its significant contribution to global rice biodiversity conservation and rice crop improvement throughout the world."
- On 10 November, during its 20th anniversary celebration in Manila, the Pilipinas Shell Foundation Inc. (PSFI) presented IRRI with an award for sharing PSFI's mission. Pilipinas Shell and IRRI have been working jointly in the formidable task of enabling disadvantaged farmers to become responsible and productive members of society, aided in part through salt-tolerant and tungro-resistant rice lines. To mark its anniversary, PSFI gave plaques and awards of recognition to many of its collaborators, beneficiaries, and benefactors. PBGB assistant scientist Joe Roxas accepted IRRI's award on behalf of the Institute.

A group of IRRI researchers won the CGIAR Outstanding Scientific Support Team Award during the CG's annual general meeting in Manila in late October. Their research—praised by *The New York Times* as a "stunning success"—allows farmers to boost their income while controlling a major rice disease with fewer applications of polluting chemicals. Their project—which has operated mainly in China but is now expanding into other countries—is called *Exploiting Biodiversity for Sustainable Pest Management*. The team winners were Alice Bordeos, Mel Revilla, Vivay Salazar, Nancy Castilla, Santy Culala, Abe Ona, Mayette Baraoidan, Florencio Balenson, Max Banasihan, Flavio Maghirang, and Nollie Vera Cruz. The award was presented by CGIAR Chairman Ian Johnson. This makes two years in a row that a Filipino support team at IRRI has won this significant CGIAR award, which last year went to the Institute's hybrid rice breeding team.

As in every year, numerous IRS and NRS received various awards and honors. See the complete listing of staff awards and honors beginning on page 61.

Ronald P. Cantrell
Director General

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

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 2002

Output 1: Conserve and characterize rice and biofertilizer genetic resources
Researchers are now using new molecular techniques to describe diversity and to identify novel alleles affecting important traits. Defining a core collection of the International Rice Genebank Collection serves as the entry point to mining it for alleles (cataloging existing alleles) useful for variety improvement. The choices made and strategy used to create the core collection determines the range of alleles in this set available for mining.

In 2002, we identified a core collection of 10,159 accessions using a semi-stratified selection scheme. The core collection contains 9,559 *Oryza sativa* samples and includes several special-purpose sets of germplasm previously defined by others. Strictly random selection has identified 157 accessions of the *O. glaberrima* species of African cultivated rice and 443 accessions of wild *Oryza* species. To date more than 4,000 accessions have been processed, establishing a "tissue bank" of freeze-dried leaves for high-throughput genomic DNA production. By early 2003, we will have processed more than 2,500 genomic DNAs, establishing a DNA bank for the core set.

Knowledge of the genetic diversity of wild and cultivated rice facilitates rice-improvement programs through better understanding of population structures. In August, we completed morphological and molecular studies on the wild species *O. officinalis* showing genetic divergence of populations according to their geographic distribution. Within the *O. officinalis* complex, both tetraploid and diploid species occur; furthermore, in some instances, tetraploid accessions have been attributed to a diploid species and, possibly, vice versa. These molecular and mophological studies seek to clarify ambiguous taxonomic placements. While morphologically similar, the tetraploid *O. officinalis* differed from the diploid form at the molecular level, indicating the need to confirm the taxonomic status of each accession in the complex. For this purpose, we have initiated molecular characterization using simple sequence repeat primers for accessions within the complex. We also started morphogical characterization of two other wild species in this group, *O. eichingeri* and *O. rhizomatis*.

Contributing to efforts to make rice more nutritious, we extended our search for rice accessions with naturally occurring beta-carotene, or pro-vitamin A. We did this by searching variety names listed in the International Rice Genebank Collection Information System (IRGCIS) for 148 words in various

languages meaning "yellow," "gold," or "orange," which may signify beta-carotene content. The search identified 4,623 accessions for screening.

Output 2: Exchange rice germplasm and evaluate it internationally

Farmer access to well adapted, pest-resistant, and high-yielding rice varieties is the key to meeting the challenge of efficient and profitable rice production. The organized exchange and dissemination of improved rice germplasm and genetic donors is the role of the 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 or that have been developed with parents 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 breeders and rice farmers.

In 2002, we identified the best entries from the INGER ecosystem-oriented and stress-tolerance nurseries that we had distributed to NARES in 2000. The breeding programs of 14 countries used 353 entries from the 2000 INGER nurseries as parents in their breeding programs, and 13 NARES further evaluated 316 promising entries from the 2000 INGER nurseries in advanced yield tests. We composed 10 types of INGER nurseries for 2002 and distributed 392 sets to 25 countries. Looking ahead, we processed and made ready for distribution to global cooperators 317 sets of 11 types of INGER nurseries for 2003. This ongoing process strengthens NARES' breeding programs with a continuous supply of elite germplasm from various sources.

In South Korea 2-5 July, INGER participated in the review of the rice technical guidelines for distinctness, uniformity, and stability testing that were formulated by the International Union for the Protection of New Varieties of Plants (UPOV).

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.

June 2002 saw the first version of the IRIS Web interface released internally and on the Internet (www.iris.irri.org). IRIS is now integrated into the new IRRI Rice Knowledge Bank (www.knowledgebank.irri.org), from where it will provide a single portal accessing all of IRRI's genetic resources and germplasm information. To this end, internal consultations have begun between the curators of the IRIS, IRGCIS, and INGERIS (INGER Information System) databases to consolidate them for integrated access.

IRIS is being developed to integrate genealogical and phenotypic information with genetic and molecular characterization contained in local databases and in international bioinformatic resources. Genealogy information on 1.1 million rice accessions, cultivars, and breeding lines from all over the world is available in the Genealogy Management System (GMS) or IRIS; more than 5 million pieces of information from 600 studies are available in the Data Management System (DMS). The IRIS Web interface and stand-alone CD make vast amounts of information on rice genetic resources, germplasm development, and evaluation available to rice researchers worldwide. Further

improvements will make it easier for users to query IRIS in more complex and useful ways.

Summary of next step activities in 2003

Output 1: Conserve and characterize rice and biofertilizer genetic resources

- Refine the "core" collection to include lines nominated by plant breeders and NARES, and use a stratified selection scheme to refine selection of *O. glaberrima* and wild species accessions.
- Test new methods for data-mining the IRGCIS.
- Process >400 accessions per month to complete the "tissue bank" and the "DNA bank."
- Continue seed production and accession purification during the remainder of DS2003 and in WS2003 and initiate evaluation studies for abiotic and biotic stresses and nutritional evaluation in collaboration with the appropriate experts (physiologists, pathologists, and plant breeders).
- Conduct DNA fingerprinting of all accessions in the *officinalis* complex and hybridize selected accessions to confirm their genomic constitution and taxonomic status.
- Clarify taxonomic status of accessions identified as *Oryza spp*. in the IRGC.

Output 2: Exchange rice germplasm and evaluate it internationally

- Continue participating in the revision of the rice technical guidelines.
- Evaluate promising entries in 2001 and 2002 yield nurseries in farmers' fields.

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

- Develop plans to migrate all functions of IRGCIS and INGERIS to IRIS thereby consolidating IRRI's germplasm databases for improved integration, quality, and efficiency.
- Continue to improve ICIS breeders' applications through collaboration with Nunza B.V. in the Netherlands and develop applications for the management of molecular information in collaboration with the European Gene-Mine project.
- Continue improvements to the stand alone applications and the Web interface to make it easier for users to query IRIS in more complex and useful ways and to retrieve information that would not be available through other means.

Partners

- **NARES:** In South and Southeast Asia, southern Africa, Australia, and Brazil for joint germplasm conservation and characterization activities, and worldwide for germplasm evaluation and documentation activities.
- **ARIs:** Institutions undertaking rice research worldwide; IRD, France; the University of Birmingham, UK; NSSL, USA; University of Adelaide, Australia.
- **CGIAR Centers:** Members of CGIAR Systemwide Genetic Resources Program for genetic conservation; WARDA and CIAT for INGER; and CGIAR centers involved in the development of ICIS for all CGIAR-mandated crops.
- **Private Sector:** Fondo Latinoamericano de Arroz de Riego (FLAR) in Latin America.

IRRI contact

Dr. Graham McLaren, biometrician and head, Biometrics and Bioinformatics Unit, g.mclaren@cgiar.org.

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

Project summary and highlights

Genetic resources conservation, evaluation, and gene discovery

Project 2: Functional genomics

THE PROJECT

A rice plant grows as the result of inactions combining its genes and developmental processes and the surrounding environment. Rice breeding relies on a thorough understanding of the biology of rice plant and these complex interactions. 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 complete 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 such manufactured genetic resources as knockout mutants (in which certain genes are disabled), 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 the obvious candidate to undertake this important task on behalf of publicly funded rice researchers and 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 2002

Building genetic stocks

IRRI now has a large stock of genetic material available for use in gene discovery. By the end of 2002, the Institute had produced 49,000 mutants of rice variety IR64 induced by chemical and irradiation mutagenesis (forced mutation). These deletion and point-mutant stocks are the largest mutant collection of indica rice in the world. We have developed high-throughput genotyping techniques for efficiently identifying gene function, by both

forward and reverse genetics, and have distributed to many parts of the world more than 9,000 mutant lines for phenotypic (gene-expression) screening and reverse genetics. We have produced many introgression lines and chromosomal-substitution lines derived from diverse gene pools to capture the functional diversity of rice germplasm in accessible form. All stocks are publicly available for functional evaluation.

In 2002, we identified novel mutations that provide new opportunities for the genetic manipulation of agronomic traits. Screening knockout mutants for tolerance to multiple stresses (disease, drought, and submergence) revealed a considerable number of "gain-of-function" mutations, suggesting that suppressor genes may commonly play a role in regulating complex traits. Identifying these genes will open up opportunities for enhancing the performance of plants regarding target traits by, for example, neutralizing suppressor genes.

We identified candidate genes for stress tolerance by integrating data on genetic makeup, phenotype, and proteomics (proteins and their role). Integrating functional data on genetic stocks, mapping, physiological, and proteomics analyses helps us draw up a shortlist of candidate genes conferring stress tolerance. Oxalate oxidase, SAM synthetase, putative aspartyl protease, and 14-3-3 proteins are strong candidates for contributing large phenotypic effects toward resistance to diseases and tolerance to drought and submergence.

Improved infrastructure and facilities

IRRI's Gene Array and Molecular Marker Application (GAMMA) laboratory became operational in 2002, providing a research-and-training facility not only for IRRI but also for its partners in the national agricultural research and extension systems. We can now apply gene array technology in IRRI's research programs, and we have produced and distributed to collaborators more than 130 arrays containing disease-defense genes. In addition, IRRI contributed 8,000 clones with unique expressed-sequence tags to the University of Illinois' effort to develop high-density gene arrays of 16,000 genes. IRRI has become a focal point for producing and distributing trait-based diagnostic arrays to collaborators.

We established on the IRRI intranet a comprehensive database on trait-directed genetic mapping, mapping populations and gene discovery. Now available within IRRI for data-mining are extensive bioinformatics tool kits as well as drafts of rice genome sequences produced by the International Rice Genome Sequencing Project and the Beijing Genomics Institute. The infrastructure and in-house bioinformatics capacity now in place at IRRI enable the Institute to capitalize on the wealth of plant genomics information being released worldwide.

New partnership

Looking forward, the Rice Functional Genomics Working Group held a meeting on 18 September during the International Rice Congress in Beijing. Participants widely endorsed the concept of forming an international consortium for rice functional genomics, thereby setting the stage for this vital development. IRRI will work with the international community to form a steering committee to establish the collaborative agenda, time-bound targets and guiding principles of collaboration. We expect to organize a committee meeting early in 2003 to formalize the consortium.

SUMMARY OF NEXT STEP ACTIVITIES IN 2003

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

- Disseminate mutant stocks widely for phenotypic screen.
- Improve documentation and characterization of allelic series of different mutants.

- Distribute superior introgression lines for testing in target environments.

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

- Continue to improve the quality of microarrays and reduce the cost of printing and processing microarrays.
- Apply the TILLING (Targeting induced local lesions in genomes) technique to detect mutations and natural variants in set of candidate genes that may play a role in stress tolerance.
- Use the 12,000-gene microarray for in-house research.
- Facilitate access and distribution of small sub-arrays and gene clones to NARES partners.

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

- Identify candidate genes for drought tolerance based on convergent evidence of sequence information, map location, and gene expression data.

Output 4. Develop databases and bioinformatic support for functional genomics

- Enhance the International Rice Information System (IRIS; www.iris.irri.org) as a unified online resource that cross-links genetic mapping, genome annotation, mutant, microarray, proteomics, metabolomics, molecular variation, germplasm genealogy, and field evaluation data.
- Apply bioinformatics infrastructure and tools to (1) accomplish positional cloning of specific loci that confer tolerance of submergence (Sub1) and phosphorus-deficiency (Pup1) and (2) locating candidate genes that contribute to drought-tolerance.

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

- Develop collective agenda for the International Rice Functional Genomics Consortium.
- Form a steering committee for the International Rice Functional Genomics Consortium to define the collaborative agenda, time-bound targets, and guiding principles in collaboration (accomplished as of January 2003).

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

- Form partnership with research teams in the National Consortium for Functional Genomics of Rice in India.
- Continue to use the GAMMA laboratory as a focal point for research and training of NARES partners.

PARTNERS

- **ARIs and NARES:** Agropolis-France, Clemson University, Cornell University, Huazhong Agricultural University, Iowa State University, Japan Rice Genome Program and National Institute of Agrobiological Resources-Japan, Japan International Research Center for Agricultural Science, Tsukuba University, John Innes Center, Kansas State University, Ohio State University, Oklahoma State University, Nagoya University, Purdue University, University of Arizona-Tucson, University of California-Davis, University of Georgia, University of Washington.
- **CGIAR Center:** CIMMYT.

IRRI CONTACT

Dr. Hei Leung, plant pathologist, h.leung@cgiar.org.

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

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 volume of rice grown 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 of 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 vitamin 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 2002

Output 1: Develop germplasm that possesses high yield, multiple resistance, and superior grain quality

We developed elite breeding lines with durable, broad-spectrum resistance to tungro, bacterial blight, and brown planthopper (BPH). We identified rice alien-introgression lines (combining cultivated and wild species) that possess resistance to the two diseases: to tungro from *Oryza rufipogon* and to bacterial blight from *O. minuta*. Two such lines with resistance to BPH from *O. minuta* and one from *O. australiensis* proved to be resistant to a Korean BPH population. Next steps include evaluating, in collaboration with partners in

national agricultural research and extension systems (NARES), the disease and insect pest resistance of these lines in infestation hot spots. One of the elite *O. rufipogon* alien-introgression lines with resistance to tungro (IR73385-1-4-3-2-1-6) has already been recommended as stop-gap variety in the Philippines.

Agronomic evaluation of elite NPT lines showed that four of the nine NPT lines tested produced more than 9.3 t/ha (approaching the target of 11 t/ha), and their average yield was 23% greater than IR72 in the dry season under transplanted conditions.

Direct seeding, as an alternative to transplanting rice, offers potential to reduce labor costs. In tests at IRRI during the 2002 dry season, we found that all 30 elite breeding lines we tested were equally productive under direct-seeded and transplanted conditions. One of the NPT lines in the trial yielded as high as 10.9 t/ha under direct seeding. We will continue evaluating elite NPT and indica lines under direct seeding in both dry and wet seasons.

Field-testing of transgenic lines conducted in 2002 in collaboration with NARES showed excellent resistance against stem borer and bacterial blight. These results will help to build public confidence in the safe use of genetically modified rice. The transgenic incorporation of stem borer resistance in the NPT is ready for field testing. We will continue collaborating with NARES to evaluate transgenic indica rice lines with resistance-enhancing *Bt* and *Xa21* genes.

Lines derived from the NPT introgressed with the wild species *O. longistaminata* produced high yields. This result suggests that wild species may possess genes useful for improving yields, in addition to genes for stress tolerance.

Regarding improved nutrition, it is vital that we successfully piggyback nutrition-enhancing traits on the superior yielding NPTs to maximize benefits to poor consumers. Among 105 released varieties and advanced breeding lines screened in 2002 for micronutrient in the grain, we found seven elite NPT lines that have high iron content in the grain. This demonstrates that high micronutrient content in the grain does not necessarily cause a yield penalty. We will continue screening advanced breeding lines for high micronutrient content and extend the screening to high-yielding aromatic rice varieties.

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

We have developed four new hybrid parent lines (IR79156A, IR80154A, IR80155A, and IR80156A) that outcross more readily than IR58025A, which had been our best performer in this regard. They also have better grain quality, as none are chalky, some possess a mild aroma, and the amylose content ranges from low (moist and sticky after cooking) to high (dry and fluffy) to suit a variety of tastes. Using these lines, we should be able to develop rice hybrids with better grain quality that will satisfy increasing demanding consumers. We will now multiply these lines and use them to develop new experimental hybrids.

We improved the agronomic management package of hybrid rice and demonstrated that hybrid rice provides a better opportunity than the NPT to break the yield barrier. Among five hybrids grown in the dry and wet seasons, IR73868H achieved a maximum yield of 10.5 t/ha, which was 7% greater than the maximum yield attained by a NPT line. Next, we will select the highest yielding hybrid for more detailed agronomic and crop-management experiments.

We developed a composite population derived from intercrossing four thermosensitive genic male sterile (TGMS) lines possessing the *tms2* gene, which permits greater flexibility in choosing parents for hybrids.

We also developed two transgenic maintainer lines—IR68899B with the insect pest-resistance gene *Bt* and IR58025B with the bacterial blight-resistance gene *Xa21*—which will be useful for breeding hybrid rice resistant to stem borer

and bacterial blight. Now we will backcross the transgenic lines with the respective nontransgenic CMS lines to develop transgenic CMS lines.

Summary of next step activities in 2003

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

- Evaluate elite breeding lines with genes introgressed from wild species in collaboration with NARES under hot spots for resistance to tungro, bacterial blight, and BPH.
- Continue molecular tagging of introgressed genes for resistance to tungro and BPH.
- Investigate the other root traits relating to N absorption for the improvement of the N recover efficiency.
- Continue evaluation of elite NPT and indica lines under direct seeded conditions in both dry and wet seasons.
- Evaluate transgenic indica lines with *Bt* and *Xa21* genes collaboratively in NARES.
- Continue genotyping of alien introgression lines using additional SSR markers to locate chromosome regions carrying the yield enhancing loci/QTL.

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

- Multiply improved CMS lines that possess higher outcrossing rate and better grain quality and use to develop new experimental hybrids.
- Extract genetically diverse TGMS lines from the composite population derived from intercrossing four TGMS lines possessing the *tms2* gene.
- Classify popular and elite CMS and restorer lines into the six putative heterotic groups (PHGs).
- Incorporate heterotic QTLs in selected R and B lines to improve their combining ability.

Partners

- **NARES:** NARES members of Irrigated Rice Research Consortium and national rice research programs of Bangladesh, China, India, Indonesia, Malaysia, Philippines, and Vietnam. National rice research and extension programs of Bangladesh, Egypt, India, Indonesia, Iran, Korea, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam. National rice research and extension programs of Bangladesh, Egypt, India, Indonesia, Iran, Korea, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam.
- **ARIs:** Kansas State University, USA; Kyushu University, Japan; University of Adelaide, Australia; and others from the USA, Germany, Switzerland, UK, France, and Australia.
- **CGIAR centers:** CIAT, IFPRI, WARDA.
- **Other agencies:** Asia Pacific Seed Association (APSA), Food and Agriculture Organization (FAO), selected NGOs in the Philippines, Bangladesh, and India.

IRRI contact

Dr. Sant Virmani, plant breeder, s.s.virmani@cgiar.org.

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

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—cause environmental worries.

Current irrigated yields, averaging 5 t/ha, are well below the estimated potential yield of 8 t/ha of existing rice cultivars. Farmers will require new 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 approach and the limitations they face will enhance the adoption of improved technologies.

RESEARCH PROGRESS IN 2002

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

We evaluated using the leaf color chart (LCC) to manage nitrogen (N) fertilizer according to plant need, as indicated by leaf color. On farms and research stations in China, India, Indonesia, Philippines, Thailand, and Vietnam, we compared this real-time system to existing farmers' practice and our best recommendations for N fertilizer application according to a fixed timetable.

Research at four locations in China confirmed opportunities to reduce N fertilizer use by 30% without reducing rice yield. These strategies, which promise to curtail N fertilizer pollution of the environment, are now ready for wider on-farm evaluation. In five seasons of research in the Philippines, real-time N management consistently matched or surpassed the grain yield and N fertilizer efficiency obtained using traditional best N management practice. In Bangladesh, we completed calibration of the LCC for six rice varieties commonly grown in that country. On-farm evaluation of the LCC for four seasons confirmed it was ready for wider evaluation and promotion in that country, for which we trained extension personnel.

National agricultural research and extension system (NARES) scientific leaders and policymakers are becoming increasingly aware of the need and opportunity to improve farmers' fertilizer-use efficiency, so the time is ripe to assist them in promoting and deploying improved N management approaches that can boost farmers' productivity and profit. Further progress will come with integrating improved N management with improved seedling and crop establishment techniques.

We documented the sustainability of the nutrient-supplying capacity of rice soil under various soil and crop management regimes. Four long-term experiments in the Philippines recording soil N changes, N mineralization, N balances, and yield trends in the absence of N fertilizer allowed us to assess the sustainability of N supply in intensive rice production from such indigenous sources as soil, water, crop residues, and biological N fixation. The indigenous supply of N, soil organic matter, and rice yield were sustained over 15 years of raising two or three crops per year. We estimated that biological N fixation ranged from 19 to 36 kg N/ha per growing season. The long-term experiments also confirmed that irrigation water is an important but location-dependent supplier of potassium (K).

The findings highlight the inherent sustainability of irrigated rice systems in which soil is submerged for most of the year. This alleviates earlier concerns of a yield decline. The results also clarify the importance of climate as the main factor influencing yield trends when good crop, nutrient, and water management practices are used. This reinforces the need for dynamic, site-specific nutrient and crop management recommendations that farmers can adopt to climatic variations.

We refined and promoted a conceptual framework for site-specific nutrient management (SSNM) through training materials, posters, and conferences. The conceptual framework of SSNM includes optimal use of indigenous nutrient sources, need-based N fertilization with the aid of the LCC, determining phosphorus (P) and K fertilizer needs through the use of omission plots, selecting the most economic combination of available fertilizers, and integrating good crop-management practices. We published a guidebook on nutrient management and nutrient deficiency symptoms for rice.

Toward developing the SSNM framework, we assessed need-based P and K management in farmers' fields and used the findings to develop guidelines for site-specific P and K management. On-farm research confirmed moderate responses to K fertilizer application and improved N management in India, Thailand, Vietnam, and Philippines. We published a revised approach to plant need-based P and K management in a pocket-sized guidebook. Now we need to assist national partners in promoting and deploying novel approaches for improved P and K management.

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

The interplanting model that we developed in China's Yunnan Province to control blast disease in rice continued to spread. The area of Yunnan under rice mixtures is estimated at 230,000 ha, and more than half a million farmers in Yunnan and 10 other provinces have adopted the environmentally friendly and profitable practice. As the interplanted areas increased, so did the number of traditional landraces used in mixtures. Farmers now interplant hybrid rice with 26 high-value but blast-susceptible traditional varieties, 10 of which occupy a substantial area. This development allows farmers to profit while preserving their invaluable rice heritage. Now we need to discover the mechanisms by which gene diversification controls blast and increases yield.

We evaluated the economic, ecological, and social acceptability of pest-management strategies, completing a survey following a campaign in central Thailand that used popular media to motivate farmers to reduce their use of insecticides early in the growing season. (The Thai minister of agriculture had

presided over the World Environment Day 2001 launch of the campaign.) The post-test survey showed that rice farmers in the project site reduced insecticide use by 40%, or double the 20% reduction in the control site (which we suspect reflected spillover from the project site). Now we will document the process and extend its implementation to Quang Ninh Province in northern Vietnam.

Regarding herbicide use, we defined optimum flooding regimes for suppressing a wide range of weeds and confirmed that farmers can significantly reduce their herbicide needs by improving the water management regimes by which they flood and drain their fields. Next steps include further developing decision-support frameworks in the form of flow charts and decision trees for use by farmers

Toward developing and deploying biological control strategies for managing diseases, pests, and weeds, we found that zizania, a vegetable grown next to rice in parts of China, is an important overwintering resource for egg parasitoids of the brown plant hopper pest. However, heavy spraying of zizania with insecticides reduces early season biological control of the pest, so we are now encouraging farmers to reduce insecticide applications on the vegetable.

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

Farm machinery developed in 2002 included laser land leveling equipment for China and a spring release tillage tine undergoing field tests in India. Postharvest studies found that hermetic grain storage systems improved seed viability, reduced insect and rodent damage, reduced moisture uptake, and maintained milling yields in Cambodia, Philippines, Indonesia, and India. Development of grain-moisture meter is ongoing at IRRI and in China, as is that of a milling chart at IRRI and in Australia.

Grain-milling surveys completed in Indonesia and the Philippines showed that milling yields are 15% below potential and grain quality is also low, with head rice (unbroken grain) yields often below 40%. Market surveys in these two countries showed that yellowness, broken grains and chalkiness are important considerations to rice purchasers and that sellers do not adhere to national standards.

Evaluation of seeding systems found that, in the dry season, wet broadcast seeding out-yielded traditional transplanting, and dry broadcast seeding. In the wet season, transplanting yielded more than broadcast, minimum till and dry seeded systems. These trials will continue for another 2.5 years.

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

We developed and evaluated rice establishment and management systems for increased water, labor, and fertilizer efficiency within rice-wheat systems that employ resource saving management for wheat. We evaluated new rice establishment strategies (direct seeding on raised beds and flat land without tillage) for integration into the rice-wheat system. Water savings of up to 25% can be obtained with new rice establishment methods. Next steps include perfecting new crop-establishment strategies for higher yields and efficient resource management.

To strengthen the capacity of NARES scientists in soil fertility research, we provided training to several NARES scientists and established a productive collaborative research program with national partners and the Rice Wheat Consortium.

We developed and evaluated integrated nutrient management (INM) strategies and quantified resource use savings using puddled and unpuddled rice management options in rice-wheat systems. We developed and evaluated SSNM or INM strategies in farmer fields in Bangladesh, India, Nepal, and Pakistan. On-farm work showed that, in areas with low to medium production potential, rice and wheat yields can be increased by up to 30% through P and K fertilizer applications and better timing of N applications; in areas with high

production potential, farmers can reduce N applications by up to 25% without any yield loss.

Summary of next step activities in 2003

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

- Integrate improved N management with improved seedling and crop establishment techniques.
- Assist national partners in promoting and deploying novel approaches for improved P and K management.

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

- Discover the mechanisms by which gene diversification controls blast and increases yield.
- Document the use of popular media to motivate farmers to reduce insecticide use early in the growing season and extend its implementation to Quang Ninh Province in northern Vietnam.
- Encourage Chinese farmers to reduce insecticide applications on zizania.

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

- Continue the development of grain-moisture meter at IRRI and in China and that of a milling chart at IRRI and in Australia.
- Continue seeding systems trials.

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

- Perfect new crop-establishment strategies for higher yields and efficient resource management.

Partners

- **NARES:** Participants in the Irrigated Rice Research Consortium and the Rice-Wheat Consortium; **Bangladesh:** BRRI, BARI, BARC, Proshika; **China:** ZU, CNRRI, YAU, CAAS, Wuhan Univ., SAAS, HAU; **India:** TNAU, DRR, NDUAT, IARI, ICAR, CRRIJF, CSSRI, HAU, GBPAUT, HPAU, IARI, IFFCO, IGAU, NDUAT, PAU, SWMRI, TNRRI, MSSRF; **Indonesia:** RIR, CRIFC; Lao PDR: NAFRI; **Malaysia:** MARDI, UPM; Nepal: APRC, NARC, RARS; **Pakistan:** NARC, PARC; **Philippines:** PhilRice, ViSCA, UPLB; **Thailand:** DOA, DOAE, SBRES, PTRRC; **Vietnam:** CLRRI, PPD, NISF, NIASI, IAS, VASI, Cantho Univ., provincial governments.
- **ARIs: Australia:** Univ. of Queensland; **Belgium:** Univ. of Gent; **Canada:** University of Western Ontario; **Denmark:** Aarhus Univ.; **England:** Imperial College, NRI, CABI, Univ. of Sheffield, Reading Univ.; **France:** ORSTOM, CIRAD, INA-PG, INRA; **Germany:** ZEF, UFZ, Beyreuth Univ.; **Japan:** University of Kyoto, KNAES, Kumamoto; **Netherlands:** WAU; **Switzerland:** ETH Zurich; **USA:** UC Davis, NC State, Ohio State, University of Florida-Gainesville.
- **Private sector:** International Fertilizer Association (IFA), France; Potash and Phosphate Institute (PPI) and Potash and Phosphate Institute of Canada (PPIC), Singapore and Canada; International Potash Institute (IPI), Switzerland.
- **IARCs:** CIMMYT, ICRISAT, CIP, IFDC, IWMI, WARDA.

IRRI contact

Dr. K.L. Heong, entomologist, k.heong@cgiar.org.

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

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 by 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 a certain extent before reapplying irrigation water. Investigation in this area will continue, but combating the looming water crisis requires exploring other technologies that entail 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 2002

Output 1. Develop strategies for enhancing water productivity at the farm level
We released the updated ORYZA2000 model for supporting analyses of field experiments on potential, water-limited and nitrogen-limited rice production and for extrapolating experimental results to other environments. The book, with model software and data files, attracted praise from many scientists and generated requests for training. This prompted us to organize a course on the use of ORYZA2000, with the first training scheduled for Chinese students in April 2003. We will also adapt the model for aerobic rice and validate and improve its modeling of the interaction between water and nitrogen.

In April, we conducted the workshop "Water-wise rice production," which attracted more than 75 participants from 12 countries. The workshop and proceedings (published in February 2003) are important steps in disseminating information on saving water. Workshop participants decided to create the International Platform for Saving Water in Rice (IPSWAR) and its associated Web site (www.irri.org/ipswar), under whose auspices a similar workshop will take place by the end of 2004.

In central Luzon, Philippines, we completed analyzing the effect of water scarcity on farm management and profitability. We found that farmers who pump groundwater (and so must pay for the power that runs the pumps) use 15–20% less water than those who have access to gravity flow, but they do not suffer a yield penalty. This suggests that water prices can be raised and/or water allocations reduced without affecting yield, provided that supplies are reliable. We will combine these results with others from sites elsewhere in the Philippines in a published analysis and conduct a follow-up survey at this same site if it experiences a serious water shortage in the upcoming El Nino.

Also in the Philippines, we completed a study on interactions between water and nitrogen under alternate wetting and drying (AWD) irrigation. Results indicate no significant interaction, which means that no new nitrogen management strategies need to be developed specifically for this irrigation regime; recommendations for standard flooded rice can be used in AWD as well.

At two contrasting sites in China, we compared various water-saving technologies including AWD, bed planting and aerobic rice cultivation. Data analysis continues. At IRRI's research plots in the Philippines, we initiated measurements of the interaction between water and nitrogen in aerobic rice systems. We are analyzing the data and repeating the experiment in the dry season of 2003.

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

We completed development of an empirical model to assess the effects of El Niño-induced water scarcity on rice production in the Philippines. El Niño events substantially reduce both the area planted to rice and rice yield at the national level. The effect on area is greater than the effect on yield, and both effects are more pronounced in the dry season than in the wet. We will use the model to make predictions for the upcoming El Niño in 2003 and present the results to Philippine water managers and statistical agencies for use in planning. We will also offer the model itself to Philippine clients and collaborators.

We prepared a report measuring water balance, reuse and productivity at various scales in the Upper Pampanga River Integrated Irrigation System in the Philippines and at Cu Chi in Vietnam. Cu Chi showed very low water productivity, with a cubic meter of water producing only 0.2 kg of rice, but there was substantial reuse of water from the drainage canals. We found that water supplies can be reduced without affecting production.

Summary of next step activities in 2003

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

- Organize a course on the use of ORYZA2000, with the first training scheduled for Chinese students in April 2003.
- Adapt ORYZA2000 for aerobic rice and validate and improve its modeling of the interaction between water and nitrogen.
- Combine Central Luzon water scarcity data with those from sites elsewhere in the Philippines in a published analysis and conduct a follow-up survey at the same site if the location experiences a serious water shortage in the upcoming El Nino.
- During the dry season, repeat the experiment at IRRI on interactions between water and nitrogen in aerobic rice systems.

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

- Use the completed empirical model to make predictions for the upcoming El Niño and present the results to Philippine water managers and statistical agencies for use in planning and also offer the model itself to Philippine clients and collaborators.

PARTNERS

- **NARES:** Wuhan University, Chinese Agricultural University, Chinese National Rice Research Institute, Indian Agricultural Research Institute; Water Technology Center (India); PhilRice; Agricultural Research Institute, Cambodia; National Irrigation Authority (Philippines); University of Agriculture and Foresty, Ho Chi Minh City (Vietnam); Sub Institute of Water Resource Planning (Vietnam); AARD (Indonesia).
- **ARIs:** Wageningen University and Research Centers, Netherlands; Australian CSIRO-Griffith; Centre for Development Studies (ZEF, Germany); University of California, Davis; University of Hawaii-Soil Management CRSP and NIFTAL Center, USA.
- **CGIAR:** International Water Management Institute.

IRRI CONTACT

Dr. T.P. Tuong, water management engineer, t.tuong@cgiar.org.

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

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 irrigated-rice country in Asia and includes on its steering committee policymakers from Bangladesh, China, India, Indonesia, Malaysia, the 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, and Rodent Ecology. The workgroups are coupled to a technical advisory committee, which ensures identification of appropriate new research, and to the overarching Achieving Impact workgroup, which provides farmer-participatory appraisals and monitors and evaluates adoption and impact.

RESEARCH PROGRESS IN 2002

Needs-and-opportunities assessments

The RTOP and Water Savings workgroups conducted needs-and-opportunities assessments (NOAs), with the assistance of the Achieving Impact workgroup, which resulted in modifications of research and extension activities in their work plans. The NOAs improved the ability of workgroups to focus demand-driven research on emerging problems, to strengthen extension strategies for promoting successful technologies in target areas, and to address policy interventions that enhance technology adoption.

As a result of the greater emphasis on delivery and extension, RTOP activities are increasingly tailored to specific needs at individual sites. This has facilitated heightened ownership by NARES, which are increasingly taking the lead in developing and extending solutions to their specific constraints. For the Water Saving workgroup, NOAs proved useful for assessing problems affecting agricultural production and identifying opportunities for improvement and development in Tarlac, Philippines. Researchers followed up NOAs with farmer surveys and frequent meetings with farmers to discuss issues that came out of the analyses.

New Web site

The IRRC launched a new Web site (www.irri.org/irrc) during the International Rice Congress in September. Success stories from the IRRC workgroups that are posted on the site demonstrate how research in irrigated rice leads to technologies that benefit Asian rice farmers. The site also shows what the workgroups are doing to ensure that research leads to technical innovations

appropriately targeted and extended to rice farmers. We will also post condensed results of the NOAs on the site.

Revised governance
The IRRC steering committee met in Bangkok in January to revise the consortium's structure and governance in the transition from Phase I to Phase II (2001–04). The seven senior NARES leaders successfully revised the governance of the IRRC for Phase II, discussed multidisciplinary research priorities of regional significance, and examined the general work plan.

Identify and prioritize initiatives
A meeting of the ad hoc technical advisory committee, with representatives from four major Asian rice-growing countries, took place in September to review and prioritize proposals received from NARES for new IRRC workgroups and activities. The committee recommended

- Establishing a new workgroup on reducing post-harvest losses, and so initiating regional collaboration with NARES in the vital area of post-harvest management.
- Providing additional support to the Achieving Impact workgroup, thereby strengthening cooperation among the workgroups in the integration of promising technologies and leading to the development of fully integrated crop-management initiatives.
- Including policy analysis within the activities of the Achieving Impact workgroup.

The IRRC steering committee subsequently endorsed these recommendations.

SUMMARY OF NEXT STEP ACTIVITIES IN 2003

- Ensure that workgroup facilitators complete the compilation and documentation of all NOAs.
- Place condensed results of the NOAs on the IRRC Web site (www.irri.org/irrc).
- Ensure follow-up activities as a result of NOAs are accomplished and findings reported.
- Plan the external review of the IRRC scheduled for Sept.–Oct 2003.
- Develop budget and work plans for the Postharvest workgroup and the new Impact workgroup activities.

PARTNERS

- **NARES and NGOs: Bangladesh:** Bangladesh Rice Research Institute, Bangladesh Agricultural Development Corporation; **China:** China National Rice Research Institute, Chinese Agricultural University, Hunan Hybrid Rice Research Center, Wuhan University, Zhejiang Academy of Agricultural Sciences, Zhejiang University; **India:** Directorate of Rice Research (DRR-ICAR), G.B. Pant University of Agriculture and Technology, Seed Wing of the Indian Council of Agricultural Research, Water Technology Centre (WTC-IARI), Indira Gandhi Agricultural University, Tamil Nadu Agricultural University, West Bengal Rice Research Station; **Indonesia:** National Seed Company, Research Institute for Rice, Seed Wing of the Ministry of Agriculture; **Malaysia:** Malaysian Agricultural Research and Development Institute; **Philippines:** Philippine Rice Research Institute, Seed Wing of the Department of Agriculture, University of the Philippines Los Baños; **Sri Lanka:** Rice Research Institute (RRI-DA), Seed & Plant Materials Division, Department of Agriculture; **Thailand:** Department of Agricultural Extension, Pathum Thani Rice Research Center (PTRRC-DOA); **Vietnam:** Cuu Long Delta Rice Research Institute, National Institute of Plant Protection, National Institute of Soils and Fertilizers, Plant Protection Department-Pesticide Control Center, Seed Wing of the Department of Agriculture and Rural Development, Vietnam Agricultural Science Institute.

IRRI CONTACT

Dr. Roland Buresh, leader, Enhancing productivity and sustainability of favorable environments, r.buresh@cgiar.org.

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

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, or avoidance (through early maturity) of drought and submergence, improved ability to grow in soils poisoned by 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 micronutrients as 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 access among the poor to micronutrients.

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 a clear breeding strategy that can now be tapped for genetic enhancement of varieties for fragile environments. Prospects are good for developing varieties with high levels of iron, zinc, and provitamin A that tolerate drought, submergence, phosphorus deficiency, and saline soils.

IRRI is in 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 national agricultural research and extension systems (NARES) in developing countries to create varieties for rice farmers in highly diverse rainfed ecosystems.

Boosting the impact of this project are NARES-IRRI shuttle breeding, farmer participatory selection that recognizes the central role of women, and linkage with the International Network for Genetic Evaluation of Rice (INGER, in Project 1) and the Consortium for Unfavorable Rice Environments (CURE, in Project 9). The Asian Rice Biotechnology Network (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 2002

Output 1. Develop superior germplasm for rainfed lowlands
Lines developed through the Rainfed Lowland Shuttle Breeding Network are now a major source of material for advanced testing by the All India Coordinated Rice Improvement Project. Many of the lines have been evaluated

on-farm in IRRI-led plant variety selection trials, are highly preferred by farmers, and are likely to find wide acceptance by farmers in the next 3–5 years. We submitted release proposals to the Indian Council of Agricultural Research for several lines selected through the shuttle breeding network, including varieties featuring tolerance of drought and submergence and resistance to gall midge and bacterial leaf blight.

Documenting the success of this network is essential to obtaining stable support for it. We are now monitoring the dissemination and impact of the released lines.

Output 2. Develop superior germplasm for flood-prone areas and infertile lowlands.
We used wide hybridization to create crosses between IR64 and three accessions of *O. rufipogon*—a wild species that grows naturally in acid sulfate soils in Vietnam—to produce a set of 460 breeding lines that we shared with Vietnam's Cuu Long Delta Rice Research Institute (CLRRI). Through the CLRRI yield-testing network, we selected for improved plant type and performance under both target (acid sulfate) conditions and non-target conditions. The Vietnamese Ministry of Agriculture and Rural Development subsequently released one breeding line for commercial cultivation. This variety, which resembles IR64 in most ways but matures 5–10 days earlier and is suitable for moderate acid sulfate conditions, now occupies 100,000 ha in Vietnam.

We developed 20 isogenic lines of IR64 (differing by a few genes) with very good submergence tolerance (able to survive under water for 12–14 days) and will test these lines for their yield under normal conditions in the coming dry season. Promising IR64 lines with submergence tolerance and good yield potential, once confirmed, will significantly alleviate poverty in flood-prone areas.

Output 3. Develop superior germplasm for infertile uplands
We made progress in developing upland cultivars resistant to blast by creating advanced backcross progenies and near-isogenic lines with multiple mechanisms of resistance to this devastating fungus. Having assigned phenotypic values (functions) to alleles (forms) of five genes related to blast resistance, we will validate the values through pyramiding. We obtained through recurrent selection two lines with good agronomic acceptability and resistance to seedling and neck blast. These results will allow us to track useful candidate alleles associated with partial blast resistance.

Cultivars able to compete with weeds can reduce the labor needed to grow upland rice. We demonstrated that vegetative-stage screening for weed competitiveness is effective and that heritability of these traits is high. We incorporated direct selection for weed competitiveness into the upland and aerobic breeding programs. We will now identify vegetative traits related to weed competitiveness, incorporate them in early-generation selection in pedigree nurseries, and extend to NARES our screening methodology.

We published the location of molecular markers associated with perenniality and drought tolerance in wide crosses of *O. sativa*/*O. longistaminata*. By facilitating the cloning of two key genes, this may advance development of perennial cereals and offer new insights into environmentally benign strategies for controlling weeds.

Output 4. Develop aerobic rice germplasm for water-scarce tropical environments
NARES partners evaluated cultivars with high yield potential in aerobic (unpuddled) conditions. In the Philippines, an IRRI-developed aerobic rice cultivar yielded nearly 4 t/ha in a favorable upland environment and over 5 t/ha under aerobic management in lowland fields. NARES collaborators in Yunnan Province, China, summarized the results of on-farm trials conducted at four sites over 3 years, in which a cultivar yielded 4.2 t/ha under aerobic

management. High-yielding aerobic rice cultivars for the tropics and subtropics continue to be evaluated in southern China, India, and the Philippines.

This first generation of input-responsive and stress-tolerant aerobic rice cultivars is suitable for use in developing and disseminating aerobic rice technology in water-short regions and for intensifying upland rice farming in favorable environments as an alternative to slash-and-burn. We will conduct on-farm tests of these cultivars and management techniques in the dry season in the Philippines. Meanwhile, we are developing a second generation of aerobic rice cultivars, including lines based on the popular cultivar IR64, that will be ready for NARES evaluation in 2004.

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

Rice that can supply significant quantities of such micronutrients as vitamin A and iron will do much to alleviate malnutrition in remote and often infertile areas. Using transformational techniques, we inserted genes for biosynthesizing beta-carotene (a precursor to vitamin A) into several popular indica rice varieties, and subsequent analysis by high performance liquid chromatography indicated levels of beta-carotene ranging from 0.1 to 1.05 mg/g in polished seeds. We also confirmed enhancement of iron in polished rice seeds of an elite line engineered with the ferritin gene but otherwise unchanged. We have commenced similar work on the popular Bangladeshi variety BR29.

Output 6. Enhance NARES-IRRI partnerships in rice breeding

We developed, tested, and extended to NARES robust participatory varietal selection methods that are cost-effectively conducted on a large scale. We found that farmer yield and preference ratings were stable over differing environments and correlated well with farmers' planting intentions, comparing favorably with results generated by on-farm trials laid out, planted, and harvested by researchers. We will follow up by investigating the relationship between farmer ratings, planting intentions, and agronomic measurements in the rainfed lowlands of Thailand, Laos, and eastern India.

Summary of next step activities in 2003

Output 1. Develop superior germplasm for rainfed lowlands.

- Closely integrate the ARBN and the shuttle-breeding network.
- Divide breeding and testing activities into components focused on the upper, middle, and lower toposequence.
- Publish a book on *A treatise on scented rices of India*.
- Continue DNA fingerprinting of indigenous germplasm.

Output 2. Develop superior germplasm for flood-prone areas and infertile lowlands

- Test the submergence-tolerant isogenic lines of IR64 for their yield under normal conditions in the dry season.
- Identify vegetative traits related to weed competitiveness.
- Send promising IR64 isogenic lines with submergence tolerance and good yield potential to NARES for testing.

Output 3. Develop superior germplasm for infertile uplands

- Identify vegetative traits related to weed competitiveness and incorporate in early-generation selection in pedigree nurseries.
- Extend the screening methodology to NARES.

Output 4. Develop aerobic rice germplasm for water-scarce tropical environments

- Conduct on-farm testing of current tropical aerobic rice cultivars and management techniques during the dry season in Luzon.
- Develop a second generation of aerobic rice cultivars and have ready for evaluation by NARES in 2004.

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

- Further improve the beta-carotene content in transgenic rice.
- Generate transgenic lines without antibiotic marker genes.
- Produce rice with both beta-carotene and high iron content.
- Combine nutritious rice with pest resistance.
- Field-evaluate transgenic nutritious rice.

Output 6. Enhance NARES-IRRI partnerships in rice breeding

- Investigate the relationship between farmer ratings, planting intentions, and agronomic measurements in the rainfed lowlands of Thailand, Laos, and eastern India.

PARTNERS

- **NARES: Bangladesh:** Bangladesh Rice Research Institute, University of Dhaka; **Brazil:** National Research Center for Rice and Beans, Goiânia; **China:** China Agricultural University, Beijing, China National Rice Research Institute, Yunnan Academy of Agricultural Sciences, Zhejiang University; **Egypt:** Agricultural Research Center, Assiut University; **India:** Bidhan Chandra Agricultural University, Kalyani, Central Rainfed Upland Rice Research Station, Hazaribagh, Assam Agricultural University, Titabar and North Lakhimpur, Assam, Central Rice Research Institute, Cuttack, Central Soil Salinity Research Institute, Karnal, Chinsurah Rice Research Institute, West Bengal, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Indira Gandhi Agricultural University, Raipur, Orissa University of Agricultural Technology, Punjab Agricultural University, Rajendra Agricultural University, Pusa and Patna, Bihar, Tamil Nadu Agricultural University, Coimbatore; **Indonesia:** Central Research Institute for Food Crops, Bogor, Research Institute for Food Crops and Biotechnology, Research Institute for Rice, Subang; **Korea:** National Honam Agricultural Experiment Station, **Lao PDR:** Australia-Lao Project, Vientiane; Myanmar: Department of Agriculture; **Philippines:** University of the Philippines Los Baños, Philippine Rice Research Institute, Mariano Marcos State University, Batac; **Thailand:** Phitsanulok Rice Research Center, Phitsanulok, Prae Rice Research Center, Prae, Rice Research Institute, Ubon Ratchathani, Kasetsart University, Kamphaeng Saen; **Vietnam:** Cuu Long Delta Rice Research Institute, Agricultural Genetics Institute, Hanoi.
- **NGOs: Bangladesh:** CARE; **India:** Institutional Linkage Village Program, Raipur, Madhya Pradesh, Krishi Vigyan Kendra, Cuttack, Orissa; Krishi Vigyan Kendra, Hazaribagh, Bihar; Ram Krishna Mission, West Bengal; **Philippines:** Basic Technology and Management Corporation; **Thailand:** Population and Development Association.
- **IARCs:** CIAT, CIMMYT, ICRISAT, IFPRI, WARDA.
- **ARIs: Australia:** Macquarie University, Sydney, University of Adelaide; University of Queensland; **Germany:** University of Bayreuth, University of Freiburg; **Japan:** Kyoto University, National Institute of Agro-Environmental Sciences; **Switzerland:** Swiss Federal Institute of Technology (ETH)-Zurich, Novartis, Basle; **UK:** Silsoe Research Institute, Bedfordshire, University of Sheffield, Sheffield; **USA:** Cornell University, Ithaca, New York, Kansas State University, Pennsylvania State University, Texas Tech University, USDA Salinity Laboratory, University of Arizona, University of California at Davis; University of South Florida, University of Utah.

IRRI CONTACT

Dr. John Bennett, senior molecular biologist, j.bennett@cgiar.org.

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

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 upland and rainfed lowland rice areas are among the poorest people in Asia. Rice yields in these less-favorable ecosystems are generally low and unstable. Risks caused by erratic water supplies, crop diseases, and pests, and problem soils discourage farmers from investing in alternative rice-production and resource-management technologies. Unsustainable farm practices can degrade the natural resource base and so threaten to send farmers spiraling ever deeper into poverty. Many inhabitants of these areas, especially the uplands, belong to ethnic minorities that are often socially and politically disadvantaged.

RESEARCH PROGRESS IN 2002

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 means that both flooding and drought can occur. Adverse climate, pests, weeds, poor soils, and a lack of suitable modern technologies prevent farmers from increasing productivity. One simple but effective remedy is improving seed health.

Seed health. In Bangladesh, we applied participatory approaches to earlier research findings on seed health, thereby increasing farmers' awareness that using clean seeds can fortify crops against disease and boost yields by 12–14%. Farmers, including women, can easily manage this simple intervention. We established procedures of seed selection prior to harvest, trained key farmers during the wet season, and are now assessing the quality of harvested seed. Meanwhile, we are testing farmers' indigenous knowledge on seed storage and comparing this with inputs from scientists. In a parallel project in Infanta, Philippines, we completed field-testing of the use of good-quality seed for pest management and higher yield—finding an average yield gain of 10%—and are now testing methods of seed selection.

We investigated the impact of farm-level seed storage in Bangladesh on plant establishment in farmer's fields. Hermetic storage of seed at a moisture content lowered to less than 14% improved the germination rate by 30%. Small, locally manufactured grain dryers allow farmers to dry seeds effectively for hermetic seed storage.

We investigated how seed priming (soaking and drying) affects the establishment, growth, and competitiveness of a wide range of upland and rainfed rice cultivars in the Philippines and Thailand. Priming improved germination speed and seedling establishment, but only for some cultivars. We could not consistently detect any difference in competitiveness of rice cultivars against grass weeds in the field. These results support findings from similar studies in Africa.

Integrated pest management. After first training Bangladeshi national partners in participatory rural appraisal techniques, we characterized 12 villages regarding food scarcity, crop diversity and insecticide use. With this

information, we selected target villages for the Livelihood Improvement Through Ecology (LITE) integrated pest management (IPM) subproject of Poverty Elimination Through Rice Research Assistance (PETRRA) and will now interview 720 farmers to document pest-management practices. In addition, we enlisted 600 poor farm households to participate in an IPM experiment on wet season rice in Bangladesh and will now collect data from on-farm trials on yield, insecticide input and cost, as well as initiate on-farm winter trials. We also recruited six students to assess differences in rice arthropod (insect) diversity to determine if the crops surrounding rice fields have a significant effect on the types and intensity of pest problems.

Laboratory experiments demonstrated that rice bugs reduce yield, grain quality, and seed viability. Other lab experiments on the effect of soil nitrogen levels on rice-bug fecundity are in progress. Meanwhile, in Lucban, Philippines, we completed three seasons of IPM field studies in farmers' fields. Next steps include identifying rice bugs' natural enemies and determining if farmers' practices for controlling rice bugs bring economic return. Finally, in Laos, we are conducting on-farm ecological, economic and management experiments with national partners to determine if weed management and insecticide treatments significantly reduce rice-bug damage at the field level.

Regarding the insect pest hispa, we assessed its impact on rice yields in Bangladesh. National partners are collecting data on hispa distribution, cropping patterns, and climate information for studies on hispa ecology and management.

Nutrient management. We identified nutrient-management strategies for improving early seedling establishment in submergence-prone lowlands. Having found that applying phosphorous at seeding significantly improved survival after flooding, and applying nitrogen at seeding did the opposite, we now need to validate these approaches in farmers' fields in India and evaluate the effects of these two key nutrients under salt stress.

In Indonesia, we identified preliminary guidelines for ecology-based management of soil, water, and weeds in rainfed lowlands with gradients in elevation. A four-season study showed that rice yields diminished on higher ground, with more than half of the variation caused by loss of standing water in the field, a problem probably correctable by "aerobic rice" varieties better adapted to mild drought stress. On average, "intensive fertilization" increased rice yield by 500 kg/ha over farmers' practice. As better nutrient management can enhance both yield and farmers' income, we will investigate introducing leaf color charts to assist farmers in timing their application of nitrogen fertilizer to match the nitrogen needs of the rice crop. And, as intensive weeding and farmers' practice both increased yield by 500 kg/ha over no weeding, we will continue analyzing the data collected on the weed community, which causes yield loss especially in the middle of the toposequence.

We identified preliminary guidelines for integrated nutrient and crop management to intensify rainfed lowlands with a post-rice legume. Two years of field research at Raipur, India, examining the benefit of legumes to a subsequent rice crop indicate greater residual benefit from chickpea than from mung bean or a post-rice fallow, and that the method of establishing the rice crop is a factor. Research continued for a second year on the on-farm evaluation of phosphorus management in rice-chickpea systems, finding that post-rice chickpea can effectively use the residual benefits of phosphorus fertilizer applied to rice.

We initiated a field experiment in Bangladesh to explore options for increasing the productivity in sugarcane-growing areas through intensification of cropping with rice and pulses.

Weed management. We ran nursery trials in Thailand to evaluate rice competitiveness against different groups of weeds, measuring growth characteristics related to competitiveness for 16 rainfed cultivars and 84 advanced rainfed lines. These entries, selected for potential yield in drought-

prone areas, demonstrated great variation in modes of competitiveness, suggesting that rapid improvements in competitiveness against weeds may be possible with currently available germplasm.

We determined the severity of weed-caused yield losses in selected biophysical and socioeconomic contexts in Bangladesh and Indonesia. In the Rajshahi District of Bangladesh, on-farm studies showed that sub-optimal weed control explains 0.5–1.5 t/ha of the yield gap between on-farm and theoretical yields. In Indonesia, we completed four seasons of on-farm experiments to measure yield gaps due to weeds. Results from on-farm trials in both areas, as well as on-station trials, suggest considerable scope for raising rice yields through improved weed management.

Drought-prone lowlands. We identified initial principles for dynamically adjusting nutrient management to environmental conditions in drought-prone rainfed lowlands. The aim is to improve farmers' decision-making skills for countering risk. We conceptualized guidelines for dynamic adjustments in the application of nutrient inputs based on rainfall and crop performance during the season and initiated research in Raipur to compare this approach to conventional fertilizer recommendations.

In the area of socioeconomic and policy studies, we developed a farmer decision-making model to analyze how risk affects technology choices made by farmers of rainfed rice in eastern India and completed farm-level surveys on their drought-coping mechanisms. We also reviewed policies on drought management in the same region, finding them oriented toward drought relief rather than long-term mitigation. Opportunities exist for combining both aspects in a watershed-based approach implemented with local participation.

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 an area for one to three years, until lowered soil fertility and worsened weed and pest infestations force them to abandon the plot and return to fallowed farmland or start cropping virgin land, if any is available.

Many biological and physical constraints limit upland rice yield. Upland soils in Asia are typically subject to erosion and rainfall is often insufficient and/or erratic. 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.

We developed and released a database on long-term phosphorus experiments (LTPE) consisting of soil, plant and weather data collected since 1994 from LTPE sites in India, Indonesia, Philippines, Thailand, and Vietnam. One paper is already published and a second one is under review. The database will help construct relationships and algorithms to improve the Phosphorus Decision Support System (PDSS) component of the NuMaSS software being developed by University of Hawaii Soil Management in a USAID-funded collaborative research support program. The PDSS will enable better diagnosis, prediction and recommendations for phosphorus in upland agriculture in Asia.

In eastern India, we diagnosed socioeconomic factors affecting changes in rice productivity and cropping patterns. We completed survey work in Chhattisgarh and Jharkhand, for which data analysis is ongoing. Productivity of upland rice and cropping patterns in the uplands have changed little. Farmers increasingly adopt modern rice varieties in bunded highland fields but not in unbunded fields, where they grow traditional upland varieties valued for their early harvest in a season of rice deficit.

We evaluated upland rice cultivars and lines for improving rice competitiveness against weeds, completing and analyzing a protocol for

evaluating weed suppression based on development of canopy cover. Combinations of different traits lead to equivalent weed-suppressive ability; it is how early the rice canopy develops that provides an effective index of the variety's ability to suppress weeds.

We identified scales of yield loss from weeds and related them to biophysical and socioeconomic causes. We completed preliminary survey work in Laos and comparative growth analyses of selected species, finding that substantial yield losses arise from five weed species, and that minimum tillage techniques selectively encourage two of them.

In Indonesia and Laos, we conducted farmer surveys of contrasting agricultural production systems, the results of which are under analysis.

Summary of next step activities in 2003

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

- Analyze the effects of different seed storage parameters (e.g., humidity and temperature of the containers and moisture content of the seeds) on seed germination and pest infestation rates and seedling vigor.
- In the LITE subprogram of PETRRA, interview 720 farmers to document pest management practices; collect yield, insecticide input, and cost data from on-farm T. Aman trials; initiate on-farm boro trials; and meet with students to review and standardize ecological protocols for determining the effect of surrounding vegetation on the types and intensity of pest problems in rice fields.
- In the submergence-prone rainfed lowlands, validate seedling management techniques in farmers' fields in India and evaluate the effects of P and N on growth and productivity under salt stress.
- In the rainfed lowlands of Indonesia, continue analyzing the data collected on the weed community, and develop site-specific need management recommendations for on-farm testing.
- In Raipur, India, complete the chickpea cropping research in early 2003, compile the results, and determine whether research should continue for a third year into 2004.
- In Rajshahi District of Bangladesh, validate and promote sustainable intensification of rice-rice farming systems through integrated management of weeds and water.

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

- In Chhattisgarh and Jharkhand, eastern India, complete the data analysis and finalize the research report on socioeconomic factors affecting changes in rice productivity and cropping patterns.

Partners

- **NARES:** CARDI, Cambodia; BRRI, Bangladesh; AAU, CRRI, CRURRS, GBPUAT, IGAU, NCAP, NDUAT, OUAT, RAU, West Bengal Directorate of Agriculture; India; AARD, CASER, CRIFC, RIR, Indonesia; NAFRI, Lao PDR; NARC, Nepal; PhilRice, ViSCA, MMSU, Philippines; DOA, Ubon Rice Research Station, Chumpae Rice Research Station, Khon Kaen Rice Research Station, Phimai Rice Research Station, Surin Rice Research Station, Khon Kaen Univ., Thailand; Thai Nguyen Univ., Hue Agricultural Univ., Vietnam.
- **ARIs:** Aarhus Univ., Denmark; Hokkaido Univ., Japan; Wageningen Univ., Netherlands; Univ. of Hawaii, NIFTAL, USA.
- **IARCs:** CIAT, IBSRAM, ICRAF.

IRRI contact

Dr. S.P. Kam, geographic information systems specialist, s.kam@cgiar.org.

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

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.

RESEARCH PROGRESS IN 2002

We created CURE by restructuring and combining the Rainfed Lowland Rice Research Consortium and the Upland Rice Research Consortium into a single consortium. We established the organizational structure of CURE, and NARES partners elected members to the combined steering committee, which held its first meeting. We anticipate that the reorganization will help identify and prioritize research in unfavorable environments for improved impact, enhances strategic IRRI-NARES research collaboration, resource-sharing and information exchange, and encourage participatory development and testing of technologies in partnership with farmers.

The consortium established six working groups based on ecosystems within the unfavorable environments and identified the key and satellite sites under each group. Key sites are the venues for implementing high-priority research activities and for monitoring and reporting research outputs and technology impacts. They also serve as the centers for coordination across working groups and sites and among countries. Each working group will develop its own medium-term plan, and the plans of the various working groups will be coordinated under a general CURE workplan at joint planning workshop. CURE will also hold a training workshop on Tools for Project Development and Management.

Working groups 4 (sloping uplands/slash-and-burn in hilly Southeast Asia) and 6 (favorable plateaus with long rainy seasons in Indonesia and Philippines) held their planning meetings in 2002, as did working groups 1 (drought-prone lowlands) and 5 (drought-prone plateaus in South Asia) in February 2003. The two working groups that have not yet met are 2 (submergence-prone lowlands) and 3 (lowlands with problems soils/salinity).

Summary of next step activities in 2003

- Draft a CURE constitution, develop concept notes, and submit them to donors.
- Develop the CURE Web site.

Partners

- **India:** NDUAT Faizabad, CRRI Cuttack, IGAU Raipur, CRURRS Hazaribagh; **Lao PDR:** NAFRI Luang Prabang; **Bangladesh:** BRRI Rajshahi; **China:** Food Crops Research Institute, Yunnan; **Thailand:** RRIT Ubon Ratchathani; **Indonesia:** CRIFC Jakenan, CRIFC Sitiung, RIFSA, Binuang; **Philippines:** MMSU Batac, USM/PhilRice; **Vietnam:** VFSN, Thai Nguyen.

IRRI contact

Dr. Tom Mew, plant pathologist, t.mew@cgiar.org.

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

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 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 rice research objectives. 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 2002

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

We conducted rice-sector analyses for Indonesia, China, India, Bangladesh, and Thailand.. In the Philippines, we developed and applied a pilot rice supply-and-demand analysis model for Region II (northeast Luzon) with the active involvement of a team from the Philippine Rice Research Institute (PhilRice). We identified substantial data gaps—on soils, irrigated areas, estimates of income, and price elasticity—that must be filled before extending the analysis nationwide. Model development is essentially complete, and PhilRice staffers are now able to run it and share it with other interested Philippine agencies. We will provide technical assistance as and when PhilRice researchers succeed in collecting the data required for analyzing the whole country.

We published the proceedings of the international workshop "Developments in the rice economy in Asia." We are distributing copies of the book, which surveys domestic and international rice markets and so is a useful resource for planners and policymakers, to government offices as well as to NARES collaborators. We also published the third edition of the *Rice Almanac*, which features updated data and write-ups on the major rice-growing countries, and continued analyzing trends in rice supply and demand.

We are still analyzing the effects of possible rice trade liberalization in the Philippines in conjunction with PhilRice and other Philippine government agencies. Our results so far indicate that rice prices in the Philippines are very high compared to neighboring countries, and that reduction of these prices would improve economic efficiency, improve the welfare of the poor, and facilitate diversification into higher valued crops.

In conjunction with researchers from the University of Illinois, we conducted an ex-ante impact analysis of golden rice. The results showed that for golden rice to have a large impact, it is important to conduct research that increases the level of beta-carotene in the grain and minimizes any possible loss of beta-carotene during storage or upon cooking. This study did not examine possible consumer attitudes toward a yellow, transgenic grain.

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

To improve our knowledge of what impact male migration has on gender roles, rural livelihoods, and agricultural efficiency—and the implications for extension programs—we conducted sample household surveys in Vietnam, Philippines, Indonesia, Thailand, and eastern India (West Bengal and Uttar Pradesh, Bihar, and Jharkhand) and presented preliminary results at the International Rice Research Congress in China in September. Data analysis continues for Bangladesh and Vietnam, as does the drafting of country reports. We will organize an international workshop.

We developed a methodology for rapid appraisal regarding natural resource management issues related to crop-livestock-forestry interactions and ways to facilitate conflict resolutions through negotiations among stakeholders. We developed and tested the method—which combines several participatory approaches in natural resource management including 3D landscape modeling, role playing and participatory simulation of innovation adoption—in the mountainous Cho Don District of Bac Kan Province in northern Vietnam. Farmers tested in their own plots the innovations they had adopted during the participatory simulation, and the first results at the end of the rainy season were promising (the critical winter period for livestock was still to come). We presented the methodology at the UN Food and Agriculture Organization's electronic conference "Livestock in conservation agriculture" in March, at the conference "Scaling up innovative approaches in agricultural development" in September in Hanoi, and in three papers submitted to the journal "Agriculture, ecosystems and environment." The next phase of the Mountain Agrarian Systems Program will see the method applied over a larger area in northern Vietnam.

We conducted participatory research appraisal and sample household surveys for generating data on rural livelihoods, while assessing the cost-effectiveness of generating qualitative data for socioeconomic characterization. Focus group discussions in the Philippines and Bangladesh generated data on how farmers decide to change their livelihood strategies. In collaboration with the Center for Policy Dialogue, we held two policy dialogues in Dhaka, Bangladesh, and will hold more.

We studied the role of livestock in rice-based household economies in rainfed lowland areas, how this role will change over time, and how these changes will affect rice and livestock production. Work advanced on a monograph to review the current status of integrated crop-livestock systems in the Philippines, Vietnam, Indonesia, Thailand, and Cambodia, including the completion of household surveys for the dry season (survey work for the wet season continues). This information will lead to a set of recommendations on technical, institutional, and policy measures to ensure sustained and balanced development of crop and livestock sectors, allowing researchers and policymakers to identify effective development activities for small farmers that derive income from both.

Output 3. Assess constraints to adoption of improved rice technologies
To improve our knowledge of the constraints to hybrid rice adoption in the tropics, we completed studies on its adoption in India (Tamil Nadu and Karnataka), Vietnam, Bangladesh, and Philippines. We presented some of the results at an international meeting in Hanoi in May and are exploring the possibility of publishing them in a special issue of the Indian journal *Economic and political weekly*.

We used a participatory approach to improve policy on pesticide use in Zhejiang Province, China, with the result that the authorities in the county of Jinhua recognized that farmers were overusing the chemicals. On World Environment Day 2002, the county's vice mayor launched the Jinhua Initiative, which aims to reduce farm chemical use by 30% in three years. A review of the pesticide distribution system resulted in the closing of five of the county's seven pesticide outlets.

Output 4. Assess impact of rice research on poverty alleviation and sustainable management of natural resources
We conducted household surveys to assess how the introduction of modern varieties affected poverty alleviation efforts in Bangladesh and India (West Bengal and eastern Uttar Pradesh). We submitted a draft report on Bangladesh to the International Food Policy and Research Institute in Washington, D.C.; further processing of data and drafting of reports continues.

We organized a regional consultation on the World Bank's new rural development strategy for poverty alleviation, which took place in February in Hanoi. We distributed a comprehensive report on CD-ROM to the World Bank, workshop participants, and concerned NARES.

To better focus research planning on economically depressed areas, we developed indicators of poverty to allow comprehensive geographical mapping of poverty. We held a workshop on methodology in Dhaka in July, collected and processed data from a 1996 agricultural census and a 2001 population census, and are computing accessibility indicators according to data on road infrastructure. We will continue to compile spatial data at the district level and use geographic information systems models to integrate thematic maps into a spatial poverty map.

Summary of next step activities in 2003

Output 1. Conduct rice-sector analysis and maintain rice statistics database and share with NARES
- Continue to update the database and compile data at subnational levels that are not available on the Internet.

Output 2. Study rural livelihood systems and analyze the interface among technology, infrastructure, and institutions
- On the impact of male migration, continue drafting country reports and begin organizing an international workshop.
- In the Mountain Agrarian Systems Program, apply the method over a larger area of northern Vietnam.
- Regarding sustainable food-feed systems, continue the wet season (dry season for Indonesia) household survey.

Output 3. Assess constraints to adoption of improved rice technologies
- Explore publishing the hybrid rice adoption papers in a special issue of the Indian journal *Economic and political weekly*.
- Analyze farm level data collected from rainfed areas of eastern India to identify factors determining differential levels and patterns of adoption of modern rice varieties.

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

- Carry out estimation of poverty at the sub-district level using sample survey and census data.
- Use geographic information systems to create thematic maps on various measures of human well-being and carry out spatial analysis of biophysical and socioeconomic factors affecting poverty.
- Carry out a household-level survey to assess the impact of IPM for Vietnam.

PARTNERS

- **NARES: Bangladesh:** Bangladesh Rice Research Institute, Bangladesh Institute of Development Studies, Bangladesh Academy for Rural Development, Bogra, Local Government Engineering Department, Department of Agricultural Extension, Bangladesh Rural Advancement Committee; **Cambodia:** CARDI; **China:** Chinese Center for Agricultural Policies, Beijing; **India:** National Center for Agricultural Policy Research, New Delhi, Directorate of Rice Research, Hyderabad, Central Rice Research Institute, Cuttack, , PAU, Ludhiana, NDUAT, Faizabad, IGAU, Raipur, RAU, Pusa, Bihar, BCKV, Kalyani, West Bengal, OAU, Bhubneswar, CRURRS, Department of Agriculture, Government of West Bengal, Indian Statistical Institute, Calcutta; **Indonesia:** Center for Socioeconomic Research, Bogor; **Malaysia:** MARDI; **Myanmar:** Myanmar Agricultural Service; **Thailand:** Kasetsart University, Khon Kaen University, Chiang Mai University, Ubon Ratchathani University, Rice Research Institute, MOAC, Prachinburi Rice Research Center; **Philippines:** UPLB, PhilRice, DA-BAS; **Vietnam:** Cantho University, VASI, CLDRRI, Cuu Long Rice Research Institute, ICARD.
- **NGOs: Bangladesh:** Bangladesh Rural Advancement Committee; **India:** Ram Krishna Mission, Center for Research and Development of Waste and Marginal Land, Lucknow.
- **ARIs: France:** CIRAD; **Japan:** Aoyama Gakuin University, Chiba University, Waseda University; **Sweden:** University of Lund; **UK:** University of East Anglia; **USA:** Economic Growth Center, Yale University, Williams College, University of California, Davis.
- **IARCs:** IFPRI, Washington, D.C., USA; ICRAF, Kenya; IBSRAM, Thailand.

IRRI CONTACT

Dr. Mahabub Hossain, head, social sciences division, m.hossain@cgiar.org.

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

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 2002

Understanding land-use changes in Bac Kac Province, northern Vietnam

We developed an ecoregional model for INRM in Bac Kan Province that is adaptable to other Ecor (I) Asia pilot sites. The Mountain Agrarian System Regional Program (SAM by its French acronym) integrated several participatory methods for facilitating sustainable NRM and applied them successfully on an experimental scale. These include the SAMBA role play, 3D participatory modeling, and farmer-participatory simulation of innovation adoption.

The SAMBA-geographic information systems (GIS) method, now fully developed and operational, combines multi-agent computer simulations, role plays that engage local stakeholders in participatory scenario development, and

a GIS that includes maps showing land-use changes over time. The SAMBA-GIS method generalizes site-specific INRM case studies to explain community behavior at a broader, more heterogeneous level. This helps researchers and extensionists identify and overcome constraints to adopting new technologies, especially by facilitating communication among stakeholders whose interests conflict.

A poster on SAMBA-GIS at the international conference "Scaling-up innovative approaches in agricultural development" in Hanoi—which attracted 400 participants in September 2002 and included a three-day field trip to Bac Kan—was one of 15 posters that, along with four oral presentations, set out aspects of our research. Two Ph D theses based on this research will be defended in 2004 and 2005. The Vietnam Agricultural Science Institute (VASI) plans to use SAMBA-GIS and other participatory tools in the newly formed Agro-ecology Center for Research and Training for the Northern Mountainous Region of Vietnam.

SAM activities, supporting events convened by the Food and Agriculture Organization for International Year of the Mountain 2002, will be illustrated in the compendium "Success stories from the mountains of Vietnam: a collection of lessons learned and case studies of successful rural development in the mountainous areas of Vietnam." Scaling up SAM's first phase results will include integrating methodologies in support to policy formulation, adapting participatory research tools for routine use by extension agents, and training of these extension agents.

SAM provided training to national agricultural research and extension system (NARES) colleagues on such integrative analytical tools as multi-agent systems (MAS) and land-use planning and analysis systems (LUPAS). Following adoption by the Vietnamese Ministry of Agriculture and Rural Development, the Vietnamese LUPAS team independently undertook land-use planning studies in northern Vietnam. A poster on the Bac Kan LUPAS study presented at the 17th World Soil Congress in August received the best poster award. The LUPAS methodology was taken up and is being further developed by researchers in the Wageningen Agricultural University project Systems Research for Integrated Resource Management and Land-use Analysis in East and Southeast Asia. Also using the methodology are a Vietnamese graduate student (for the Mekong River Delta) and the International Water Management Institute's Southeast Asia Regional Office.

The book "Doi moi in the mountains: land use changes and farmers' livelihood strategies in Bac Kan Province, Viet Nam," released in September, compiles biophysical and socioeconomic analyses of the constraints farmers face in the uplands of northern Vietnam. We will release all written materials generated so far through SAM in CD-ROM format. In the second phase of the project, we will continue to document the process of innovation adoption and assess its impact.

Understanding land-use changes in the Mekong River Delta

We identified forces driving land-use change in a part of the Mekong River Delta newly protected from salinity intrusion and quantified effects on livelihoods. In so doing, we helped the Bac Lieu provincial government choose scenarios for operating canal sluice gates to manage a dual saline/freshwater regime allowing, in different areas, rice intensification and shrimp raising. Applying the Vietnamese River System and Plains hydraulic and salinity model, we developed a prototype MAS model to depict land-use changes, and so assemble and integrate a knowledge base for exploring the sustainability of various scenarios of water management and agricultural production. At the farm level, our NARES partners developed innovative approaches to engage farmers in evaluating several rice technologies, including salt-tolerant rice varieties, cultural practices for acid sulfate soils, and using the leaf color chart for nutrient management.

The project's timely outputs led to revised land-use zoning and management of brackish and freshwater resources for the benefit of both rice and shrimp farmers. At the project's mid-term review workshop in June, Vietnamese scientists and government authorities expressed their appreciation and asked IRRI to extend the study to surrounding provinces. We now need to complete data analysis for delineating resource-management domains, continue the income-enhancing participatory transfer of technologies to rice and rice-shrimp farmers, and arrange in-country publication of research results for wide dissemination within Vietnam.

Understanding land-uses changes in north and northeast Thailand

We built MAS models for exploring development scenarios and evaluating their effects on decision-making and resource allocation. A prototype MAS model called Sugarice, designed with stakeholders in Khon Kaen Province, simulates current patterns and defines possible scenarios for systems combining sugarcane and rainfed rice. Using the "companion modeling" approach, we conducted case studies aiming to understand interactions between sugarcane expansion, rainfed lowland rice production, and other components of local farming systems. Next steps include analyzing, together with stakeholders, the simulation results generated by the Sugarice model and designing an agent-based model and related role-playing.

We initiated with Thai institutions a similar activity focused on farmers' rice-variety management and decision-making processes in Ubon Ratchathani Province. We developed a conceptual framework for a LUPAS land- and water-use optimization model for the Land Reform Area of Ubon Ratchathani Province. The methodology will allow testing of a proposed integrated farming system designed for sustainability and food self-sufficiency, which the King of Thailand put forward and which ranks high on the development agenda. We now need to integrate existing knowledge and secondary data, to prepare a participatory modeling workshop with farmers in Ubon, and to develop the conceptual model into a fully operational LUPAS model able to run development scenarios using different land-use options and water-availability factors.

We conceptualized a prototype model on land-use changes and watershed management in a highland agro-ecosystem of Chiang Mai Province. By incorporating more economic and social dynamics, we improved the MAS and GIS-based negotiation-support tool for managing crop diversification and land-degradation risk on sloping land in Chiang Rai Province, designed a related role play, and tested it with students and trainees at Chiang Mai University.

The new International Post Graduate Training in Systems Agriculture at Khon Kaen University, which opened in October, now links the "companion modeling" participatory INRM research approach used in Khon Kaen with similar case studies in Ubon Ratchathani (managing rainfed lowland rice biodiversity) and the Lam Dome Yai watershed (collective water management). We documented and disseminated the approach through two conference papers, seminars and presentations in training courses, and lectures at Thai universities.

We conducted four training courses for NARES partners from various Southeast Asian countries on MAS for INRM, social and computer sciences, integration with GIS and applications to watershed management—attracting participants from eight countries to the two-week course in October—and plan four advanced short-term courses for 2003. We also provided technical support to NARES partners developing MAS for INRM applications in Vietnam, the Philippines, and Thailand.

Effect of male out-migration in India and Thailand

We conducted 1,600 household surveys to determine the effect of seasonal out-migration of men from rural areas in eastern India (eastern Uttar Pradesh, West

Bengal, Bihar, and the Jharkhand Plateau). As men go off in search of work, leaving women in charge of the farm, changing profiles of farm labor and management have implications for training and extension services. We presented initial survey results at workshops in Patna, Bihar, and Beijing, China.

We conducted a case study on the same topic in 13 villages in Khon Kaen Province, northeast Thailand, and submitted a proposal to an Australian donor for an extensive collaborative study between Khon Kaen University and IRRI that will assess the impact of labor migration on rice efficiency and gender roles in major rainfed rice areas in northeast and north Thailand.

Summary of next step activities in 2003

- In scaling up SAM's first phase results, integrate methodologies in support to policy formulation, adapt participatory research tools for routine use by extension agents, and train these extension agents.
- Release all written materials generated so far through SAM in CD-ROM format.
- In SAM's second phase, continue to document the process of innovation adoption and assess its impact.
- In the Mekong River Delta, complete data analysis for delineating resource-management domains, continue the income-enhancing participatory transfer of technologies to rice and rice-shrimp farmers, and arrange in-country publication of research results for wide dissemination within Vietnam.
- In north and northeast Thailand, analyze the simulation results generated by the Sugarice model and design an agent-based model and related role-playing.
- For the LUPAS land- and water-use optimization model, integrate existing knowledge and secondary data, prepare a participatory modeling workshop with farmers in Ubon, and develop the conceptual model into a fully operational LUPAS model.

Partners

- ***NARES and other national (government and nongovernment) agencies:*** **Vietnam:** Ministry of Agriculture and Rural Development (MARD), Department of Science, Technology and Product Quality (DSTPQ), Vietnam Agricultural Science Institute (VASI), National Institute for Soils and Fertilizers (NISF), National Institute for Agricultural Projection and Planning (NIAPP), Vietnam Institute for Water Resources Research (VIWRR), Sub-Institute of Water Resources Planning (SWIRP), Integrated Resources Mapping Centre (IRMC of Sub-NIAPP), provincial and district agricultural research and extension authorities, provincial and district administrative departments, Hanoi Agricultural University (HAU), Thai Nguyen University (TNU), Vietnam National University (VNU), Can Tho University (CTU), Cuu Long Rice Research Institute (CLRRI), Research and Technology Exchange Group (GRET). **Thailand:** Ministry of Agriculture and Cooperatives (MOAC), Department of Agriculture (DOA), Land Development Department (LDD), Ubon Rice Research Institute (URRC), Agricultural Land Reform Office (ALRO), Chiang Mai University (CMU), Khon Kaen University (KKU), Kasetsart University (KU), Chulalongkorn University (CU), Ubon Ratchathani University (UBU). **South Asia:** Indian Council for Agricultural Research (ICAR), National Center for Agricultural Policies (NCAP), Indian Agricultural Research Institute (IARI), Bidhan Chandra Agricultural University (BCAU), Narendra Deva University of Agricultural Technology (NDUAT), U.P. Remote Sensing Applications Center, Center for Research and Development on Waste and Marginal Lands (CRDWML), Lucknow.
- ***IARCs:*** CIAT, CIFOR, CIMMYT, ICLARM, ICRAF, ILRI.
- ***ARIs and other international programs:*** CIRAD, IRD, INRA, Cemagref, Paris X University, Montpellier II University Centre des Sciences Humaines

(CSH), Institut Français de Pondichery (New Delhi), Wageningen University and Research Center, University of Newcastle, Manchester University, Groningen University, Asian Institute of Technology, Resilient Alliance Network, Agent Links European Network, international development programs in the Red River Basin.

IRRI CONTACT

Dr. S.P. Kam, geographic information systems specialist, s.kam@cgiar.org.

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

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? In this way, 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.

RESEARCH PROGRESS IN 2002

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

We formally launched the Rice Knowledge Bank at the International Rice Congress in Beijing. The Web site (www.knowledgebank.irri.org) has recorded nearly a million hits since May 2002, and we have distributed to NARES more than 200 copies of the site in CD format. The Rice Knowledge Bank confirms IRRI's leadership within the CGIAR in branding, packaging, and managing knowledge generated through publicly funded agricultural research. We now aim to coordinate the Rice Knowledge Bank with similar activities CGIAR-wide.

Content has expanded to include 20 reference guides, two decision-support tools, two e-learning courses, five fact sheets and more than 450 training materials. We reviewed and enhanced the decision-support tool TropRice (www.knowledgebank.irri.org/troprice/troprice.htm) with the addition of new content and improved design. National collaborators in the Philippines field-tested the other decision-support tool, Rice Doctor (www.knowledgebank.irri.org/ricedoctor_mx/ricedoctor.htm), which we refined and restructured for placement on the Web. We designed the training materials area for instructors' sharing of lesson plans, Powerpoint presentations, and reference guides, thereby speeding course development. By strengthening existing partnerships and establishing new ones, we will ensure that content development is driven by demand.

More than 25 participants from the CGIAR and partner institutions received training through e-learning courses, and IRRI's first-ever Digital Extension workshop attracted 14 participants from local NARES. We will

continue to build assets and expand distance-learning methodologies to provide "360-degree learning capacity"—available at any time and place regardless of technological limitations. Next steps include developing additional in-country partnerships for testing, translation and delivery of knowledge and creating a children's entry point to the Rice Knowledge Bank.

The IRRI-led project Poverty Elimination Through Rice Research Assistance (PETRRA) in Bangladesh developed extension and training partnerships by bringing together more than 40 organizations on various sub-projects. Most sub-projects run through partnerships joining, in various combinations, IRRI, Bangladesh Rice Research Institute, Bangladesh Agricultural Development Corporation, Bangladesh Academy for Rural Development, Bangladesh Agricultural Research Council, Bangladesh Agricultural Research Institute, Rural Development Academy, Natural Resources Institute, CAB International, universities, NGOs, and private organizations.

We developed and circulated strategies on gender, communication, and environment to guide project design, implementation, monitoring, and evaluation. To increase farmer awareness of improved rice technologies—and, in particular, to improve access for the poor—we used folksongs, dramas, leaflets, posters, videos, and brochures.

We identified PETRRA sub-projects and verified uptake methods for rice seed dissemination using farmer-to-farmer seed exchange, sustainable rice seed networks, market-linked seed dissemination, a federation-based sustainable approach for quality seed promotion, a cultural extension approach for quality rice seed led by women, and a village institutional approach for rice technology dissemination. Some participating organizations institutionalized these uptake methods to achieve greater impact, and we recently commissioned seven more sub-projects to test extension methods.

HAM radio enhanced interactive communication between researchers at two Indian stations and farmers in five villages, as we finished installing equipment and erecting antenna towers at four sites. Every working day, researchers interact directly with farmers, providing information and technical advise on rice and other crops.

Output 2. Validation of technological and methodological options for matching priority needs with available options using farmer participatory experiments and partnerships
We disseminated integrated crop management (ICM) techniques in 14 provinces of Indonesia, signaling wider acceptance of ICM by NARES partners. We trained staffers of the Assessment Institute of Agricultural Technology on site-specific nutrient management (which will enable them to help farmers use inputs more efficiently) and data management and analysis. We developed site-specific recommendations for applying phosphorous and potassium fertilizer based on soil maps and omission plot trials. Next steps include assessing training needs for extensionists and key farmers.

We evaluated at the village level the leaf color chart (LCC) nutrient-management method and collected farmers' feedback in India, Philippines, and Vietnam. Farmers report 20–30% savings in nitrogen fertilizer use, lower pesticide use, improved plant health, and reduced lodging (rice plants falling over). We are now exploring ways to combine the LCC with other tools to enhance benefits to farmers.

In the Philippine provinces of Tarlac and Nueva Ecija, we set up two "lighthouse" centers for participatory development and demonstration of water-saving techniques. Using controlled irrigation, farmers in Tarlac maintained yield while recording water savings of 5–25% and improving average income by US$25/ha. Planting aerobic rice in the wet season, pilot farmers in Tarlac obtained 5 t/ha, achieving a gain of 1 t/ha over conventional rice while using less labor. We found two promising deepwater rice lines for wet-season cropping in low-lying areas of Tarlac. The National Irrigation Administration (NIA) organized two farmer field school days that attracted 200

farmers. Now we will recruit more farmers in Tarlac to cooperatively develop aerobic rice and alternate wetting and drying, which is another water-saving technique. We will also develop and organize training on water-saving technologies for heads of farmer irrigation associations and irrigation system managers and transfer the courseware to the NIA and Philippine Rice Research Institute.

In northern China, we established two participatory research-and-development sites at which farmers successfully grew aerobic rice on land where water scarcity had previously limited lowland rice production. Farmers and irrigation system managers expressed excitement at the first-year results. We will conduct a second year of participatory research and development at the same sites and others.

We developed drafts of training materials on water-saving technologies and plan to develop primers on aerobic rice to distribute to farmers.

We conducted farmer-participatory evaluations of upland rice varieties in northern Laos. Several of the six upland varieties evaluated in mother-baby trails yielded 0.5 t/ha higher than local varieties and were highly preferred by farmers. These may become the first varieties recommended for the Lao uplands. Between 1991 and 2000, we identified some promising lines but collected results from only 6% of on-farm evaluation trails. In 2002—working with local district officers, several NGOs, and international organizations and 350 farmers of various ethnicity—we gathered information from more than 90% of the trials thanks to timely and directed training and frequent visits by research staff. This activity allows us to identify farmers' preferred variety traits—information we can use early in the evaluation process to remove undesirable varieties and develop an efficient variety-selection program that takes into account staffing limitations.

Output 3. Human capital development of NARES rice professionals

We trained more than 300 trainers with the following courses in Los Baños: rice production; biometrics; grain quality/quantity; integrated nutrient management (including LCC use); integrated pest management; land leveling; multi-agent systems for natural resource management; principles and practices of farm management; seed health; water management; International Crop Information System training; genetic engineering and nutrition in rice; genomics and bioinformatics; rice breeding; needs and opportunities assessment; e-learning for development; English as a second language; instructional video presentation; leadership for women; research and project management; scientific writing and presentation; and technology transfer.

In addition, we co-developed, supervised, and implemented courses in South Korea (technology transfer) and Myanmar (strategic planning, needs-and-opportunities assessment, project management, and rural development). We conducted NARES surveys to identify priority training needs as part of a new partnership model for enhancing in-country training and delivery.

Within PETRRA, we trained 80 agricultural and social scientists from the Bangladesh Rice Research Institute and other collaborators on project cycle management (resulting in improved logical framework development at the sub-project level), 28 trainees on methods of participatory rural appraisal (several sub-projects subsequently underwent farmer-participatory proposal development), and 10 trainees on gender and development (raising awareness of gender issues and women's participation at the sub-project level). In addition, 20 staffers of partner organizations completed a course on training of trainers, whose multiplier effect maximizes impact. Finally, a forum on uptake developed the capacity of our research partners.

See page 95 for a tabular summary of training activities at IRRI in 2002.

Summary of next step activities in 2003

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

- Continue to build assets and expand distance-learning methodologies.
- Develop additional in-country partnerships for testing, translation, and delivery of knowledge.
- Create a children's entry point to the Rice Knowledge Bank.

Output 2. Validation of technological and methodological options for matching priority needs with available options using farming participatory experiments and partnerships

- Assess training needs for extensionists and key farmers in Indonesia.
- Explore ways to combine the LCC with other tools to enhance benefits to farmers.
- Develop and organize training on water-saving technologies for heads of farmer irrigation associations and irrigation system managers and transfer the courseware to the NIA and Philippine Rice Research Institute.
- In northern China, conduct a second year of participatory research and development involving aerobic rice.

Output 3. Human capital development of NARES rice professionals

- Continue to strengthen NARES capacity in new and emerging technologies and methods.
- Provide courses and on-the-job training in response to national program demands.

Partners

Training and action research activities will involve many NARES partners, especially from Africa (Madagascar and Tanzania) and Asia (Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Iran, Japan, Korea, Lao PDR, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam).

- **NGOs:** A range of NGOs will be involved in the work, including CARE (Bangladesh); Population and Community Development Association (Thailand); Bangladesh Rural Advancement Committee; Swaminathan Association (India); Process Foundation (Philippines), plus various NGOs in Cambodia; Proshika in Bangladesh; Center for Research and Development of Waste and Marginal Lands, Samata Vikas Mulak, and R.K. Mission in India.
- **ARIs:** University of California, Davis, California; Centre for Pest Information Technology and Transfer, University of Queensland, Australia; Simon Fraser University (Canada); University of British Colombia, Canada; Commonwealth of Learning (Canada).
- **IARCs:** ICRAF (Lao PDR), CIAT (Lao PDR), CIMMYT (Bangladesh, India), IBSRAM (Lao PDR).

IRRI contact

Dr. Mark Bell, head, Training Center and IPMO, m.bell@cgiar.org.

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

MEMORANDA OF AGREEMENT: PARTNER INSTITUTIONS IRRI ENTERED INTO AGREEMENTS WITH IN 2002

Australia

- University of Queensland (UQ). Amendment No. 1 to the Memorandum of Agreement between UQ, Brisbane, and IRRI extending the period of the agreement for a further period of 3 years effective December 2001.
- Australian Agency for International Development (AusAID). Fourth Amendment to Exchange of Letters dated 1999-04-17 regarding an extension of the Cambodia-IRRI-Australia Project (CIAP) from January to July 2002 (DPPC1997-10).

Bangladesh

- IRRI-PETRRA Project by the Department for International Development (DfID). Research Agreement on the project *Technological development of production, processing, and marketing system of aromatic rice in northwest region of Bangladesh* (DPPC2002-28), 2002-04-01 – 2004-03-31.

Cambodia

- Cambodian Agricultural Research and Development Institute (CARDI). Research Agreement between CARDI and IRRI on the project *Sustainable food-feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component* (DPPC2001-51), 2002-03-01 – 2003-12-31.

China

- Hunan Agricultural University (HAU). Amendment No. 1 to the Memorandum of Agreement between HAU and IRRI on the project *Reaching towards optimum productivity, Phase II* (DPPC2000-10), 2002-07-21 – 2003-04-30.
- Yangzhou University (YU). Amendment No. 1 to the Memorandum of Agreement between YU and IRRI on the project *Reaching towards optimum productivity, Phase II* (DPPC2000-10), 2002-07-13 – 2003-04-30.
- Rice Research Institute, Guangdong Academy of Agricultural Seicness (RRI-GAAS). Amendment No. 1 to the Memorandum of Agreement between GAAS and IRRI on the project *Reaching towards optimum productivity, Phase II* (DPPC2000-10), 2002-07-12 – 2003-04-30.
- China National Rice Research Institute (CNRRI). Memorandum of Agreement between CNRRI and IRRI on the *Shuttle breeding for new plant type rice (super rice) project*, 2002-03-07 – 2006-03-06.
- Yunnan Agricultural University (YAU). Memorandum of Agreement between YAU and IRRI on the project *Exploiting biodiversity for sustainable pest management*, 2002-05-06 – 2005-05-05.

Colombia

- Centro Internacional de Agricultura Tropical (CIAT). Memorandum of Agreement for research collaboration between CIAT and IRRI, 2002-01-01 – 2004-12-31.

France

- Institut de recherché pour de développement (IRD). Protocol of Agreement between IRD and IRRI to commission Dr. Georges Reversat to develop a joint IRD-IRRI shuttle project under the guidance of IRRI-EPPD Division, 2002-02-01 – 2006-01-31.

- Centre de coopération internationale en recherché agronomique pour le développement (CIRAD). Protocol of Agreement between CIRAD and IRRI relative to Dr. Tanguy Lafarge's secondment to IRRI, 2002-06-18 – 2005-06-17.

Germany

- Deutsche Gessellschaft für Technische Zusammenarbeit (GTZ) GmbH. Grant Agreement between GTZ and IRRI for the cosponsored workshop on *Management of soil organic matter* (DPPC2001-67), 2002-04-01 – 2002-05-05.

Indonesia

- Central Research Institute for Animal Science (CRIAS). Research Agreement between CRIAS and IRRI on the project *Sustainable food-feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component* (DPPC2001-51), 2002-03-01 – 2003-12-31.

Japan

- Japan International Center for Agricultural Sciences (JIRCAS). Memorandum of Understanding for collaboration in agricultural research between IRRI and JIRCAS, 2002-03-03 – open.
- National Institute of Agrobiological Sciences (NIAS). Memorandum of Agreement between NIAS and IRRI for collaboration in agricultural research, 2002-12-19 – 2007-12-18.

Myanmar

- Myanma Agriculture Service (MAS). Agreement between Myanma Agriculture Service and IRRI on the project *Reaching towards optimum productivity, Phase II* (DPPC2002-33), 2002-07-17 – 2004-12-31.

Netherlands

- Nunza B.V. Project Agreement between Nunza B.V. and IRRI on the project *Further development of International Crop Information Systems (ICIS) in collaboration with Nunza* (DPPC2001-69), 2002-04-09 – 2005-03-31.

Philippines

- Asian Development Bank (ADB). Technical Assistance Agreement on the project *RETA No. 6005—Sustaining food security in Asia through the development and dissemination of hybrid rice technology, Phase 2* (DPPC2001-08), 2002-02-13 – 2002-02-13.
- Department of Agriculture, Bureau of Agricultural Research (DA-BAR) and Philippine Rice Research Institute (PhilRice). Memorandum of Understanding between DA-BAR and PhilRice and IRRI on the project *Assessing the impact of potential trade liberalization of the Philippine rice sector* (DPPC2001-48), 2002-04-25 – 2004-09-30.
- University of the Philippines at Los Baños Foundation, Inc. (UPLBFI). Addendum No. 2 to the September 2001 IRRI-UPLBFI MOA on the project *Breeding for iron-dense rice: a low-cost, sustainable approach to reduce anemia in Asia* (DPPC2001-54), 2002-01-15 – 2002-06-30.
- Philippine Rice Research Institute (PhilRice). Letter of Agreement granting ₱355,000 to IRRI to cover conference expenses for the project *Assessing the impact of potential trade liberalization of the Philippine rice sector* (DPPC2001-48).
- Southeast Asian Ministers of Educational Organization-Regional Center for Graduate Study and Research in Agriculture (SEAMEO-SEARCA). Memorandum of Agreement between SEAMEO-SEARCA and IRRI on the project *Gender-disaggregated socioeconomic indicators and database for agriculture (Philippines)*, 2002-05-01 – 2003-12-31.

- Philippine Rice Research Institute (PhilRice). Research Agreement between PhilRice and IRRI on the project *Sustainable food-feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component* (DPPC2001-51), 2002-03-01 – 2003-12-31.

Switzerland

- Swiss Agency for Development and Cooperation (SDC). Agreement between the Government of Switzerland and IRRI on the *Lao PDR Rice Biodiversity Project, Phase 2* (DPPC2002-12), 2003-01-01 – 2005-12-31.

Syria

- International Center for Agricultural Research in the Dry Areas (ICARDA). Memorandum of Understanding for collaboration on agricultural research and development in central Asia to form a consortium to meet NARS needs among nine CG centers (ICRISAT, IFPRI, ICARDA, CIMMYT, ILRI, ISNAR, IPGRI, IIMI, and IRRI), 2002-05-15 – open.

Thailand

- Food and Agriculture Organization (FAO) Regional Office for Asia and the Pacific. Letter of Agreement regarding provision of funds to support the 4th International Symposium on Hybrid Rice held in Hanoi, Vietnam, 14-17 May 2002, relative to the project *Sustaining food security in Asia through the development and dissemination of hybrid rice technology (Phase 2).*
- Khon Kaen University (KKU). Research Agreement between KKU and IRRI on the project *Sustainable food-feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component* (DPPC2001-51), 2002-03-01 – 2003-12-31.

United Kingdom

- University of Liverpool School of Biological Sciences. Amendment No. 1 to the Memorandum of Agreement between the University of Liverpool School of Biological Sciences and IRRI on the project *Assessing the potential scale and impact of transgene outcrossing to wild and weedy rices in Vietnam* (DPPC2001-50), 2002-06-11 – 2004-09-30.
- Department for International Development (DfID). Amendment to the Competitive Research Facility Project R7256 *The management of weedy rices in Asia* (DPPC1999-09) confirming approval of budget realignment.

United States

- Ohio State University Research Foundation (OSURF). Addendum No. 2 to Memorandum of Agreement between OSURF and IRRI on the project *Assessing the potential scale and impact of transgene outcrossing to wild and weedy rices in Vietnam* (DPPC2001-50), 2002-04-24 – 2004-09-30.
- McKnight Foundation, Minneapolis, Minnesota. Letter of Agreement between the McKnight Foundation and IRRI for the workshop on cereal genomics, held at IRRI on 2-5 Dec 2002 (DPPC2002-40).
- Pennsylvania State University (PSU). Amendment No. 2 to Unnumbered Memorandum of Understanding between PSU and IRRI on the project *USAID support for collaboration with US universities (Phase 2)* (DPPC1997-12), 2002-04-15 – 2002-12-31.
- Kansas State University (KSU). Subaward Agreement S01015 – Modification No. 1 extending the period of the project *Rice deletion mutants for dissection of quantitative resistance* through 2003-7-31 (DPPC1999-27).
- Center for Microbial Ecology (CME) at Michigan State University. Memorandum of Agreement between IRRI and CME for the

collaborative research *Effect of long-term agricultural treatments on microbial community structure and diversity in irrigated rice paddy soils*, 2002-02-18 – 2004-02-19.

- United States Department of Agriculture (USDA). Amendment No. 6 to Agreement 58-3148-7-069 *Improving rice productivity in salt-affected soils*, a component of the USDA-funded project *Agricultural technology utilization and transfer* (ATUT) (DPPC1997-11) granting additional budget.
- United States Department of Agriculture (USDA). Amendment No. 6 to Agreement 58-3148-7-059 *Enhancement of hybrid rice research and development in Egypt*, a component of the USDA-funded project *Agricultural technology utilization and transfer* (ATUT) (DPPC1997-11) granting additional budget.

Vietnam

- Vietnam Agricultural Science Institute (VASI). Research Agreement between VASI and IRRI on the project *Sustainable food-feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component* (DPPC2001-51), 2002-03-01 – 2003-12-31.
- Mekong Delta Farming Systems Research and Development Institute (FSRDI), Cantho, Vietnam. Research Agreement between Mekong Delta FSRDI and IRRI on the project *Sustainable food-feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component* (DPPC2001-51), 2002-03-01 – 2003-12-31.

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SPECIAL-FUNDED PROJECTS: PROPOSALS APPROVED BY DONOR AGENCIES IN 2002

- *Asian Development Bank (ADB)*
  Sustaining food security in Asia through the development and dissemination of hybrid rice technology (Phase 2) (DPPC2001-08), US$1.0 M, 2002 Jan 01 – 2004 Dec 31.

- *Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development) (BMZ)*
  Managing crop residues for healthy soils in rice ecosystems (DPPC2001-11), US$1.2 M, 3 years (to start in 2003).

- *Department for International Development (DfID)*
  Livelihood improvement through ecology (LITE), a sub-project of Poverty Elimination Through Rice Research Assistance (PETRRA) (DPPC2002-14), US$312,767, 2002 Apr 01 – 2004 Mar 31.

- *International Fund for Agricultural Development (IFAD)*
  Accelerating technology adoption to improve rural livelihoods in the rainfed Eastern Gangetic Plains (DPPC2002-27), US$1.5 M, 3 years (to start in 2003).

- *Nunza BV*
  Further development of the International Crop Information Systems (ICIS) in collaboration with Nunza (DPPC2001-69), US$60,000, 2002 Apr 01 – 2005 Mar 31.

- *Potash & Phosphate Institute – Potash & Phosphate Institute of Canada (PPI-PPIC)*
  Reaching toward optimal productivity in intensive, irrigated rice systems: the development, evaluation, and delivery of site-specific nutrient management in Myanmar (DPPC2002-33), US$15,000, 2002 Jul 01 – 2005 Jun 30.

- *Rockefeller Foundation (RF)*
  b. Using entertainment education (EE) approach to motivate rice farmers reduce pesticide use in the Mekong basin (DPPC2002-30), US$300K, 2003 Jan 1 –2005 Dec 31
  c. A seven-component project proposal on drought tolerance in rice (DPPC2002-03), US$1.5 M, 2002 Apr 01 – 2005 Mar 31.

- *Swiss Agency for Development and Cooperation (SDC)*
  Lao PDR: Conserving rice biodiversity through the maintenance of farmer knowledge and indigenous varieties (Phase 2) (DPPC2002-12), US$422,500, 2003 Jan 01 – 2005 Dec 31.

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HONORS AND AWARDS RECEIVED BY IRS AND NRS IN 2002

- **Alice Bordeos, Mel Revilla, Vivay Salazar, Nancy Castilla, Santy Culala, Abe Ona, Mayette Baraoidan, Florencio Balenson, Max Banasihan, Flavio Maghirang,** and **Nollie Vera Cruz,** IRRI's team on exploiting biodiversity for sustainable pest management.
  CGIAR Excellence in Science Award for The Outstanding Scientific Support Team, in Manila, Philippines, October.

- **L.M. Borines, E.D. Redoña, B. Porter, F. White, M.P. Natural, C.M. Vera Cruz,** and **Hei Leung,** Entomology and Plant Pathology Division (EPPD)
  Received the Philippine Phytopathological Society, Inc. Best Paper Award during the 33rd Annual Scientific Conference of the Pest Management Council of the Philippines, Davao City, Philippines, May.

- **Darshan Brar,** plant breeder, Plant Breeding, Genetics, and Biochemistry Division (PBGB)
  Named Honorary Fellow of the Crop Science Society of the Philippines (CSSP), at the CSSP 32nd Annual Scientific Conference, Tagbilaran City, Bohol, Philippines, April.

- **Josie Lynn A. Catindig** and **K.L. Heong,** assistant scientist and entomologist and deputy head, EPPD
  Received the Best Poster award of the Philippine Association of Entomologists, Inc. during the 33rd Annual Scientific Conference of the Pest Management Council of the Philippines, Davao City, Philippines, May.

- **Swapan K. Datta, Niranjan Baisakh, Marta de Vasconcelos, Lina Torrizo, Editha Abrigo, Norman Oliva, Md. Khalekuzzaman, Sellappan Krishnan, Mayank Rai, Saida Rehana, Annie Setter, Jing Tan,** and **Karabi Datta,** Tissue Culture and Genetic Engineering Laboratory, PBGB
  Received the Best Poster Award during the 32nd Annual Scientific Conference of the Crop Science Society of the Philippines, Tagbiliran City, Bohol, May.

- **Carmelo O. Garcia** and **James E. Hill,** researcher and agronomist, Crop, Soil, and Water Sciences Division (CSWS)
  Received the Best Paper Award in Weed Science during the 33rd Annual Scientific Conference of the Pest Management Council of the Philippines, Davao City, Philippines, May.

- **Thomas George,** consultant, CSWS
  Named 2002-2003 Reuters Digital Vision Fellow, at Stanford University, September.

- **Glenn Gregorio,** affiliate scientist, PBGB
  Appointed Honorary Scientist of the Rural Development Administration (RDA) of Korea, February.

- **K.L. Heong,** entomologist and deputy head, EPPD
  Presented with the Doctor of Science (DSc) degree by the Rector of the Imperial College during the Annual Postgraduate Awards Ceremony, University of London, May.

- **Gurdev S. Khush,** consultant, PBGB
  1) Awarded a Presidential Citation for developing improved rice varieties and for his contributions to increasing rice production in the Philippines, from President Gloria Macapagal-Arroyo, Malacañan Palace, Manila, April.
  2) Elected Foreign Member of the Chinese Academy of Sciences, China, June.
  3) Elected Foreign Academician of the Russian Academy of Agricultural Sciences, June.
  4) Named an adopted and distinguished son of the Province of Laguna in recognition of his exemplary leadership and unwavering commitment in the realization of IRRI's rice breeding program, in Sta. Cruz, Laguna, September.

- **J.K. Ladha,** soil nutritionist, CSWS
  Named Fellow of the American Society of Agronomy (ASA), June.

- **Juan Lazaro IV, Ariel Javellana,** and **Gene Hettel,** Communication and Publications Services (CPS)
  Won two Silver Awards in the graphic design category from the Agricultural Communicators in Education (ACE) for a set of four rice landscape posters and for the jewel box and CD design for the RiceIPM CD, August.

- **Jo Manalo, M.V. Reveche, L.M. Borines, I.P. Oña, C.M. Millena, S. Begum, E.R Angeles, K. Webb, J.E. Leach,** and **C.M. Vera Cruz,** EPPD
  Received the Best Poster Award of the Philippine Phytopathological Society, Inc., during the 33rd Annual Scientific Conference of the Pest Management Council of the Philippines, Davao City, Philippines, May.

- **Ruth McNally, Ric Angeles, Jason Talag, Pepito Cabauatan, Parminder Virk, Zhikang Li, Mike Cohen, Gurdev Khush, Darshan Brar,** PBGB and EPPD (with **Bui Chi Buu** of the Cuu Long Delta Rice Research Institute, Omon, Vietnam and **Buang Abdullah** of the Food Crops Research Institute, Bogor, Indonesia)
  Received the Best Paper Award during the 32nd Annual Scientific Conference of the Crop Science Society of the Philippines, Tagbiliran City, Bohol, Philippines, May.

- **Tom Mew,** plant pathologist and head, EPPD
  1) Named Fellow of the American Phytopathological Society (APS), Milwaukee, July.
  2) Received the Friendship Prize 2002 awarded by the Jiangsu Provincial Government, Jiangsu, China, September.

- **Calvin Qualset,** BOT member, IRRI
  Received the 2002 Charles A. Black Award for his life's work in germplasm preservation and enhancement, Council for Agricultural Science and Technology (CAST), in Arlington, Virginia, March.

- **Domingo Tabbal,** senior associate scientist, CSWS
  Appointed by President Gloria Macapagal-Arroyo as a member of the Board of Agricultural Engineering, Manila, Philippines, June.

- **Casiana M. Vera Cruz,** plant pathologist, EPPD
  Received the Philippine Phytopathogical Society Inc. GO Ocfemia Award in Plant Pathology during the 33rd Annual Scientific Conference of the Pest Management Council of the Philippines, Davao City, Philippines, May.

- **Vietnam-IRRI IPM Project**
  Received the St. Andrews Prize, the only international environmental prize in the UK, St. Andrews University, Scotland, May. **K.L. Heong,** EPPD deputy head, initiated the project in Long An Province in 1994 with **Monina Escalada,** department head at the Visayas State College of Agriculture as the project team's representative.

- **S.S. Virmani,** plant breeder and deputy head, PBGB
  1) Received the Agriculture and Rural Development Medal (with **Professor Yuan Long-ping,** the "Father of hybrid rice in China" and **Dat Van Tran,** executive secretary, Plant Production and Protection Division, FAO) from the deputy Prime Minister, Socialist Republic of Vietnam, Hon. Nguyen Cong Tan, Vietnam, May.
  2) Received the International Service in Crop Science Award from the Crop Science Society of America (CSSA), June.
  3) Received the Third World Network of Scientific Organizations (TWNSO) Award in Agriculture for 2002, New Delhi, October.

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Publications and seminars in 2002

Institute publications

Books
ORYZA2000: modeling lowland rice. 2001. 235 p.
A handbook of rice seedborne fungi. 2002. 83 p.
Developments in the Asian rice economy. 2002. 436 p.
Direct seeding: research strategies and opportunities. 2002. 383 p.
Doi Moi in the mountains. 2002. 284 p.
Land use analysis and planning for sustainable food security: with an illustration for the state of Haryana, India. 2002. 167 p.
Plant Breeding, Genetics, and Biochemistry Division 2001 annual report. 70 p.
Proceedings of the Second Temperate rice Conference. 714 p.
Rice almanac, third edition. 2002. 253 p.
Rice: a practical guide to nutrient management. 2002. 140 p.
Rice: the fabric of life in Laos. 2002. 41 p.
Water-wise rice production. 2002. 356 p.

Periodicals/serials
International rice research notes, vol. 27, nos. 1 & 2
IRRI discussion paper series, no. 44
IRRI limited proceedings series, no. 2
Rice literature update, vol. 10, nos. 1 & 2
Rice today, vol. 1, nos. 1 & 2

Administration
Cantrell RP, Reeves TG. 2002. The cereal of the world's poor takes center stage. Science 296: 53.
Leung H, Hettel GP, Cantrell RP. 2002. *See* **Entomology and Plant Pathology.**

Analytical Service Laboratories
Olk DC, Dancel MC, Moscoso E, Jimenez RR, Dayrit FM. 2002. *See* Crop, Soil, and Water Sciences.

Biometrics and Bioinformatics Unit
Courtois B, Bartolome V, Chaudhary D, McLaren G. 2002. *See* Plant Breeding, Genetics, and Biochemistry.
Hossain M, Gollin D, Cabanilla V, Cabrera E, Johnson N, Khush GS, McLaren G. 2002. *See* **Social Sciences.**

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Leung H, Hettel GP, Cantrell RP. 2002. *See* **Entomology and Plant Pathology.**

Crop, Soil, and Water Sciences
Allen LH Jr., Vu JCV, Sheehy JE. 2002. Carbon dioxide, plants and transpiration. Encyclopedia of water science. New York: Marcel Dekker.
Anonymous. 2002. Some like it salty, some like it not. Focus on rice shrimp farming in Bac Lieu, Vietnam (based on interview with T.P.Tuong of IRRI [DFID-funded project]). New Agric. (on-line) 2 Apr 2002 (www.new-agri.co.uk/02-4/focuson.html#06).
Atlin GN, Lafitte HR. 2002. *See* **Plant Breeding, Genetics, and Biochemistry.**
Banziger M, Edmeades GO, Lafitte HR. 2002. Physiological mechanisms contributing to the increased N stress tolerance of tropical maize selected for drought tolerance. Field Crops Res. 75: 223-233.
Bhandari AL, Ladha JK, Pathak H, Padre AP, Dawe D, Gupta RK. 2002. *See* **Social Sciences.**
Bijay-Singh, Yadvinder Singh, Ladha JK, Bronson KF, Balasubramanian V, Singh J, Khind CS. 2002. Chlorophyll meter and leaf color chart-based nitrogen management for rice and wheat in northwestern India. Agron. J. 94:821-829.
Bouman BAM, Castañeda A, Bhuiyan SI. 2002. Nitrate and pesticide contamination of groundwater under rice-based cropping systems: evidence from the Philippines. Agric. Ecosyst. Environ. 92: 185-199.

Bouman BAM, Huaqi W, Xiaoguang Y, Zhao JF, Wang CG. 2002. Aerobic rice (Han Dao): a new way of growing rice in water-short areas. In: Proceedings of the 12th International Soil Conservation Organization Conference, 2002 May 26-31. Beijing (China): Tsinghua University Press. p 175-181.

Bouman BAM, Tabbal DF, Lampayan RA, Cuyno RV, Quiamco MB, Vicmudo VR, Norte T.M, Lactaoen AT, Quilang EJP, de Dios JL. 2002. Knowledge transfer for water-saving technologies in rice production in the Philippines. In: Proceedings of the 52nd Philippine Agricultural Engineering Annual National Convention, 2002 Apr 22-26, Puerto Princesa City, Palawan, Philippines. p 14-30.

Bouman BAM, Tuong TP. 2002. Growing rice with less water. In: Issues of water management in agriculture: compilation of essays. In: Comprehensive assessment of water management in agriculture. Colombo (Sri Lanka): IWMI. p 39-42.

Bui Tan Yen, Kam SP, Pham Quang Ha, Chu Thai Hoanh, Bui Huy Hien, Castella JC, Ho Quang Duc, Vu Dinh Tuan, Vu Nguyen, Cao Ky Son. 2002. Exploring land use options for agricultural development in Bac Kan province, Vietnam. In: Proceedings of the 17th World Congress of Soil Sciences, 2002 Aug 14-21, Bangkok, Thailand. Paper No. 1217. p 1-10.

Cabangon RJ, Castillo EG, Bao LX, Lu GA, Wang GH, Cui YL, Tuong TP, Bouman BAM, Li YH, Chen CD, Wang ZJ. 2001. Impact of alternate wetting and drying irrigation on rice growth and resource-use efficiency. In: Barker R, Li YH, Tuong TP, editors. Water-saving irrigation for rice. Proceedings of an international workshop held in Wuhan, China, 2001 Mar 23-25. Colombo: IWMI. p 550-580.

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Social Sciences

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Witt C, Buresh RJ, Balasubramanian V, Dawe D, Dobermann A. 2002. *See* **Crop, Soil, and Water Sciences.**

Rice research seminars

The rice-wheat system: food and employment for millions. Dr. J.K. Ladha.

Heterozygotes, history, and host plant resistance. Dr. M. Cohen.

The amazing world of QTLs: what we have learned from rice. Dr. Z. Li.

Knowledge management with a sense of humor. Mr. P. O'Nolan.

IRRI training…its past, present, and future: a panel discussion. Dr. P. Marcotte.

IRRI's training program beyond e: the potential, problems, and paranoia that surround e-learning in agriculture. Mr. A. Atkinson.

Participatory and centralized breeding: the changes needed for effective partnerships. Dr. J. Witcombe.

Farmers' experiences with hybrid adoption in the tropics: a socioeconomic assessment. Dr. A. Janaiah and Dr. M. Hossain.

Unraveling the myths and mysteries of rice production in aerobic soil. Dr. T. George.

Golden rice and beyond. Dr. S. Datta.
Golden rice: what role can it play in alleviating vitamin A deficiency. Dr. D. Dawe.
The battle on GMO crops: a panel discussion. Dr. S. Datta and Dr. J. Bennett.
Integrating plant nutrition: how far are we from having impact? Dr. C. Witt.
Plant-insect interactions in rice. Dr. J.S. Bentur.
Improvement of rainfed lowland rice systems in South and Southeast Asia: interdisciplinary and collaborative researchat various levels of integration. Dr. L. Wade.
Increasing the productivity of irrigated rice-based systems in West Africa. Dr. S. Haefele, candidate for soil scientist/agronomist position.
Patterns of rice productivity growth in eastern India: implications for rice research. Dr. S. Pandey.
Selecting more competitive rice cultivars to suppress those $@#&*! weeds. Dr. B. Caton.
Notes from the field: anthropological experience in technology development. Dr. S. Morin.
Managing living resources: a vision for insect ecology. Dr. G. Jahn.
Communication and impact in resource management: lessons from rice pest management. Dr. M. Escalada, candidate for international research fellow position.
The Global Challenge Program in biofortification. Dr. R. Graham.
Opportunities in Laos. Dr. K. Goeppert.
Bioinformatics—less obscure than you realize. Dr. R. Bruskiewich.
Is rice research a sinking ship?: cheap rice and IRRI's future. Dr. D. Dawe.
The future of IRRI. Dr. R.P. Cantrell.

Division seminars

Crop, Soil, and Water Sciences

Soil fertility made simple. Dr. R.J. Buresh.
Modeling leaf development and tillering dynamics in grain sorghum under contrasting environments. Dr. T. Lafarge, CIRAD-CA.

Entomology and Plant Pathology

Biology of the striped stem borer in relation to resistance management for *Bt* rice. Dr. Ngo Luc Ciong.
Little murderers in Philippine rice fields. Dr. A.T. Barrion.
Rice virus research: high risk, high return on investment. Dr. Il Ryong Choi.
Of leps and eggs. Dr. S. Ramaswamy, professor and head, Entomology Department, Kansas State University.

Genetic Resources Center

Rice genetic resources: a developing vision. Dr. N.R. Sackville Hamilton.

Plant Breeding, Genetics, and Biochemistry

Rices in the deep and troubled waters. Dr. N.L. Manigbas, research associate, Philippine Sugar Research Institute, Victorias City, Negros Occidental.
Rice in Portugal–past, present and perspectives. Dr. M. Margarida Oliveira, head, Laboratory of Plant Genetic Engineering, Instituto de Biologia Experimental e Tecnologica, Oeiras, Portugal.
A pair of dominant complementary genes determine the rhizome formation in *O. longistaminata*. Mr. Hu Fengyi, on-the-job trainee.
A new mite, Pangrangja, in Graminae species. Dr. Nam-Soo Kim, associate professor, Division of Biotechnology, Kangwon National University, Chunchon, Korea.
Breeding for iron-dense rice–progress in the NARES. Dr. J. Stanguolis, research fellow, Department of Plant Science, Waite Agricultural Research Institute, University of Adelaide, Australia.
Mapping zinc loading genes in Barley. Dr. P. Lonergan, postdoctoral fellow, Department of Plant Science, Waite Agricultural Research Institute, University of Adelaide, Australia.

Social Sciences

Technology diffusion, demand for varietal traits, and IRRI's contribution: an exploration in the economy of modern rice varieties in China. Dr. R. Hu.
WTO and its implications on agriculture in less developed countries (LDCs). Prof. P. G. Chengappa, professor, Agricultural Economics, and director, College of Agriculture, University of Agricultural Sciences, GKVK.
Agricultural research and development worldwide: new evidence on public and private roles. Dr. P. G. Pardey, professor of Science and Technology Policy, Department of Applied Economics, University of Minnesota.
Discourse in technology development. Dr. S. Morin and anthropology staff.
Evolution of rice price policies under globalization: time series analysis of Thailand, Indonesia, and the Philippines over four decades. Dr. K. Kajisa, Foundation for Advanced Studies on International Development, Tokyo, Japan.
Irrigation, poverty, and inequality in rural China. Dr. Q. Huang, Department of Agricultural and Resource Economics, University of California, Davis USA.
Multi-scale land use analysis for Ilocos Norte Province, Philippines: farm-level modeling—preliminary results. Ms. Xiang Bi and Mr. W. Pradel, affiliate research scholars, Development Economics Group, Wageningen UR, The Netherlands.

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

Staff changes in 2002

January

Dr. Ken-ichi Kakuda joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Jian-Long Xu joined as postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Shawn Golinowski joined as consultant, Training Center.

Dr. Ken Schoenly joined as consultant, Entomology and Plant Pathology Division; left after completing his assignment on the same month.

Dr. Jatinder Kumar joined as visiting research fellow, Entomology and Plant Pathology Division.

Mr. Mou Tongmin joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Jong-Cheol Ko joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. A.K.M. Alamgir joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Md. Atiqur R. Bhuiyan joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Jong-Hee Lee joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Ms. Shahanaz Sultana joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. M. Ilyas Ahmed joined as consultant, Plant Breeding, Genetics, and Biochemistry Division; left after completing his assignment on the same month.

Dr. Noel Mamicpic, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Prof. P.G. Chengappa, consultant, Social Sciences Division, left after completing his assignment.

Dr. Ruffa Hu, visiting research fellow, Social Sciences Division, left after completing his assignment.

Dr. Do-Yeon Kwak, visiting research fellow, Entomology and Plant Pathology Division, left after completing his assignment.

Mr. A.K.M. A. Chowdhury joined as consultant, Social Sciences Division.

February

Dr. Thomas George, internationally recruited staff seconded from the University of Hawaii, Crop, Soil, and Water Sciences Division, left after completing his assignment.

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

Dr. Duong Van Ni joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Mr. Toan Trinh Nguyen joined as visiting research fellow, Entomology and Plant Pathology Division.

Dr. Jin-Il Choung joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Chang-Ihn Yang joined as collaborative research fellow, Genetic Resources Center.

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

Dr. Eung-Gi Jeong joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Raj Shrestha, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Jianli Wu, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Nilufer H. Karim joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Nguyen Tri Khiem joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Dr. Ahmed Dirie, consultant, Training Center, left after completing his assignment.

March

Dr. Michael B. Cohen, entomologist, Entomology and Plant Pathology Division, resigned.

Dr. Jianli Wu, joined as postdoctoral fellow, Entomology and Plant Pathology Division.

Dr. Benjamin Samson joined as consultant, Crop, Soil, and Water Sciences Division.

Ms. Samjhana Shrestha joined as consultant, Training Center.

Dr. Bhuban Barah joined as visiting research fellow, Social Sciences Division.

Dr. A.W. Julfiquar joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Thomas George joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Young-Chan Cho, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. A.K.M. Alamgir, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Nilufer H. Karim, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Nguyen Tri Khiem, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Hak-Soo Suh, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Mr. Md. Atiqur R. Bhuiyan, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Mr. Jong-Hee Lee, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Ms. Shahanaz Sultana, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing her assignment.

Mr. A.K.M. A. Chowdhury, consultant, Social Sciences Division, left after completing his assignment.

April

Dr. Paul Marcotte, head of Training Center, resigned.

Dr. James E. Hill, head of Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Sena Balachandran, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Mr. Geert Balzer joined as consultant, Office of the Director for Program Planning and Coordination; left after completing his assignment on the same month.

Dr. Bhuban Barah, visiting research fellow, Social Sciences Division; left after completing his assignment.

Dr. A.W. Julfiquar, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Jatinder Kumar, visiting research fellow, Entomology and Plant Pathology Division, left after completing his assignment.

Dr. Duong Van Ni, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Parshuram Samal joined as visiting research fellow, Social Sciences Division.

Dr. Rogelio Cuyno, visiting research fellow, Training Center, left after completinghis assignment.

Dr. Jin-Il Choung, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Mr. Chang-Ihn Yang, collaborative research fellow, Genetic Resources Center, left after completing his assignment.

Dr. Aldas Janaiah, project scientist, Social Sciences Division, left after completing his assignment.

Mr. Jong-Cheol Ko, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

May

Dr. Robert Bakker, affiliate scientist, Agricultural Engineering Unit, left after completing his assignment..

Dr. Jan Orsini joined as consultant, Social Sciences Division.

Mr. Mou Tongmin, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Ms. Reena Bakker, consultant, Training Center, left after completing her assignment.

Ms. Samjhana Shrestha, consultant, Training Center, left after completing her assignment.

Dr. Binayak Sen joined as consultant, Social Sciences Division; left after completing his assignment on the same month.

Dr. Shailaja Hittalmani joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Un-Sang Yeo, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Parshuram Samal, visiting research fellow, Social Sciences Division, left after completing his assignment.

Mr. Toan Trinh Nguyen, visiting research fellow, Entomology and Plant Pathology Division, left after completing his assignment.

June

Dr. Len J. Wade, agronomist, Crop, Soil, and Water Sciences Division, resigned.

Dr. Robin Graham joined as international research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Tanguy Lafarge joined as internationally recruited staff seconded from CIRAD, Crop, Soil, and Water Sciences Division.

Mr. Gordon B. MacNeil, treasurer and director for finance, Director General's Office, resigned.

Dr. Surapong Sarkarung, plant breeder, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Madduma P. Dhanapala, affiliate scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Xuehui Sun joined as collaborative research fellow, Biometrics and Bioinformatics Unit.

Ms. Hendrika van Laar joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Satish Kedia joined as consultant, Social Sciences Division.

Dr. Manik Lal Bose, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Thomas George, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Ravindra Kumar joined as consultant, Crop, Soil, and Water Sciences Division; left after completing his assignment on the same month.

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

Dr. Zeba I. Seraj joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division; left after completing her assignment.

Dr. Shailaja Hittalmani, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing her assignment.

Mr. F.E.M. Chowdhury joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

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

July

Dr. Stephen R. Morin, anthropologist, Social Sciences Division, left after completing his assignment.

Dr. Barney Caton, affiliate scientist, Crop, Soil, and Water Sciences Division, resigned.

Dr. Manik Lal Bose joined as postdoctoral fellow, Social Sciences Division.

Dr. Devendra K. Dwivedi joined as postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Boonrat Jongdee joined as postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Yadvinder Singh joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Satish Kedia, consultant, Social Sciences Division, left after completing his assignment.

Dr. Guy Kirk, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Jacob Nieuwenhuis, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

August

Dr. Nigel Ruaraidh Sackville Hamilton joined as head, Genetic Resources Center.

Dr. Nobuhiko Fuwa joined as international research fellow, Social Sciences Division.

Dr. Ish Kumar joined as international research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Mr. Kwame Akuffo-Akoto joined as treasurer and director for finance, Director General's Office.

Dr. David Shires rejoined as consultant, Training Center.

Mr. Hideki Yamamoto joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Ms. Xing Zhang joined as collaborative research fellow, Crop, Soil, and Water Sciences Division.

Dr. Choon-Kwan Kang joined as collaborative research fellow, Crop, Soil, and Water Sciences Division; left after completing his assignment on the same month.

Dr. Abdul Karim Makarim, postdoctoral fellow, Training Center, left after completing his assignment.

Dr. Chang-Xiang Mao, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Oui-Woung Kim, visiting research fellow, Agricultural Engineering Unit, left after completing his assignment.

Dr. Yadvinder Singh, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

September

Dr. Ravindra Kumar joined as international research fellow, Crop, Soil, and Water Sciences Division.

Dr. Humnath Bhandari joined as postdoctoral fellow, Social Sciences Division.

Dr. Mohammed M. Alam joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Ms. Mika Takita joined as collaborative research fellow, Crop, Soil, and Water Sciences Division.
Ms. Kimberly Webb joined as collaborative research fellow, Entomology and Plant Pathology Division
Dr. Enrique Angeles, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Ms. Joyce Gorsuch, consultant, Training Center, left after completing her assignment.
Dr. Gurdev S. Khush, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Mr. F.E.M. Chowdhury, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Ms. Hendrika van Laar, consultant, Crop, Soil, and Water Sciences Division, left after completing her assignment.
Dr. C.H.M. Vijayakumar, postdoctoral fellow, left after completing his assignment.

October
Dr. Monina Escalada joined as international research fellow, International Programs Management Office.
Mr. Bui Tan Yen joined as visiting research fellow, Social Sciences Division.
Ms. Jenny Edwards joined as consultant, International Programs Management Office.
Ms. Samjhana Shrestha rejoined as consultant, International Programs Management Office.
Dr. M.V. Ramana Rao joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Ms. Wilailak Sommut joined as visiting research fellow, Social Sciences Division.
Dr. Jeom-Ho Lee joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division; left after completing his assignment on the same month.
Dr. Anand P. Gupta joined as consultant, Crop, Soil, and Water Sciences Division; left after completing his assignment on the same month.
Dr. Leonard Wade joined as consultant, Crop, Soil, and Water Sciences Division; left after completing his assignment on the same month.
Dr. Jonna Estudillo joined as visiting research fellow, Social Sciences Division.

November
Mr. D.C. Gupta joined as visiting research fellow, Social Sciences Division.
Dr. Nguyen Tri Khiem rejoined as visiting research fellow, Social Sciences Division.
Dr. Satish Verulkar joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Aldas Janaiah joined as consultant, Social Sciences Division.
Mr. Ki-Yong Ha joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Ms. Wilailak Sommut, visiting research fellow, Social Sciences Division, left after completing her assignment.
Dr. Benjamin Samson, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Dr. Jonna Estudillo, visiting research fellow, Social Sciences Division, left after completing her assignment.
Dr. Rod A. Wing joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Scott A. Jackson joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.

December
Dr. Virendra Pal Singh, agronomist, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Dr. Rod A. Wing, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Scott A. Jackson, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Cailin Lei, postdoctoral fellow, Entomology and Plant Pathology Division, left after completing his assignment.
Dr. Tilathoo Ram, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Abubacker Jauhar Ali, postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Pompe Sta. Cruz, postdoctoral fellow, Training Center, left after completing his assignment.
Dr. Olivier Panaud joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Mr. D.C. Gupta, visiting research fellow, Social Sciences Division, left after completing his assignment.
Dr. Nguyen Tri Khiem, visiting research fellow, Social Sciences Division, left after completing his assignment.
Ms. Jenny Edwards, consultant, International Programs Management Office, left after completing her assignment.

Dr. Aldas Janaiah, consultant, Social Sciences Division, left after completing his assignment.

Ms. Kimberly Webb, collaborative research fellow, Entomology and Plant Pathology Division, left after completing her assignment.

Dr. Xuehui Sun, collaborative research fellow, Biometrics and Bioinformatics Unit, left after completing his assignment.

Mr. Hideki Yamamoto, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

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

Research support services

ANALYTICAL SERVICE LABORATORIES

This year, the Analytical Service Laboratories (ASL) continued to provide both analytical and analysis-related services to IRRI's research projects, in addition to undertakings that aim to improve its analytical capability.

A total of 43,658 analyses were performed on plant, soil, solution, and fertilizer samples, including elemental C/N and stable isotope ratio analysis of ^{13}C and ^{15}N. Of these, 60% were carried out on plants, 27% on solutions, 11% on soil, and the remaining 2% on fertilizer and other nonstandard samples. Eighty percent were analyzed for the Crop, Soil, and Water Sciences Division, majority of which were for projects that include nutrient and natural resource management in irrigated rice systems, yield potential experiments, C4 pathway and nutrient management in unfavorable rice systems; the rest were distributed between the Plant Breeding, Genetics, and Biochemistry Division (rice nutrition and salinity tolerance) and the Entomology and Plant Pathology Division (plant competition and blast resistance).

Improved turnaround time for 17,744 multielement analyses (~40% of all analyses) was achieved using inductively coupled argon plasma. A more efficient method of grain and other plant analysis was developed, resulting in improved recoveries of 10 elements. In-house enhancement of mechanical to electronic controllers improved the efficiency of sample preparation.

Central to the activities of an analytical laboratory is quality assurance. Its analytical procedures must give reliable and reproducible data. An important control measure is participation in proficiency-testing schemes. The ASL's participation in the Wageningen Evaluating Programmes for Analytical Laboratories-International Plant Analytical Exchange (WEPAL-IPE) has been instrumental in the identification of constraints to Fe, Al, and Si analyses and has made analyses of other elements more robust. More than 250 analytical laboratories take part in the WEPAL-IPE. Each laboratory receives samples four times a year and submits results from which a median is calculated. Comparison of the observed values of 13 elements analyzed by ASL and the IPE median has shown an improvement—from an $r^2 = 0.719$ in 2001 to 0.954 this year.

Cognizant of environmental constraints and budget restrictions, the ASL widened its analytical methodology to include nontraditional prodedures. Near-infrared spectroscopy (NIRS), an environment-friendly and cost-effective method, has been developed to reduce the load of wet Kjeldahl N analysis.

A new nitrogen, carbon, and sulfur analyzer was installed during the latter part of 2002. The analyzer uses the Dumas or dry combustion technique to determine total nitrogen, carbon, and sulfur simultaneously in plant, soil, and other samples. A Windows-based software controls instrument operation and data acquisition and enables easy monitoring, maintenance, and troubleshooting. Experiments were performed to evaluate, calibrate, and set up appropriate parameters for the analysis of different types of samples.

User laboratories

Radioisotope Laboratory. Projects assisted through the use of radioisotope laboratory facilities and liaison services of the Philippine Nuclear Research Institute:

- Salinity tolerance in rice
- Cloning genes for apomixis
- Sulfur nutrition
- Drought tolerance
- DNA isolation and fingerprinting
- Microbial productivity and mineralization rate measurement
- Rice transformation for golden rice
- Rice transformation using disease and pest resistance genes

- DNA labeling for antibiotic resistance
- Biological nitrogen fixation in rice

Organic Analysis Laboratory. The ASL provided consulting services, method development, and run-ready gas chromatography-mass spectrometry facilities to UPLB graduate student requests:
- Analysis of volatile oil
- Analysis of food flavors and fragrances

BIOMETRICS AND BIOINFORMATICS UNIT

Consulting

The Biometrics group provides statistical consulting service for IRRI staff, trainees, and collaborators. We have assisted with the analysis of the following projects:
- Analysis of data from the IRRI Mega Project, including estimation of various variance components which contribute to the variation in indigenous nutrient supplies in rice.
- Design and analysis of data from experiments dealing with micronutrients in rice.
- Analysis of Bruce Linquist's long-term experiment involving different fertilizer levels and residue. The experiment is split-plot with years as repeated measures.
- Analysis of data from a line-sprinkler experiment from Ubon, Thailand.

Statistical research

- Further development of IRRISTAT software to incorporate more help information and new algorithms for handling missing data in pattern analysis.
- Examination of gains in estimation efficiency from incorporating information on pedigree relationships into analysis of breeders' evaluations.
- Development of new modes of G × E interaction which explicitly incorporate correlation between performances in different environments without requiring randomly selected genotypes.

Biometrics training

BBU delivered four in-house training courses within the year and served as trainors in three short-term courses in collaboration with the Training Center. There were also four in-country training courses where BBU staff expertise was availed of. Some participants in these training courses opted to stay longer for on-the-job training within BBU. Details of the training courses are summarized in the following tables:

BBU in-house training course	Date	Participants (no.)
Introduction to SAS for Windows	6–10 May	16
Introduction to IRRISTAT	3–7 Jun	17
Analysis of Unbalanced Data	12–16 Aug	8
IRIS Training Course	26–30 Aug	17

Short-term course	Date	Participants (no.)
Integrated Nutrient Management	11 Feb–1 Mar	25
Rice Breeders' Course	5–23 Aug	20
ARBN Workshop on DNA Microarrays & Bioinformatics	2–4 Dec	50

In-country training course	Country	Date	Participants (no.)
Use of IRIS and Advanced Design and Analysis for Multi-environment Variety Testing	Thailand	30 Apr–7 May	50
Use of ICIS to Manage Breeding Projects for Diverse Vegetable Crops	Italy	28–31 Oct	3
Experimental Design and Data Analysis	Bhutan	4–7 Nov	15
Data Management and Integrated Data Analysis for Crop Management	Indonesia	14–19 Nov	32

Interns and visiting scientists	Country	Date
Mr. Seok-Kyu Yun	Korea	31 Aug–14 Sep
Dr. Satya Ranjan Das	India	31 Aug–6 Sep

Database development and deployment

International Rice Information System (ICIS)
- Carried out the conversion of DMS structure as recommended at the November ICIS workshop; it is now being tested
- Completed the loading of historical INGER data into IRIS
- Published IRIS a www and link it to GRAMENE and SINGER
- Work is ongoing to further develop breeders' applications; SETGEN and WorkBook
- Developed links with Directorate of Rice Research, Hyderabad, to enter national testing data into IRIS

Bioinformatics

- Integrating traditional plant breeding and field evaluation data with functional data, in the IRIS
- Developing laboratory information management systems (LIMS), including bar coding, for managing a variety of functional genomics

experimental materials and data: cDNA clone libraries, DNA microarrays, proteomics
- BMZ/RF-funded Drought Project:
  - Drought-stressed panicle cDNA library and other cDNA clone collections; sequence integration with 2D gels
  - Drought QTL map integration
  - Gene/pathway catalog development
- Search for candidate genes of specific priority traits:
  - *Sub1* (submergence)
  - *Pup1* (phosphorus uptake)
  - Chromosome 1 stress QTL

COMMUNICATION AND PUBLICATIONS SERVICES

IRRI on the Web

IRRI's system of Web sites, including www.irri.org, www.riceweb.org, and www.riceworld.org, continues to grow in popularity and usage. During 2002, more than 685,000 visitors to these sites made just over 2.5 million "hits," or movements within them. These figures do not include the rapidly growing Rice Knowledge Bank at www.knowledgebank.irri.org, which, in recent months, has been garnering more than 2,700 hits from nearly 450 users on a daily basis. Clients downloaded more than 625,000 files—usually in portable document format (pdf format)—of popular information products, such as installments of the discussion paper series, issues of the Institute's new popular magazine *Rice today*, sections of the *International rice research notes* (*IRRN*), abstracts of papers presented at the International Rice Congress in Beijing, and IRRI-developed software.

During the year, the Web sites were enhanced by the addition of
- Two issues of the *IRRN* (www.irri.org/irrn.htm).
- Two issues of the new magazine, *Rice today* (www.irri.org/RiceToday/RiceToday.htm).
- Abstracts of recent IRRI conference and workshop proceedings (www.irri.org/absidx.htm).
- The Medium-Term Plan for 2003-2005 (http://www.irri.org/MTP2003-2005.html).
- A new site for the Irrigated Rice Research Consortium (www.irri.org/irrc).
- A new site for the International Platform for Saving Water in Rice (www.irri.org/ipswar).

IRRI's rice image bank

In 2002, this database of more than 5,000 photographs (depicting landscapes, people, events, markets, laboratories, pests, and diseases) was made available externally on the Web at http://rice-photos.irri.org. Persons who register online are given access for viewing the images only. Those who would like to gain downloading capability or purchase IRRI images in either high or low resolution can contact CPS at irripub@cgiar.org.

One outside user of the image bank stated: "I was really struck, overall, in my browsing through the images at how many beautiful and compelling pictures you have available. Taken together, these images really tell a story (or perhaps they tell a lot of stories). As an economist who works a lot with data, I often feel that the visual element is missing from the messages that I try to convey. These pictures bring home the reality powerfully—the beauty, the drudgery, the sweat, etc. After looking through a lot of IRRI pictures of paddies, my feet started to feel muddy."

Electronic publications archive

In 2002, a new avenue was established for disseminating information—and possibly generating additional income for the Institute. A searchable, electronic archive of IRRI's research publications (nearly 400 titles published over the last 42 years) is now online internally via the IRRI Intranet. IRRI staff members can search for and download relevant chapters of books in pdf format. Saleable products emanating from this database via the external Web site or CDs could include packages of 28 years of the *IRRN,* 40 years of the Annual/Program Report (for research purposes and study), and perhaps other collections, by topic, of IRRI's rich rice research literature.

Traditional publications

CPS produced and distributed 17 titles, including 10 scientific books, one limited proceedings, two issues of the new biannual magazine *Rice today*, one CD on *GIS tools for rural development*, the 2003 rice landscape calendar, a revised IRRI publication catalog, and a special publication, *Rice, the fabric of life in Laos*. Also produced were two issues each of the *IRRN* and *Rice literature update*.

A number of dual- or multiple-imprint arrangements with outside publishers were either completed or initiated in 2002. Perhaps most successful was the contract negotiated with CABI to produce a hardcover version of the 3rd edition of the *Rice almanac*. In addition to CABI and IRRI, others billed as co-publishers on the Almanac cover include FAO, WARDA, and CIAT. Two dual-imprint projects with Oxford & IBH Publishing Ltd. in India included 1) *A handbook of rice seedborne fungi*—published in September and 2) *Increasing productivity of intensive rice systems through site-specific nutrient management*—scheduled for printing in 2003. In conjunction with the Potash and Phosphate Institute (PPI), a *Practical guide to nutrient management* was produced. It is a companion publication to the *Handbook on nutrient*

deficiencies and disorders of rice. IRRI and PPI will be working together to develop local language versions of this handy practical guide for use by both extension specialists and farmers.

Communication support

CPS continues to provide communication support for the entire Institute, including editing, graphic design, art and illustration, audiovisual, photography, video, and printing. In 2002, the unit printed 1,411, 210 pages of text, not including IRRI books, which were contracted out. About 1,696 original slides were produced and 2,099 photographs were printed. IRRI graphic artists produced 139 illustrations, laid out 3,826 pages for publications, and prepared 204 posters. In addition to the work reported here, IRRI editors worked on 688 journal articles and miscellaneous papers (conference papers, abstracts, proposals, and others) totaling about 3,011 pages of text, tables, and figures.

EXPERIMENT STATION

The Experiment Station (ES) supported 40 experiments in the Phytotron, 107 experiments in the greenhouses, 18 experiments in the CL4, served 223 requests for land and field facilities, and provided support services to some 291 ha of rice crop.

Division	Dry season (ha)	Wet season (ha)
PBGB	88.82	69.69
GRC	15.64	4.04
CSWS	11.81	10.02
ES/AE	9.77	64.72
EPPD	5.56	2.82
CIAT	4.00	3.00
TC	1.84	—
Total	137.44	154.29

Total cropped area in 2002 was higher by 17% as compared with the previous year's land utilization. Increased land use was noted in PBGB, ES, GRC, CIAT, and TC. PBGB used a total of 158.51 ha during the year and has remained as the biggest user of the farm.

Land preparation operations were completed for 291 ha of land. This reflected a 20% increase in the overall demand for related ES services as compared with the 2001 levels. Land preparation using four-wheel-drive tractors remains to be the main bulk of heavy equipment operations done by regular staff. On the other hand, the use of small and medium-sized equipment, which used to be done by daily paid emergency staff, has been contracted out through registered service providers and paid on piece-meal basis. This change resulted in improved overall efficiency of the land preparation operations as well as reduced manpower and overhead costs.

The ES provided support and maintenance services for the nurseries, which totaled 9.75 ha (5.75 ha drybed and 4.0 ha wetbed). Drybed nurseries were constructed with the use of the modified tractor-powered rototillers, which are equipped with fluted rollers that mark the rows and furrows. Increased preference for use of the drybed nurseries was noted. The wetbed nurseries were used mainly by PBGB's hybrid trials and a few other experiments of the other divisions. ES used a modified dapog system for its transplanted crop production operations. Seeds are sown and raised on seedling trays topped with a thin layer of soil and fertilizer mixture. This system was found to be more efficient than conventional wetbed and drybed methods of raising seedlings as it significantly reduced the time, area, labor, and the costs required to produce seedlings. Maintaining the seedling flats and harvesting the seedlings for transplanting were also less cumbersome with this method. Other groups in research divisions such as CSWS have started to adopt the same system.

Mechanized direct seeding was the standard crop establishment method used by the farm in rice production whenever weather and field conditions allow. However, with too much rainfall in some cases or deep mud and very wet field conditions in others, the transplanted method of crop establishment was occasionally used in ES-managed production plots. The mechanical transplanter, drum seeder, seed drill, and manual direct seeding methods were used as alternative systems as the situation allows. Under all these schemes, tramlines were commonly established during land preparation to facilitate and improve the efficiency of mechanized crop maintenance operations such as herbicide and fertilizer applications. The standard practice of integrated pest management (IPM) resulted in zero insecticide application in all ES production plots.

The production plots managed by ES for breeder seed increase and crop production occupied a total of 74.79 ha. While yields exceeding 4 t were noted in some of these production plots, a total yield of 296 t was recorded, bringing about an average yield of 3.96 t ha^{-1}.

Two fallow upland fields were grown to *Stylosanthes*, a low-maintenance legume cover crop. This procedure was found to be effective for weed control as well as for improving soil nitrogen levels. Six hectares in the upland area were rotated to maize, peanut, and mungbean during the year for field maintenance and better management of populations of common upland rice pests such as mole crickets and nematodes. Another 4 ha of upland field was leveled and flooded also to control these pests. From one trial in another upland field, solarization using

black plastic sheets was also noted to be very effective in reducing nematode populations, although the cost may be prohibitive. Compared with various methods tested, flooding for a season has apparently been a safe, cheaper, environment-friendly, and more effective nonchemical control of nematodes and crickets.

ES conducted integrated rat control trials during the year using the concept of a community trap barrier system (CTBS) and the line trap barrier system (LTBS). CTBS and LTBS crop and structures were established about 3-4 wk before the 2002 dry season plantings. Flame throwing and destruction of rat burrows were periodically done as needed. Field hygiene was maintained by early land preparation right after harvest and weed control using machines and herbicides. Compared with 2001 levels, there were fewer requests for rat control services noted during the year. Only 39 ha of rice fields were protected with rat fences throughout the two growing seasons and only about 746 baiting stations and 1,100 live traps were installed. These figures are much lower than the previous year, which were 83 ha, 1,714 baiting stations, and 1,351 live traps, respectively. Rat catch for the year totaled only 4,500, which is 61% lower compared with 11,413 rats caught in 2001. Furthermore, no serious rat infestation in the fields was also reported this year. These figures can be taken as a possible indication that the integrated approach to rat control could have effectively reduced rat populations during the trial. It was suggested that a follow-up trial to confirm this be conducted in 2003.

Some 105 t of fertilizer in the form of ammonium sulfate, complete, muriate of potash, solophos, urea, zinc oxide, and zinc sulfate were supplied to various divisions during the 2002 plantings. Compared with 2001 levels, molluscicide and insecticide use was higher by 12% and 15%, respectively. Herbicide use also increased by 31%. The increase in agrochemical use, however, has been primarily attributed to the significant (17%) increase in cropped area during 2002. Relative to previous years, a lower incidence of snails and insect pests was actually noted during 2002. The possible benefits of maintaining fallow fields through dry tillage, water management, and weed control cannot be discounted. Increase in herbicide use was also attributed to the relatively prolonged wet season and well-distributed rainfall, especially throughout the later half of the year, which favored vigorous growth of weeds. Application frequencies in most fallow fields, perimeter areas, and levees had to be increased. Application of sublethal doses of nonselective herbicide was regularly done to reduce cost of mowing and brush cutting in maintaining fallow areas, levees, and perimeter fences. Preplant and postplant application of molluscicide and preemergence application of herbicides was commonly done using the Mudmaster. Herbicide applications to maintain fallow and perimeter areas were done using tractor boom and hand tractor sprayers.

Land development work done during 2002 covered a total area of 15 ha. The earthworks included the leveling and conversion of upland fields into lowland fields in blocks D, UJ, UQ1, UQ4, UR1, UR2, UT1, UX1, UX2, UZ1, and UZ4. Most of the development and conversion works were done to meet changing requirements of scientists in these crop-growing areas. Major road rehabilitation work was done on 1,800 m of the main road of old, lowland, and upland areas. Road maintenance work included the reshaping and back-filling of about 15 km of road networks. The lot adjacent to ES building 2 was also cleared and the coarse base foundation for the new rice mill building was also established and compacted in the site using some 700 m^3 of filling and binding materials. Excavation and land development support with the use of ES heavy equipment was provided to the landfill site. Land development was also done on 7 ha of lowland fields to meet the different requirements of both UPLB and IRRI as part of the land reallocation agreement for 2002, which was also negotiated through ES initiative. Year-round maintenance work of the mechanical operations unit also included upkeep of the upland soil rotation site, regular back-filling of the dumpsite in block US, trash collection, and gathering of rice stalks and straw around the fields.

Five hundred and two requests for repair and maintenance of light and heavy equipment, implements, and reservoir pumps were served. Fabrication works include connectors and fuel tank mounting for mobile pumps, a corn seeder, a sweep plow, and two prototype trailers. Repair and maintenance services for small farm equipment and machinery were provided year-round. ES also fabricated and assembled a specially designed zero-till seeder and a tractor complete with a bucket leveler and laser-leveling accessories for use by a CSWS group in their rice techno-demo projects in Tarlac and Nueva Ecija.

Continuous improvement of the irrigation and drainage systems include, among others, the installation of 400 m of polyvinyl chloride pipes in block UY; excavation works for some 180 m of drainage in series 400 to 700; installation of 17 manhole covers at the old area; upgrade and painting of 262 riser pipes; replacement of four gate valves; and the design and construction of 42 drainage outlets in the new lowland and upland areas. Extraction, repair, and installation of submersible pumps in block C1, F, and UT were also completed during the year. To improve further on the reliability of irrigation services, a new 40-horsepower tow-away mobile pump and three spliced standby

submersible pumps were acquired and set up for stop-gap, quick-response operations in case of pump breakdown at anytime especially during the peak seasons.

Refurbishment works on three ES buildings were completed during the year. These included repainting, improvements on the roof and support structures as well as the comfort rooms, and modernization of the ES administration offices to improve efficiency, communication, and productivity in these areas. The mechanical shop compound was reorganized to remove unnecessary clutter and open up more space in the covered shed for heavy equipment parking. An open space of the mechanical shop compound was concrete-paved and designated as the outdoor holding area for tractor implements. Thirty-six tractor implements were also rustproofed and repainted to extend their useful life and improve aesthetics. One thousand four hundred meters of cyclone wire fencing was installed around the reservoirs in blocks H, J, K, L, and upper MN for safety and security in these areas. Construction of a modern rice mill facility was also completed during the year. The recirculating drier has been relocated and a new modern grain dryer was put up; it is now fully operational in the upland area. A new combine harvester was also acquired later during the year.

The Controlled Growth Facilities and Grounds unit of the Experiment Station served some 717 maintenance requests. About 4,680 pots were issued to various users this year to meet increased demand from pot experiments. This is in addition to the 8,000 assorted pots, which were provided during the previous years. A total of 802 t of soil was provided to various research requirements. Installation of the 10-horsepower soil-grinding machine and the construction of the new soil grinding shed in the upland farm was completed and now fully operational.

Renovation and refurbishment work done in 12 glasshouses, 11 screenhouses, and 2 headhouses included repainting, re-roofing, and siding replacements with new standard replacement materials. In accordance with the requirements of the National Committee on Biosafety of the Philippines (NCBP), two screenhouses were also modified and renovated for use in screenhouse growing of transgenic materials.

Staggered 1-mo shutdown operations were done on all greenhouses to facilitate preventive maintenance work and more importantly to break pest and disease cycles. The annual shutdown for Phytotron preventive maintenance operations was done in November following the new standard procedure established the year before. As in the previous year, this strategy has facilitated earlier scheduling of experiments for the coming year, helped avoid the work peaks and holiday rush, and significantly reduced overtime costs associated with the long holidays of December.

Improvements in the CL4 facility included replacements of the worn-out ceiling in the autoclave room and pass-through autoclave area. Entire greenhouse roof replacement with UV-resistant polycarbonate material was also completed and closely coordinated with the IRRI Biosafety Committee (IBC), Bureau of Plant Industry (BPI), and the NCBP. The replacement process was also coordinated with IRRI and UPLB scientists conducting their experiments in this facility for assurance on adherence to agreed protocols, rules, regulations, and requirements of the various committees and government agencies.

Repainting was done on support structures of the Phytotron. The chilled water pump system and the hot and cold water tanks were also rehabilitated. Six new replacement humidifiers were installed on the glasshouse bays. New 3-horsepower and 10-horsepower compressors were also acquired to back up both the CL4 and Phytotron cooling systems. Installation and test run of a new computerized controller system were also initiated in December.

Use of reverse osmosis grade water at the Phytotron increased from 54,000 L last year to 65,000 L this year. Some 1,006 requests for use of the sample-drying oven were served. Increased utilization of the hurricane dryer at the Phytotron and the autoclave in the CL4 was also noted.

Routine ground maintenance and development operations were done year-round in both staff housing and the research center. Low-cost re-landscaping was done to improve aesthetic appeal in a number of locations, which include the Swaminathan Building frontage, the boardroom, the islet near post II, and some areas in the main entrance. Lotuses and lilies were replanted in all the fishponds and a recirculating fountain was installed in the NCBL pond, both for aesthetics and for improving oxygen levels for the fishes. Regular mowing operations, road sweeping, brush cutting, and garbage collection formed the main bulk of daily operations. The research center ground shed was extended to house more equipment and increase the nursery work area. A number of equipment were also upgraded to increase efficiency and reduce maintenance costs. Equipment replacement acquisitions included three push mowers, two brush cutters, and various hand gadgets and kits, among other essential tools and instruments. Plant arrangement support was provided throughout the year for the various seminars, workshops, and special events, which include IRRI days I and II.

Various changes were introduced to improve the kabesilya system. Kabesilya coordinators have been

tasked through the division heads to help in monitoring the levels of utilization, adherence to guidelines, as well as the quality of services of the kabesilya workers, among others, within each division. ES, with the support and guidance of the office of the Deputy Director General for Partnerships and the Legal services, Treasury and Accounting offices, and the DDG-P consultant, successfully organized the kabesilya leaders into a cooperative. One of the ES storage rooms was refurbished and equipped to serve as the cooperative's new office. A number of operational procedures were also put in place to improve adherence to national and institutional requirements. Policies and guidelines established by IRRI, in accordance with the requirements of the Department of Labor and Employment, as well as the Bureau of Working Conditions, were strictly implemented through a number of control measures and checkpoints that have been incorporated into the revised operational procedures. A new ID system has also been implemented.

Government-mandated adjustment in the minimum wage of contractual farm workers upped daily pay rates by 10%. Consequently, coupled with the increase in land utilization by 17%, institute expenditures went higher by 2% for contract work, despite the overall reduction in the total number of man-hours utilized for this service. Bird boy expenditures, on the other hand, was even higher, attributable to both the increase in pay rates and the increase in areas of production that needed to be protected against bird damage. The year 2002 man-hour utilization, which totaled 774,538 for contract work and 155,028 for the bird boys, was down by about 7% and up by 22%, respectively, when compared with 2001 levels. In the overall analysis, total cost incurred by the institute for kabesilya and bird boy services combined went up by only 6%, despite the 10% pay hike and the 17% increase in land utilization.

Twenty-three staff of the ES joined the staff retrenchment program during the year. In anticipation of possible operational difficulties due to staff reduction, on-the-job training on the use and maintenance of specialized equipment was provided to selected staff early on during the year. For instance, staff members from the greenhouse unit were provided in-house, on-the-job training on the maintenance and operation of sensitive Phytotron and CL4 equipment, while several other farm staff were trained on use of farm heavy equipment such as graders, road rollers, combine harvesters, and farm tractors, among others. These efforts, along with other restructuring strategies, facilitated a smooth transition period within the whole ES.

ES provided full field logistical support to the CGIAR pre-Annual General Meeting (AGM). Experimental plots and crops were established to serve as demonstration areas that highlighted the important research projects and activities of the institute. The rest of the research center farm and grounds was kept in highly presentable condition. A number of trailers were redesigned, converted, and fabricated at the lowest cost possible to transport the participants safely and comfortably during the IRRI field days (IRRI days I and II). A strategic and systematic tour scheme was conceptualized and several dry runs were organized, orchestrated, and coordinated through ES to help ensure the success of the field days, most importantly, the pre-AGM at IRRI.

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 NGOs, and the municipalities and barangays of Los Baños and Bay, among others.

LIBRARY AND DOCUMENTATION SERVICE

- The Library's computerized system was upgraded to the web-based Innopac Millennium.
- The Z39.50 broadcast software was installed, enabling instant import of data from libraries worldwide.
- A total of 3,056 bibliographic records were added to the Online Public Access Catalog (OPAC); it now has 70,710 entries.
- The rice bibliography database now includes 205,869 records, with the addition of 10,150 rice literature citations.
- Three hundred and sixteen electronic resources were cataloged and added to the OPAC.
- Two issues of the *Rice Literature Update* were published.
- The International Bibliography of Rice Research CD-ROM was distributed to scientists and institutions worldwide.
- Conventional and electronic document delivery was provided to researchers from 51 countries, including those from the CGIAR system.
- Current awareness was strengthened through the updated list of conferences, list of new acquisitions, and regular announcements in the electronic *IRRI Bulletin* and the public announcements folder.

VISITORS AND INFORMATION SERVICES

Information services

- Provided information and media support for the International Rice Congress on 16-20 Sep in Beijing. More than 40 media representatives attended, including Reuters, AP-TV, AP, and *Singapore Straits Times*. Issued three press releases. The ministers of Agriculture or their representatives from 16 nations unofficially endorsed the Beijing Declaration on Rice. Coordinated and developed a major IRRI exhibit.
- Provided information and media support for the AGM of the Consultative Group on International Agricultural Research (CGIAR) in Manila. Press representatives numbered 23 at the AGM launch at the Department of Agriculture in Manila, 11 at the CGIAR-Farmers Dialogue, 14 at Philippines Day, four at IRRI Day, 11 at the CGIAR Science Awards, and 28 at a press conference.
- International and local press clippings on the CGIAR AGM 2002 totaled 77. Other international press clippings referring to IRRI or rice research tallied at 210 items; these appeared in the *Star Ledger*, *Canberra Times*, *Panorama*, *Asian Wall Street Journal*, *Frankfurter Allgemeine Sonntagszeitung* (German newspaper), *Washington Post*, and *Bangkok Post*. Placed features produced in-house on IRRI projects in Vietnam in half a dozen general-interest or development-oriented publications. National clippings totaled 131 and Web site clippings, 69.
- Replaced the annual report with the biannual, popular-format magazine *Rice Today*, the first two issues of which attracted several dozen favorable responses and/or requests for copies. Issued 25 press releases and five photo releases. Placed 11 major press releases and four major photo releases on the IRRI Media Hotline Internet site. Issued several letters to the editor in response to misrepresentation of IRRI activities or positions regarding Golden Rice, genetic modification, pesticide use, jasmine rice, or staff reduction.
- Produced four *IRRI Hotline* issues and distributed them electronically via IRRI Web sites. Distributed 10 issues of the in-house publication *Sandiwa* to IRRI staff.
- Strengthened partnerships with foreign and national media such as the Manila-based Foreign Correspondents Association of the Philippines and supported the activities of the Philippine Science Journalists Association. Provided support for IRRI's participation in various activities of the Los Baños Science Community and the municipal government of Los Baños, notably on information and environment issues.
- Developed programs and organized interviews for more than 20 visiting local and foreign journalists, including those from the Danish International Development Agency-supported Express TV Produktion, Reuters, WDR Radio of Cologne, NHK of Japan, Department for International Development-commissioned WREN media of London, *GEO Journal* of Germany, and Canadian Broadcasting Corporation.
- Rendered editorial services to the Director for Program Planning and Development (executive summaries for donor documents) and the Office of the Director General, including development and placement of an op-ed in the *Canberra Times* newspaper and a paper in *Asia Pacific Biotech News*.

Visitor services

- Handled 55,909 visitors during the year, a decline of 5,416 visitors, or 11% from 61,325 in 2001. Among distinguished visitors were 17 high government officials including His Excellency Prime Minister Boun-nhang Vorachit of the Lao People's Democratic Republic; the Australian and Bangladeshi ministers of Agriculture; the Japanese minister of Foreign Affairs; a top Philippine presidential adviser; seven members of the Philippine Congressional Committee on Agriculture, Food, and Fisheries; a provincial governor of Papua New Guinea; and a four-member delegation from the Federated States of Micronesia. Among diplomatic visitors were the ambassadors to the Philippines of India, Cuba, Japan, South Korea, and Bangladesh and a consul of Belize.
- Meetings and events connected with CGIAR AGM 2002 in October brought to IRRI the board chairs of nine CGIAR centers (CIFOR, CIMMYT, ICARDA, ICRISAT, ILRI, IRRI, ISNAR, IWMI, and WARDA), the directors-general of 13 centers (CIAT, CIFOR, CIP, ICLARM, ICRAF, ICRISAT, IITA, ILRI, IPGRI, ISNAR, IFPRI, IWMI, and WARDA), and representatives of many donors and partners including the Swedish International Development Authority (SIDA), Swedish Agency for Research Cooperation with Developing Countries (SAREC), United States Agency for International Development (USAID), German Federal Ministry for Economic Cooperation (BMZ), German Agency for Technical Cooperation (GTZ), German Advisory Service on Agricultural Research for Development (BEAF), Japan International Research Center for Agricultural Sciences (JIRCAS), Swiss Development and Cooperation (SDC), German Foundation for International Development and Food and Agriculture Development Center (DSE/ZEL), British Department for International Development (DFID), Japanese Ministry of

Foreign Affairs, Philippine Department of Agriculture, Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF), European Commission (EC), Danish Ministry of Foreign Affairs, and World Bank/Japan. Among visitors earlier in the year were a large delegation from USAID, the directors of the CGIAR, and the Bangladesh Rice Research Institute, and the director of Research of WARDA.

- Hosted or cohosted 19 regional or international conferences, workshops, and symposia, drawing 1,159 participants from 59 countries (see table), in addition to in-house seminars, workshops, and meetings.
- In Riceworld Learning Center, renovated the Training Center exhibit to feature the Rice Knowledge Bank Web site and created an exhibit near the farming implements section for the leaf color chart. Developed plans for further renovations in the engineering and biotech sections in early 2003.

Community projects

- Donated 10 computers each to a high school and a program for out-of-school youth in Bay municipality, one to an elementary school, and four to the University of the Philippines Los Baños.
- Provided 5 days of neighborhood emergency services team (NEST) training (first aid, emergency rescue, etc.) for 39 local youths and service employees in Los Baños municipality.
- Delivered free medical services in monthly missions to 16 villages and neighborhoods, providing 920 local residents with diagnostic tests covering blood sugar, cholesterol, and triglyceride levels, blood typing, and heart health, as well as medical consultations.
- Conducted livelihood training for residents of neighboring villages in basic electrical wiring of buildings, soap making, coconut milk preservation, vinegar fermentation, and candy making.

International and regional conferences, workshops, symposia and meetings hosted or co-sponsored by IRRI in 2002.

Date	Title	Venue	Number of participants	Countries represented
15-16 Jan	**Irrigated Rice Research Consortium Steering Committee Meeting**	**Thailand**	**30**	**10**
15 Feb	ICAR-IRRI Collaborative Workplan	India	55	2
18-20 Feb	**Workshop on the International Treaty on Plant Genetic Resources for Food and Agriculture**	**IRRI**	**43**	**16**
21-22 Feb	Genetic Resources Policy Committee Meeting	IRRI	17	10
26-28 Feb	**Asian Regional Consultation on the World Bank's Rural Development Strategy**	**Vietnam**	**50**	**14**
12-15 Mar	Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia	IRRI	60	11
18-20 Mar	**Inaugural meeting of the IRRI-Asian Development Bank project on hybrid rice**	**IRRI**	**36**	**12**
22-25 Apr	Planning workshop: Managing soil organic matter and crop residues for sustained productivity in rice ecosystems	IRRI	17	5
24-28 Apr	**2002-2003 Workplan for collaborative research and training between the Rural Development Administration of the Republic of Korea and IRRI**	**Korea**	**29**	**2**
17-20 May	4th National Symposium on Hybrid Rice	Vietnam	180	20
20-22 May	**Planning workshop: Integrated nutrient and pest management in intensive irrigated rice ecosystems**	**IRRI**	**17**	**5**
27-30 May	An international workshop on progress toward developing resilient crops for drought-prone areas	IRRI	112	17
28-30 July	**ATUT food crops research: final workshop meeting**	**Egypt**	**91**	**3**
2-3 Sep	Irrigated Rice Research Consortium Ad Hoc Technical Advisory	IRRI	16	5
16-20 Sep	**First International Rice Congress**	**IRRI**	**236**	**48**
29 Sep-12 Oct	Training workshop on rice technology transfer systems in Asia	IRRI	19	11
8-11 Nov	**Water-Wise Rice Production**	**IRRI**	**54**	**11**
26-27 Nov	Consortium on unfavorable rice environments. Working Group 6 Workshop on Favorable Plateau Uplands.	IRRI	27	2
2-7 Dec	**Microarray and Bioinformatics Workshop II: Gene array applications and candidate gene identification in rice and other cereal crops**	**IRRI**	**70**	**11**
TOTAL			**1,159**	**59**

INFORMATION TECHNOLOGY SERVICES

Infrastructure

The 2-year-old connection between the research center and staff housing was upgraded from a 1-Mbps DSL connection this year to a 1-Gpbs (1,000 Mpbs) fiber optic link. The new link will support voice communications with a new telephone system as well as network communications. Connectivity over 40-year-old phone lines will be retained for resilient connectivity (i.e., we will revert to DSL if the fiber goes down). Wireless network access points were installed in major meeting rooms at the research center and in the IRRI Guesthouse.

Data cabinets. Data cabinets and Ethernet infrastructure in several buildings on campus were rehabilitated (24 of the 59 data cabinets on campus in all). Old 10 Mbps Ethernet hubs were replaced with higher density 100 Mbps Ethernet switches and patch cords were replaced with shorter ones, labeled, and generally tidied up. In some places, cables damaged by rats were replaced.

Other changes included upgrading of the storage network (a separate network for storage traffic) from 100 Mbps Ethernet to Gigabit Ethernet. A new telephone cable was extended to Pleasant Village Apartments. This will be used to implement a DSL circuit to bring these onto the IRRI network in 2003. The DMZ and untrusted firewall zones of the campus network were extended from the CPS building computer room to the Umali data center. The servers hosted in the Umali data center can now be configured to be accessible from the Internet. The CPS, Umali, F.F. Hill and NCBL buildings will be interconnected in a logical ring so that a break in the ring will not cause a loss of connectivity on campus. This network backbone will be also be upgraded to Gigabit Ethernet in 2003 (10x faster) to accommodate growing network traffic.

Storage area network (SAN) capacity expanded. An extra shelf was added to our storage network and additional disks ordered. Part of the extra capacity was allocated for a K: (for Knowledge) drive—a read-only archive of reference information, part of a growing digital media assets collection managed by CPS. The hub of the Network Appliance (www.netapp.com) SAN is expected to expand in future and play a role as important as the library today in facilitating access to IRRI information in electronic form. The SAN currently stores email, Intranet web portal content, the contents of personal network drives of scientists. In future, it is intended to store all information currently stored on all PCs and most servers.

We continued our effort to implement an IRRI standard server-operating environment. These servers are essentially identical and feature interchangeable drives. With application data stored on the storage network, it is possible to swap drives and bring up an application, e.g., email using a backup server. We did this several times in 2002 as our Compaq servers proved to have a generic fault with their power supplies which caused them to fail (all were replaced by Jan 2003).

Disaster recovery

A disaster recovery plan for IRRI's IT operations was reviewed by an external IT auditor in 2002 and reportedly considered "excellent." During the year, we recovered in 1 hour from a mail system hardware failure and were able to switch in hours to a backup Internet connection when our main Internet Service Provider experienced an outage. Future plans will focus on improving our ability to recover from more serious incidents, including fires and acts of terrorism.

Asset management

In July, 1 year into it and with phase one (a full hardware and software inventory) completed, we cancelled an asset management project outsourced to Wesolve Inc. and negotiated a full refund of expenses. The software used for the project was withdrawn from the market by the manufacturer (Computer Associates) mainly because it was acknowledged to be incapable of meeting customer requirements in the area of automated software deployment, an intended second phase of the project.

After this setback, we then undertook the work ourselves, using a different solution. We now have complete hardware and software inventory information for more than 940 computers used to log in to the IRRI network. In all, we have more than 1,100 Internet addresses in use on our network with a growing population of instruments, cameras, swipe card readers, and other devices. Most of the computers belong to IRRI but hundreds belong to visiting scientists, staff housing residents, the ISLB, and staff of sister institutes on campus. The automated inventory data are available online in the form of web pages and will be available to each organizational unit.

We introduced bar coding of IT assets in 2002 and adopted a fixed device-naming convention, both of which, combined with new operating procedures, will help ensure that institute records of IT assets and their disposition remain current at all times in future.

Security

Restrictions in use of Windows 2000 Administrator passwords were applied using a network logon

script and numerous other security policies were put in place in 2002. These included restrictions in logon times and locations and enforcement of strong password policies.

In 2002, we implemented software to automatically manage the network configuration settings of devices on the IRRI network, restricting access to the network to known hardware. Future plans include segmenting the network to enable visitors to have wireless Internet access automatically without access to the IRRI network.

Several administrative cases of inappropriate use of IT facilities were filed. All were resolved in IRRI's favor, with disciplinary sanctions in some cases and a significant refund to IRRI in the case of a consultant employed on site.

Telecommunications

As planned and communicated to external auditors in 2001, IRRI began the process of phasing out the employment of contract staff in the telecommunications room. One of the operators was recruited as an IRRI employee; another IRRI employee replaced the second contract employee in Jan 2003.

Tenders. Telecoms services were tendered for in the first quarter and the number of providers was subsequently cut from five to two: PLDT and PT&T (the latter is used mainly for backup). Tendering for the replacement of 13-year-old Siemens telephone system was completed and an award made to Nortel reseller MDI for the installation of a Nortel Meridian 81c telephone system.

Systems

The new system, the installation of which began in December, offers numerous advantages over its predecessor. These include voicemail, integrated fax messaging, teleconferencing, and Internet telephony capabilities (for use by IRRI country offices and traveling staff).

New services. A DSL circuit was provided to IRRI Makati office, giving immediate, rather than periodic, dial-up access to IRRI email and to the Internet. In 2003, this connection will be used to provide access to IRRI's network via a virtual private network (VPN) connection.

A 64-k dedicated circuit linking IRRI to the network operating center of the CGIAR's integrated voice and data network (IVDN) in Menlo Park, California, came into operation in April. Cisco voice over Internet protocol (VOIP) technology was deployed successfully with this circuit. The result of this project was a major improvement in the quality of IVDN calls.

Internet bandwidth doubled to 2 Mb. This Internet service provider (ISP) change, from Eastern Telecom to PLDT, took a few weeks to complete, during which time both circuits were operational. The last ISP change, from CGNET Services to Eastern Telecom, took several months to complete. Future changes will now be possible within a day due to other network changes implemented in 2002.

A second E1 (2 Mb) off campus broadband link was commissioned for use as a backup circuit using PT&T IVDN tower. This was tested and used successfully during a PLDT circuit outage.

A digital (ISDN BRI) circuit was provided for video conferencing and a Sony PCS 1600 video conferencing system was installed in the IRRI board room. The system was successfully tested (but not yet with international call). The dedicated circuit is provisioned temporarily, pending the installation of a new phone system that will use a higher capacity digital (ISDN PRI) circuit.

Services

ITS announced the opening of an online store ("IRRIconnection") in December 2001 to provide immediate delivery of commonly required items. The service expanded significantly in 2002 and is now used routinely by IRRI staff.

Training

ITS introduced e-learning courses that enabled staff to learn at their desks by taking courses online. While the courseware was well received, many staff members expressed a wish to get away from their desks to avoid interruptions while learning and, in some cases, to have classroom training as well.

Improvements/innovations

In 2002, ITS began use of credit card for online ordering of software utilities and minor pre-approved expenses. The result was a much faster procurement system.

IRRI took a lead role in arranging the first software license for an application to be deployed on all CGIAR desks running Microsoft Outlook (negotiated by Paul O'Nolan –for 80-20 Retriever) (More information at: http://www.80-20.com/aboutus/news/2002_02_12.htm.) This software provides staff with a personal search engine for their own email and documents.

Following the conclusion by the CGIAR CIO of negotiations with Microsoft, IRRI can obtain all Microsoft products at charity pricing. Previously we obtained academic pricing, which many centers could not obtain on a range of products. The arrangement is slightly less favorable to IRRI but will save the CGIAR money overall.

ITS introduced a weekly dashboard with summary information about various projects and resource demands (e.g., bandwidth resources used during the period monitored).

IRRI.PH domain was used for email communications with IT Services staff when IRRI email is unavailable or inaccessible to traveling staff. The address support@irri.ph is monitored automatically every 5 min during working hours and periodically at other times. Future plans include adoption of SMS messaging for this and other alerts.

IRRI Information Online in China: www.irri.org.cn

At the International Rice Congress held in Beijing in September 2002, IRRI announced that a copy of its Internet Web site is now online in China. With the cooperation of Dr. Juncai Ma, director of the Information Network Center of the Institute of Microbiology of the Chinese Academy of Sciences, a so-called mirror copy of the IRRI Web site now exists online at www.irri.org.cn. China is the first country to have an IRRI mirror site like this established.

Today, access to international online information resources from China can be costly and sometimes difficult (individuals pay per hour and per kilobyte for Internet access and information). Chinese scientists and students now have faster and lower cost access to IRRI's information resources in China.

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

Degree and postdegree training in 2002

1. Number of scholars who completed their training in 2002.

Region	Country	Type I[a]		Type II[b]		Type III[c]	Total
		PhD	MS	PhD	MS	ND	
Africa							
	Ethiopia	0	1	0	0	0	1
	Madagascar	0	0	1	0	0	1
	Subtotal	0	1	1	0	0	2
Asia							
	Bangladesh	1	0	0	0	0	1
	China	1	1	0	0	2	4
	India	1	1	0	0	4	6
	Indonesia	0	0	0	0	2	2
	Iran	0	0	2	0	0	2
	Japan	3	0	0	0	0	3
	Korea	0	0	0	0	3	3
	Pakistan	1	0	1	0	1	3
	Philippines	0	1	0	0	0	1
	Thailand	0	0	1	0	0	1
	Vietnam	0	1	1	0	3	5
	Subtotal	7	4	5	0	15	31
Europe							
	Portugal	0	0	0	0	1	1
	Subtotal	0	0	0	0	1	1
North America							
	Cuba	0	0	0	0	1	1
	Subtotal	0	0	0	0	1	1
South America							
	Peru	0	1	0	0	0	1
	Subtotal	0	1	0	0	0	1
Total		7	6	6	0	17	36

[a]Type I = MS and PhD scholars, thesis research at IRRI. [b]Type II = MS and PhD scholars, coursework and thesis at IRRI. [c]Type III = On-the-job/ nondegree.

2. Number of current scholars on board in 2002.

Region	Country	Type I[a]		Type II[b]		Type III[c]	Total
		PhD	MS	PhD	MS	ND	
Africa							
	Ethiopia	0	0	1	0	0	1
	Ghana	0	0	0	1	0	1
	Tanzania	0	0	2	0	0	2
	Subtotal	0	0	3	1	0	4
Asia							
	Bangladesh	6	0	1	0	0	7
	Cambodia	0	0	1	0	0	1
	China	7	3	0	0	1	11
	India	9	0	0	0	1	10
	Indonesia	0	1	2	0	0	3
	Iran	1	0	1	0	0	2
	Japan	3	0	0	0	0	3
	Korea	1	0	0	0	0	1
	Myanmar	1	0	0	0	0	1
	Nepal	1	1	3	1	0	6
	Pakistan	1	0	0	0	0	1
	Philippines	2	4	2	0	0	8
	Vietnam	2	1	4	2	0	9
	Subtotal	34	10	14	3	2	63
Europe							
	Germany	1	0	0	0	0	1
	Netherlands	1	0	0	0	0	1
	Portugal	1	0	0	0	0	1
	Subtotal	3	0	0	0	0	3
North America							
	United States	0	1	0	0	0	1
	Subtotal	0	1	0	0	0	1
Total		37	11	17	4	2	71

[a]Type I = MS and PhD scholars, thesis research at IRRI.[b]Type II = MS and PhD scholars, coursework and thesis at IRRI. [c]Type III = On-the-job/ nondegree.

3. Group training courses in 2002 (headquarters).

Date	Course title	Duration	No. of participants
21 Jan – 01 Feb	Two-Week Rice Production Course	2 wk	26
11 Feb – 01 Mar	Developing Integrated Nutrient Management Options	3 wk	25
4 – 22 Mar	Principles and Practices of Farm Management	3 wk	19
01 – 26 Apr	Integrated Pest Management Course	4 wk	27
06 – 10 May	Introduction to SAS for Windows	1 wk	14
13 – 24 May	Scientific Writing and Presentation Skills	2 wk	14
20 – 24 May	Genetic Engineering and Nutrition in Rice	1 wk	12
03 – 07 Jun	Introduction to IRRISTAT Statistical Software	1 wk	17
24 Jun – 19 Jul	Instructional Video Production	4 wk	7
22 Jul – 2 Aug	Two-Week Rice Production Course	2 wk	26
5 – 23 Aug	Plant Breeding Course	3 wk	20
12 – 16 Aug	Unbalanced Data Analysis	1 wk	8
26 – 30 Aug	International Rice Information System for Plant Breeders Training	1 wk	17
1 – 13 Sep	e-Learning for Development	2 wk	7
11 – 22 Nov	Leadership Course for Asian Women in Agriculture R & D	2 wk	20
Total			**259**

4. Collaborative in-country courses in 2002.

Course title	Date	Venue	No. of participants
MAS Training	25 Feb – 1 Mar	Faculty of Agriculture, Chiang Mai University	19
Quantitative and Qualitative Research Methods	26 Feb – 1 Mar	Cuu Long Delta Rice Research Institute (CLRRI), Cantho, South Vietnam	25
MAS Training	1 – 5 Apr	Khon Kaen University	23
MAS Training	8 – 19 Apr	IRRI – CIRAD	22
MAS Training	22 – 26 Apr	Center of Ecological Economics, Chulalongkorn University	31
Laser Leveling	28 – 31 Jul	Department of Irrigation and Water, Delhi, India	10
	5 – 7 Aug	China Agricultural University, Beijing	42
Taq Polymerase Extraction and Basic Molecular Biology Laboratory Design and Setup	10 – 13 Sep	Shanghai Agrobiological Gene Center, Shanghai, China	8
Training Workshop on Rice Technology Transfer Systems in Asia	29 Sep – 12 Oct	International Technical Cooperation Center, RDA, Suweon, Korea	19
MAS Training	14 – 25 Oct	Faculty of Agriculture, Chiang Mai University	31
MAS Training	8 – 19 Oct	Khon Kaen University	34
Experimental Design and Data Analysis	4 – 7 Nov	Renewable Natural Resources Research Center, Bajothang, Wangduephodran, Bhutan	15
Data Management and Data Analysis for Integrated Crop Management	14 – 19 Nov	Sukamandi Rice Research Institute, Sukamandi, Indonesia	32
Conducting instructional classes on "data gathering and record keeping on the utilization of hybrid rice breeding nurseries"	23 – 26 Nov	Bangladesh Rice Research Institute, Gazipur, Bangladesh	10
Total			**321**

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

Finances

Summary of financial support to IRRI research agenda, 2002. (in US$'000).

Asian Development Bank	490
Australia	805
Belgium	92
Canada	
Canadian International Development Agency	686
China	130
Denmark	663
European Commission	2,304
France	632
Germany	
Federal Ministry for Economic Cooperation	235
Federal Ministry for Economic Cooperation/German Agency for Technical Cooperation	728
India	150
International Fund for Agricultural Development	159
Iran	112
Japan	3,560
Korea	524
Netherlands	326
Norway	200
Philippines	97
Portugal	81
Rockefeller Foundation	1,130
Sweden	397
Switzerland	2,156
Thailand	26
United Kingdom	4,635
United States of America	
United States Agency for International Development	3,786
United States Department of Agriculture	84
Vietnam	15
World Bank	3,862
Others	340
TOTAL	**28,405**

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

Weather summary

Annual rainfall for year 2002 was 1,681 mm for the IRRI dryland (upland) site and 1,726 mm for the wetland (lowland) site (see table). These values were 438 mm lower than the long-term average rainfall for the upland site and 319 mm lower for the lowland site. Los Baños experienced twice more rainfall in July this year, compared with the long-term amount (Fig. 1). The wettest day at IRRI occurred 20 Jul with more than 138 mm rainfall per day. The longest recorded continuous wet spell was 9 d at the upland site (4–12 Oct) and 10 d at the lowland site (1–10 Jul). The longest continuous dry spell was 21 d at the upland and lowland sites (24 Mar–13 April).

Mean monthly solar radiation reached a peak in April (more than 23 MJ m^{-2} d^{-1}) and gradually declined to 13.8 MJ m^{-2} d^{-1} in November (Fig. 2). Solar radiation was relatively low during the first decade of July. The highest recorded cumulated solar radiation (29.6 MJ m^{-2} d^{-1}) occurred 4 May. The average duration of bright sunshine was about 10 h d^{-1} in April and declined to low values of 4.4 h d^{-1} in July. The longest record of sunshine at Los Baños was on 28 Apr and 7 May with 12.1 h of bright sunshine.

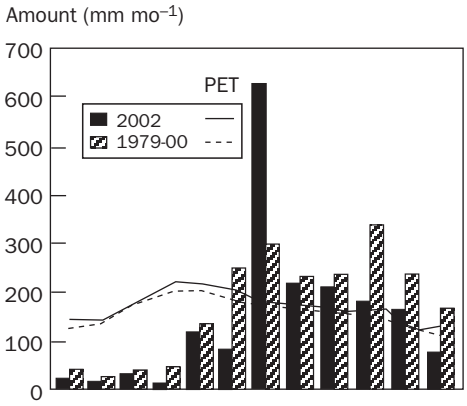
Maximum temperature reached its highest monthly mean value in May (34.6 °C at the upland site and 33.1 °C at the lowland site); it then gradually dropped to its lowest monthly mean value in January (29.6 °C at the upland site and 28.5 °C at the lowland site) (Fig. 3). Except for July, the recorded averages of maximum temperature for 2002 were higher than the long-term average. The hottest day in Los Baños was on 11 May with 36.7 °C of recorded maximum temperature at the upland site. The distribution of minimum temperatures was more stable than the distribution of the maximum temperatures. The coldest days for 2002 was on 6 Jan and 4 Feb with 19.4 °C in the upland site and 5 Jan with 19.0 °C in the lowland site.

Mean early morning relative humidity ranged from 75 to 89% in the upland site and from 79 to 87% in the lowland site. Midday vapor pressure deficit was consistently higher in the upland site than in the lowland site (Fig. 4).

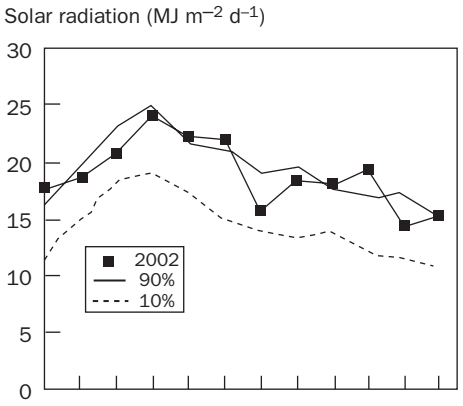
Daily mean windspeed, measured at 2-m height was 1.6 m s^{-1} for the upland site and 1.5 m s^{-1} in the lowland site. Windspeed was generally low (<2.6 m s^{-1}), except during tropical disturbances. Maximum 24-h average windspeed was 6.4 m s^{-1} at the lowland site on 8 Jul.

Because of a slightly higher air temperature, lower amount of rainfall, and higher vapor pressure deficit at midday, free water evaporation at the upland site was slightly higher than at the lowland site. Open-pan evaporation totals were 1,886 mm at the upland site and 1,703 mm at the lowland site. These values were 50 mm higher than the long-term evaporation total at the upland site and 31 mm higher than the long-term evaporation at the lowland site.

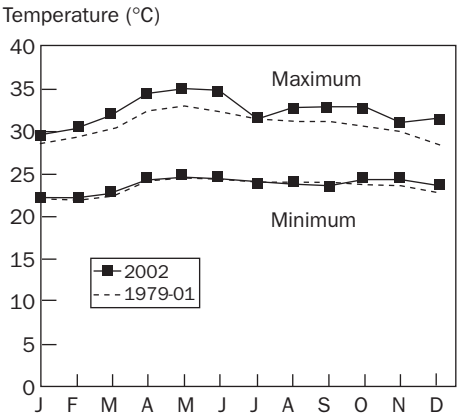
Thirteen tropical disturbances passed through the Philippines' area of responsibility. Six of these disturbances occurred in July, which resulted in higher accumulated rainfall total.



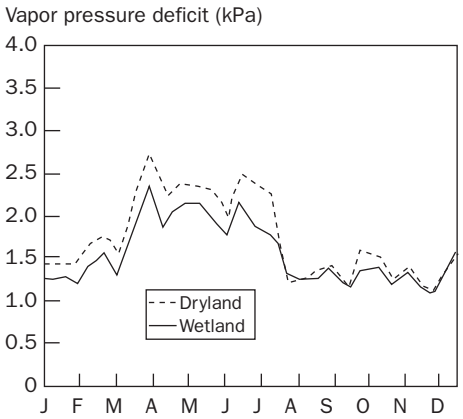
1. Rainfall and PET patterns at Los Baños. IRRI, 2002.



2. Mean monthly solar radiation with 10 and 90% probability of occurrence. IRRI, 2002.



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



4. Midday vapor pressure deficit at the dryland and wetland sites. IRRI, 2002.

Monthly weather data for IRRI and cooperating weather stations in the Philippines, 2002.

Site		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total or daily average
						Rainfall (mm mo^{-1})								
IRRI, dryland site	(14°13' N, 121°15' E)	14	10	24	8	111	79	623	209	205	174	153	71	1681
IRRI, wetland site	(14°11' N, 121°15' E)	15	15	17	8	143	89	606	216	158	195	188	76	1726
						Solar radiation (MJ m^{-2} d^{-1})								
IRRI, dryland site		17.5	18.4	20.5	23.8	22.1	21.9	15.6	18.1	18.0	19.2	14.2	15.2	18.7
IRRI, wetland site		16.8	17.7	19.8	23.3	21.6	21.4	15.2	17.7	17.6	18.9	13.8	14.6	18.2
						Relative humidity (%)								
IRRI, dryland site		82	81	81	75	79	80	86	88	87	88	87	89	84
IRRI, wetland site		82	82	83	79	80	81	86	87	86	86	86	87	84
						Temperature (°C)								
IRRI, dryland site	Max	29.6	30.0	31.8	34.3	34.6	34.5	31.3	32.3	32.3	32.3	30.8	30.9	32.1
	Min	22.1	22.3	22.8	24.2	24.8	24.4	24.0	23.8	23.5	24.2	24.1	23.3	23.6
IRRI, wetland site	Max	28.5	28.5	29.8	32.3	33.1	33.0	30.9	31.2	31.2	31.4	29.6	29.6	30.8
	Min	22.1	22.3	22.7	23.8	24.8	25.0	24.8	24.5	24.0	24.6	24.2	23.5	23.9
						Windspeed (m s^{-1})								
IRRI, dryland site		1.8	1.8	1.8	2.0	1.8	1.5	2.6	1.3	1.3	0.9	1.0	1.2	1.6
IRRI, wetland site		2.1	1.8	1.7	1.8	1.6	1.3	2.2	1.0	1.0	1.1	1.3	1.5	1.5
						Evaporation (mm mo^{-1})								
IRRI, dryland site		147	145	191	245	224	193	141	135	135	132	98	101	1886
IRRI, wetland site		135	129	166	206	192	169	137	130	122	130	91	96	1703

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

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P.O. Box BW 699
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Tel/Fax: (263-4) 860-196
E-mail: askamba@mweb.co.zw

Mr. Fazle Hasan Abed
Founder and Executive Director
Bangladesh Rural Advancement Committee
BRAC Centre
75 Mohakhali, Dhaka 1212, Bangladesh
Tel: (880-2) 882-4180
Fax: (880-2) 882-3542
E-mail: abed.fh@brac.net

Dr. Shigemi Akita
Professor
The University of Shiga Prefecture
2500 Hassaka-cho
Hikone City, Shiga 522-8533, Japan
Tel: (81-749) 28-8327
Fax: (81-749) 28-8469
E-mail: akita@ses.usp.ac.jp

Dr. Kay Beese
European Commission
Health and Consumer Protection Directorate-General
Unit E1 – Plant Health
Office: F101 5/92
B-1049 Brussels, Belgium
Tel: (32-2) 29.66808
Fax: (32-2) 29.69399
E-mail: kay.beese@cec.eu.int

Dr. Ronald P. Cantrell (ex officio)
Director General
International Rice Research Institute
DAPO Box 7777
Metro Manila, Philippines
Tel: (63-2) 818-1926; 580-5600
Fax: (63-2) 891-1292; 761-2404; 761-2406
E-mail: r.cantrell@cgiar.org

Dr. Achmad Mudzakkir Fagi
Senior Researcher
Agency for Agricultural Research and Development
Ministry of Agriculture
Jalan Ragunan 29, Pasarminggu
Jakarta Selatan 12540, Indonesia
Tel: (62-21) 780-5395; 780-6202
Fax: (62-21) 780-0644
E-mail: amfagi@cbn.net.id

Prof. Michael Denis Gale
Associate Research Director
John Innes Centre
Norwich Research Park
Colney, Norwich NR4 7UJ
Norfolk, United Kingdom
Tel: (44-1603) 452-571
Fax: (44-1603) 456-844
E-mail: mike.gale@bbsrc.ac.uk

Dr. Eun-Jong Lee
Ex-Administrator
Rural Development Administration
Jugong Apt. 216-1302, 861 Jowon-dong
Suwon, 440-716, Republic of Korea
Tel: (82-31) 268-7086
Fax: (82-31) 253-8969
E-mail: eunjong41@yahoo.co.kr

Mr. Luis P. Lorenzo, Jr. (ex officio)
Secretary
Department of Agriculture
Elliptical Road, Diliman
3008 Quezon City, Philippines
Tel: (63-2) 920-4323; 920-4358
Fax: (63-2) 929-8183; 928-5140
E-mail: hea@da.gov.ph or seclorenzo@da.gov.ph

Dr. Francisco Nemenzo (ex officio)
President
University of the Philippines
Diliman, Quezon City, Philippines
Tel: (63-2) 928-3014; 928-0110
Fax: (63-2) 920-6882
E-mail: pfn@surfshop.net.ph

Prof. Keijiro Otsuka
Deputy Director
FASID Graduate Program
Professor, National Graduate Institute
for Policy Studies
GRIPS/FASID Joint Graduate Program
2-2 Wakamatsu-cho, Shinjuku-ku
Tokyo 162-8677, Japan
Tel: (81-3) 3341-0670
Fax: (81-3) 3341-1030
E-mail: otsuka@grips.ac.p

Dr. Calvin O. Qualset
Director
Genetic Resources Conservation Program
Division of Agriculture and Natural Resources
University of California
One Shields Avenue, Davis
California 95616-8602, U.S.A.
Tel: (1-530) 754-8502
Fax: (1-530) 754-8505
E-mail: coqualset@ucdavis.edu

Dr. Emanuel Adilson S. Serrão
Director General
Embrapa Amazônia Oriental
Trav. Dr. Enéas Pinheiro s/n
Bairro: Marco – Belém-PA
CEP: 66095-100
Tel: (55-091) 276-1941; 299-4518
Fax: (55-091) 276-0323
E-mail: aserrao@cpatu.embrapa.br

Dr. E.A. Siddiq
Distinguished Chair
Centre for DNA Fingerprinting and Diagnostics
Department of Biotechnology, and
Hon. Professor, Biotechnology
Acharya N.G. Ranga Agricultural University
81 Happy Homes Colony
Upparapally, Hyderabad 500-064, India
Tel: (91-40) 24018625
Fax: (91-40) 24014072
E-mail: easiddiq@rediffmail.com

Dr. Jian Song
Vice Chairman
Chinese People's Political Consultative Conference and
Honorary Chairman
Chinese Academy of Engineering Sciences
3 Fuxing Road
Beijing 100038, China
Tel: (86-10) 6852-2665
Fax: (86-10) 6852-3054
E-mail: xuan@mail.ied.ac.cn

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

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Pablo V. Victoria, *research technician II1*[1]
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Isidro M. Tolentino, *research technician I*

Entomology and Plant Pathology

Twng-Wah W. Mew, *PhD, plant pathologist and head; leader, Improving Productivity and Livelihood for Fragile Environments Program*
Michael Benjamin Cohen, *PhD, entomologist*[1]
Il Ryong Choi, *PhD, plant virologist*
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Cailen Lee, *PhD, project scientist*
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Alberto T. Barrion, *PhD, senior associate scientist*[1]
Pepito Q. Cabauatan, *PhD, senior associate scientist*
Francisco A. Elazegui, *MS, senior associate scientist*[1]
Remedios Aguda, *MS, assistant scientist*[1]
Marietta R. Baraoidan, *MS, assistant scientist II*
Marichu A. Bernardo, *MS, assistant scientist II*[1]
Alicia A. Bordeos, *MS, assistant scientist II*
Rogelio Cabunagan, *MS, assistant scientist II*
Isaias T. Domingo, *BS, assistant scientist II*[1]
Isabelita P. Ona, *MS, assistant scientist II*
Filomena C. Sta Cruz, *MS, assistant scientist II*[1]
Nancy P. Castilla, *PhD, assistant scientist II*
Liberty Almazan, *BS, assistant scientist I*
Helen A. Barrios, *BS, assistant scientist I*[1]
Josie Lynn A. Catindig, *MS, assistant scientist I*
Luzviminda R. Fernandez, *BS, assistant scientist I*
Gilda J. Miranda, *MS, assistant scientist I*[1]
Raymond S. Pamplona, *MS, assistant scientist I*[1]
Angelita M. Romena, *MS, assistant scientist I*
Lourdes M. Sunio, *BS, assistant scientist I*[1]
Carmencita C. Bernal, *BS, researcher*
Edgardo L. Coloquio, *BS, researcher*
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Marilou Pamplona, *BS, researcher*[1]
Maria Suzette Madamba, *BS, researcher*[4]
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Maria Ymber Reveche, *BS, researcher*
Veritas Morena Salazar, *BS, researcher*
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Nonnie P. Bunyi, *BS, secretary II*
Elena G. Genil, *BS, secretary II*[1]
Josefina Y. Mata, *BS, secretary II*[1]
Crisanta G. Culala, *BS, secretary II*
Cecilia L. Salonga, *BS, secretary II*
Noel L. Sosa, *office clerk*
Epifania F. Garcia, *lead research technician III*
Wilfredo M. Lanip, *lead research technician III*
Elenita T. Silab, *lead research technician III*
Leonido M. Angeles, *research technician III*
Esquirion A. Baguioso, *research technician III*
Florencio R. Balenson, *research technician III*
Maximino G. Banasihan, *research technician III*
Conrado P. Bandian, *research technician III*
Ernesto M. Camangon, *research technician III*[1]
Benedicto H. Consignado, *research technician III*
Lilibeth F. Datoon, *research technician III*[1]
Noriel P. Deomano, *research technician III*[1]
Ponciano H. Edeza, *research technician III*[1]
Fernando V. Elec, *research technician III*[1]
Panfilo T. Domingo, Jr., *research technician III*
Mario R. Izon, *research technician III*
Armando C. Iranzo, *research technician III*[1]
Glicerio M. Javier, *research technician III*[1]
Hernando A. Jordan, *research technician III*[1]
Flavio A. Maghirang, *research technician III*
Levorio G. Pamulaklakin, *research technician III*[1]
Eufrocino M. Pizarra, *research technician III*
Alexander G. Ramos, *research technician III*
Pedro F. Reano, *research technician III*
Errol T. Rico, *research technician III*
Romulo B. Sernadilla, Sr., *research technician III*[1]
Danilo D. Vasquez, *research technician III*
Sergio G. Velasco, *research technician III*
Rodante R. Abas, *research technician II*
Ruben C. Abuyo, *research technician II*
Nestor M. Amoloza, *research technician II*
Romulo Aquino, *research technician II*
Modesto A. Calica, *research technician II*
Diomedes M. Dizon, *research technician II*
Tomas S. Llaneta, *research technician II*[1]
Nicanor D. Lobos, *research technician II*[1,5]
Clemencio A. Mamiit, *research technician II*[1]
Leovino B. Matundan, *research technician II*
Alberto L. Naredo, *research technician II*
Reyuel C. Quintana, *research technician II*
Juan B. Reyes, *research technician II*
Venancio M. Reyes, *research technician II*[1]
Noel L. Salac, *research technician II*
Antonio M. Salamatin, *research technician II*

Plant Breeding, Genetics, and Biochemistry

David J. Mackill, *PhD, head and leader, Genetic Resource Conservation, Evaluation, and Gene Discovery Program*
Sant S. Virmani, *PhD, plant breeder*
John Bennett, *PhD, senior molecular biologist*
Darshan S. Brar, *PhD, plant breeder*
Zhikang Li, *PhD, plant molecular geneticist*
Surapong Sarkarung, *PhD, plant breeder*[1]
Swapan K. Datta, *PhD, plant biotechnologist*
Karabi Datta, *PhD, plant biotechnologist and consultant*
Gary Atlin, *PhD, rainfed lowland rice breeder*
Ho-Yeong Kim, *PhD, IRS seconded from RDA-Korea*
Seiji Yanagihara, *PhD, plant breeder*
Yoshimichi Fukuta, *PhD, plant breeder*
Edwin L. Javier, *PhD, plant breeder and INGER coordinator*[8]
Glenn Gregorio, *PhD, affiliate scientist*
Parminder S. Virk, *PhD, irrigated rice breeder*
Arumugam Kathiresan, *PhD, international research fellow*
Dr. Ish Kumar, *PhD, international research fellow*[4]
Shailaja Hittalmani, *PhD, visiting scientist*[1]
Hak-Soo Suh, *PhD, visiting scientist*[1]
Jauhar Ali, *PhD, postdoctoral fellow*
Etsuko Araki, *PhD, postdoctoral fellow*
Sena Balachandran, *PhD, postdoctoral fellow*

Niranjan Baisakh, *PhD, postdoctoral fellow*
Jongdee Boonrat, *PhD, postdoctoral fellow*[4]
Gloria Cabuslay, *PhD, postdoctoral fellow*
Devendra K. Dwivedi, *PhD, postdoctoral fellow*[4]
Binying Fu, *PhD, postdoctoral fellow*
Yongming Gao, *PhD, postdoctoral fellow*
Changxiao Mao, *PhD, postdoctoral fellow*[1]
Tilathoo Ram, *PhD, postdoctoral fellow*
C.H.M. Vijayakumar, *PhD, postdoctoral fellow*[1]
Jian-Long Xu, *PhD, postdoctoral fellow*[4]
Jing Tan, *PhD, consultant*
Enrique R. Angeles, *PhD, consultant*[1]
Ellen Tumimbang, *MS, assistant scientist I*[5]
Normita M. dela Cruz, *MS, senior associate scientist*[1]
Antonio A. Evangelista, *BS, assistant scientist II*
Alvaro M. Pamplona, *BS, assistant scientist II*
Concepcion U. Toledo, *MS, assistant scientist II*
Rodolfo S. Toledo, *MS, assistant scientist II*
Vitaliano L. Lopena, BS, *assistant scientist II*
Dante Adorada, *BS, assistant scientist I*[5]
Editha M. Abrigo, *BS, assistant scientist I*
Modesto M. Amante, *MS, assistant scientist I*
Mark Dondi Arboleda, *MS, assistant scientist I*[1]
Carlos L. Casal, Jr., *BS, assistant scientist I*
Julio Romeo T. Chavez, *BS, assistant scientist I*[5]
Susan V. Constantino, *BS, assistant scientist I*[1]
Leodegario A. Ebron, *MS, assistant scientist I*[2,5]
Marcelino A. Laza, *BS, assistant scientist I*
Ruth E. McNally, *MS, assistant scientist I*[1]
Rhulyx O. Mendoza, *BS, assistant scientist I*
Norman P. Oliva, *MS, assistant scientist I*
Robert C. Ona, *BS, assistant scientist I*[1]
Adoracion P. Resurreccion, *MS, assistant scientist I*
Jessica D. Rey, *MS*, *assistant scientist I*
Benito U. Romena, *BS*, *assistant scientist I*
Jose P. Roxas, *MS, assistant scientist I*
Ma. Cristina B. Sison, *MS*, *assistant scientist I*[5]
Lina B. Torrizo, *MS*, *assistant scientist I*
Mary Jeannie Yanoria, *BS, assistant scientist I*[5]
Grace Lee Serioso-Capilit, *BS, database administrator II*
Elmer V. Aquino, *BS, researcher*[1,5]
Justina M. De Palma, *BS, researcher*[5]
Reycel M. Maghirang, *MS, researcher*
Doris M. Mercado, *BS, researcher*[1,5]
Joie M. Ramos, *BS*, *researcher*
Apollo Neil R. Monroy, *BS*, *researcher*
Mark Tamerlane S. Nas, *BS*, *researcher*[5]
Eric L. Paragas, *BS, researcher*[1]
Darlene L. Sanchez, *BS, researcher*[5]
Jason D. Talag, *BS, researcher*
Ma. Theresa G. Sta. Cruz, *BS, researcher*[5]
Rosalie E. Lanceras, *BS, researcher*[1]
Elma N. Nicolas, *BS, administrative coordinator*
Leila H. Herbano, *BS, administrative coordinator*[1]
Marietta D. Nadal, *BS, program coordinator*[1]
Leonida P. Nazarea, *BS, secretary II*
Yolanda C. Aranguren, *BS, secretary II*[5]
Minerva B. Bandian, *BS, secretary II*
Felicidad Danglay, *secretary II*[8]
Nelie M. delos Reyes, *BS, secretary II*
Florie Hernandez, *BS, secretary II*[1]
Emily P. Alcantara, *BS*, *secretary I*[5]
Lorelie S. Olivo, *BS*, *secretary I*[5]
Michelle H. Viray, *BS*, *secretary I*[5]
Leonardo S. Estenor, *lead research technician*
Blesilda G. Albano, *BS, research technician III*
Virgilio T. Ancheta, *research technician III*
Jose L. Angeles, *research technician III*[1]
Danilo B. Balagtas, *research technician III*
Socorro Carandang, *research technician III*
Danilo C. De Ocampo, *research technician III*
Mario M. Escote, *research technician III*[5]
Melquiades G. Evangelista, *research technician III*[1]
Angelito S. Francisco, *research technician III*
Reynaldo P. Garcia, *research technician III*
German T. Jara, *research technician III*[1]
Virgilio P. Magat, *research technician III*
Roberto G. Marasigan, *research technician III*[1]
Joselito U. Oboza, *research technician III*[1]
Inofra I. Sandoval, *BS, research technician III*
Ernesto C. Sumague, *research technician III*
Alfredo L. Tandingan, *research technician III*[1]
Jonathan R. Abengania, *BS, research technician II*
Emmanuel R. Adique, *research technician II*[5]
Juan L. Alzona, *research technician II*
William D. Angeles, *research technician II*[1,5]
Virgilio M. Angeles, *research technician II*
Gener P. Aquino, *research technician II*[1]
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*
Imelda V. Galang, *research technician II*[1,5]
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]
Mario A. Lapiz, *research technician II*[1]
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*[1,5]
Eduardo T. Managat, *research technician II*
Eleazar O. Manalaysay, *research technician II*[5]
Alejandro C. Manio, *research technician II*
Marina C. Manzanilla, *BS, research technician II*[1,6]
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*
Joselito Panting, *research technician II*[1]
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*
Carlos L. Rosales, *research technician II*[1,5]
Rosalio L. Rosario, *research technician II*[1,5]
Julito P. Talay, *research technician II*
Gil T. Tamisin, *research technician II*[1]
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*
Allan Trinidad, *research technician I*[5]

Social Sciences

Mahabub Hossain, *PhD, economist and head; leader, Strengthening Linkages between Research and Development Program*
Sushil Pandey, *PhD, deputy head and agricultural economist*
David Dawe , *PhD, agricultural economist*
Kam Suan Pheng, *PhD, GIS specialist*
Mercedita A. Sombilla, *PhD, policy economist*
Stephen Morin, *PhD, anthropologist*[1]
Thelma R. Paris, *PhD, gender specialist*
Nobuhiko Fuwa, *PhD, impact assessment specialist*[1]
Guy Trebuil, *PhD, IRS seconded from CIRAD*
Francois Bousquet, *IRS seconded from CIRAD*
Manik Lal Bose, *PhD, postdoctoral fellow*[1]
Hum Nath Bhandari, *PhD, postdoctoral fellow*[1]
Aldas Janaiah, *PhD, postdoctoral fellow*[4]
Ruifa Hu, *PhD, visiting scientist*[1]
Piedad F. Moya, *MS, senior associate scientist*
Violeta G. Cordova, *MS, senior associate scientist*[1]
Alice Laborte, *MS, assistant scientist*
Catalina P. Diaz, *MS, assistant scientist*
Nestor G. Fabellar, *BS, assistant scientist*
Ma. Isabel Ferino, *MS, assistant scientist*[1]
Fe B. Gascon, *MS, assistant scientist*[1]
Joyce S. Luis, *MS, assistant scientist*
Florencia G. Palis, *PhD, assistant scientist*
Imelda Revilla, *MS, assistant scientist*[2]
Maritess M. Tiongco, *PhD, assistant scientist*[1,5]
Lourdes E. Velasco, *MS, assistant scientist*
Lolita Garcia, *MS, program coordinator*[1]
Josephine H. Narciso, *BS, database administrator*
Arnel Rala, *MS, system analyst/programmer*
Aileen Alvaran, *BS, researcher*
Ellanie R. Cabrera, *BS, researcher*
Pio Adan A. Cenas, *BS, researcher*
Sharon Fajardo, *MS, researcher*
Wenifredo Geraldino, *BS, researcher*[1]
Melinda Magsumbol, *BS, researcher*[1]
Esther B. Marciano, *BS, researcher*
Aida M. Papag, *BS, researcher*[1]
Ma. Shiela Valencia, *BS, researcher*
Lorena Villano, *BS, researcher*
Mirla Domingo, *BS, administrative coordinator*
Lydia Damian, *BS, senior secretary*
Jocelyn Go, *BS, secretary*
Angelina Malabrigo, *BS, senior secretary*
Remedios Vivas, *BS, secretary*[1]
Ramil Gutierrez, *BS, secretary*
Nancy Palma, *BS, lead research technician*
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*
Loreto B. Aclan, *BS, ES supervisor II*[1]
Bienvenido B. Manimtim, *BS, ES supervisor II*
Vivencio P. Marciano, *BS, ES supervisor II*[1]
Myra L. Collado, *BS, programmer*
Erlinda A. Oracion, *BS, administrative coordinator*
Roberto P. Escandor, *BS, ES supervisor I*
Lauro R. Malihan, *AB, ES supervisor I*[1]
Mario A. Mandilag, Sr., *ES supervisor I*
Apolinario B. Resurreccion, *ES supervisor I*[1]
Candido S. Solivas, *BS, lead research technician*[1]
Isaias C. Abuyo, *lead research technician*
Jose D. Manuel, *BS, lead research technician*
Celso L. Varron, *lead research technician*
Jose H. Sacdalan, *lead research technician*[1]
Rolando D. Llorico, *lead research technician*[1]
Napoleon C. Calatraba, *lead research technician*[1]
Sulpicio J. Malabanan, *lead research technician*
Valentin C. Burgos, *lead research technician*[1]
Nazario B. Timbol, *lead research technician*
Jesse C. Banasihan, *lead research technician*
Manuel B. Demontano, *equipment operator I*[9]
Jose F. Hernandez, *equipment operator II*
Nicasio V. Malabanan, *equipment operator II*[1]
Leopoldo J. Mercado, *equipment operator II*[1]
Marcial E. Pabalate, *equipment operator II*[1]
Democrito A. Puma, *equipment operator II*[1]
Francisco G. Calibo, *equipment operator I*
Edgardo B. Pamulaklakin, *equipment operator I*[1]
Marcelo P. Torres, *equipment operator I*[1]
Rolando G. Guevarra, *mechanic II*
Rogelio R. Pamulaklakin, *mechanic II*
Juanito M. Rosario, *mechanic II*
Efren E. Viquiera, *mechanic II*
Virginia G. Aranda, *BS, secretary II*
Enrico A. Lucero, *secretary II*
Cecilio L. Villamayor, *secretary I*
Luzvimindo L. Mapiscay, *electrician I*[1]
Rolando R. Esguerra, *BS, stock assistant*[1]
Rolando R. Pacion, *stock assistant*
Romeo T. Llamas, *welder*
Abraham G. Dalid, *AB, research technician III*
Sabino M. Parducho, *research technician III*[1]
Ricardo C. Sioson, *research technician II*[1]
Pedro C. Aala, *research technician II*
Efren A. Bagui, *research technician II*
Luis M. Calma, *research technician II*
Aurelio M. Catangay, *research technician II*
Gaudencio S. Indico, *research technician II*
Rogelio M. Elbo, *research technician II*
Pedro A. Maghirang, *research technician II*[1]
Pedro C. Mendoza, *research technician II*
Ramiro C. Panting, *research technician II*
Reynaldo A. Pelegrina, *research technician II*

Godofredo E. Ramos, *research technician II*[1]
Roberto B. Revilleza, *research technician II*
Nestor G. Rizaldo, *research technician II*
Efren L. Blanco, *research technician II*
Cesar Z. Esguerra, *research technician II*
Benjamin C. Garcia, *research technician II*
Andres M. Mercado, *research technician II*
Fabian L. Alcachupas, *research technician II*
Nestor M. Angeles, *research technician II*
Severo B. Bonsol, *research technician II*[1]
William C. Fortuna, *research technician II*
Vicente E. Carandang, *research technician II*
Virgilio T. Lalap, *research technician II*
Marcelino O. Magpantay, *research technician II*
Leopoldo P. Manito, *research technician II*
Antonio B. Rivera, *research technician II*
Pablito M. Pabalate, *research technician II*
Daniel A. Barrion, *research technician II*
Delfin M. Ilagan, *research technician II*
Eduardo A. Lajarca, *research technician II*
Danilo O. Amoloza, *research technician II*
Godofredo M. Mercado, *research technician II*
Restituto M. Bandoy, *research technician II*
Pedro C. Cabrera, Sr., *research technician II*
Abraham G. Javier, *research technician II*
Gregorio S. Oca, *research technician II*
Melecio J. Arcillas, *research technician II*
Oscar L. Caspillo, *research technician II*
Ariel R. Dimapilis, *research technician II*
Rogelio V. Bargola, *research technician II*
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*
Lino M. Carandang, *research technician II*
Bonifacio B. de Chavez, *research technician II*
Efren P. Bautista, *research technician II*
Gelardo R. Morales, *research technician II*
Virgilio Q. Oruga, *research technician II*[1]
Policarpio S. Barbadillo, *research technician II*
Edgardo T. Diaz, *research technician II*
Quirino L. Atienza, *research technician I*
Lucas M. Malbataan, *research technician I*
Mario M. Malbataan, *research technician I*

Seed Health Unit

Twng-Wah Mew, *PhD, plant pathologist and head*
Silvino D. Merca, *MS, assistant scientist II*[1]
Patria G. Gonzales, *MS, assistant scientist II*
Carlos C. Huelma, *BS, assistant scientist I*
Jocelyn O. Guevarra, *BS, researcher*[1]
Evangeline G. Gonzales, *BS, secretary I*
Isabel L. Penales, *research technician III*
Pedro E. Aquino, *BS, research technician III*[1]
Gertrudo R. Arcillas, *research technician III*[1]
Atanacio B. Orense, *research technician III*
Florencio Lapiz, *research technician II*
Jose Banasihan, *research technician I*
Aurelio Gamba, *research technician I*
Salome Palmones, *data encoder*

Analytical Service Laboratories

Rhoda S. Lantin, *MS, ASL manager*
Bernardita E. Mandac, *MS, assistant scientist II*[1]
Rosario R. Jimenez, *BS, assistant scientist I*
Joselito T. Guyo, *BS, instrumentation specialist*[1]
Marnol Santos, *BS, instrumentation specialist*[4]
Lilia R. Molina, *BS, researcher*
Ma. Carmela Ong, *BS, research assistant*
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 II*

Biometrics and Bioinformatics Unit

Christopher Graham McLaren, *PhD, biometrician and head*
Richard Bruskiewich, *PhD, bioinformatics specialist*
Violeta Bartolome, *MOS, statistical specialist*
Alexander Cosico, *BS, systems analyst/programmer*[7]
William Eusebio, *IT technician*
Lourdes C. Paunlagui, *BS, administrative coordinator*
Arllet Portugal, *MS, database administrator II*
Criselda Ramos, *MS, assistant scientist I*
Luralyn Ramos, *BS, database administrator II*
Ma. Teresa Reyes, *BS, systems analyst programmer*[1]
Victor Jun Ulat, *MS, database administrator II*[4]

Genetic Resources Center

Nigel Ruaraidh Sackville Hamilton, *PhD, head*[4]
Kenneth L. McNally, *PhD, molecular geneticist/taxonomist*
Flora C. de Guzman, *MS, senior associate scientist*
Renato A. Reaño, *MS, assistant scientist II*
Ma. Socorro R. Almazan, *BS, assistant scientist I*
Amita B. Juliano, *BS, assistant scientist I*
Ma. Elizabeth B. Naredo, *MS, assistant scientist I*
Adelaida P. Alcantara, *BS, database administrator II*
Evangeline B. Guevarra, *AB, database administrator II*[1]
Victoria C. Lopez, *BS, database administrator II*[1]
Sheila Mae E. Quilloy, *BS, researcher*[5]
Minerva I. Macatangay, *lead research technician*
Bernardo P. Mercado, *lead research technician*
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*
Nelia A. Resurreccion, *BSBA, research technician III*
Mila D. Obligado, *secretary II*[1]
Digna I. Salisi, *BS, secretary II*
Teresita C. Santos, *AB, secretary II*
Remegio L. Aguilar, *research technician II*
Noel R. Banzuela, *research technician II*
Rolando V. Evangelista, *research technician II*[1]
Arnold B. Gonzales, *research technician II*
Romulo R. Quilantang, *research technician II*[1]
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]
Minerva N. Eloria, *AB, research technician I*[5]
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

Eugene P. Hettel, *MA, science editor and head*
Bill Hardy, *PhD, science editor/publisher*
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*
Melita Q. Magsino, AB, *CPS supervisor I*[1]
Eva B. Ramin, *BS, CPS supervisor I*[1]
Rogelio M. Alfonso, *CPS supervisor I*
Jose M. Ibabao, *video production supervisor*
Juan V. Lazaro IV, *graphic designer*
Grant L. Leceta, *BS, graphic designer*[1]
Emmanuel A. Panisales, *BS, graphic designer*
Erlie E. Putungan, *BS, graphic designer*[1]
George R. Reyes, *BS, graphic designer*
Ariel Javellana, *BS, photography supervisor*
Aileen del Rosario, *BS, photography assistant*[4]
Rodolfo L. Carpio, *video specialist*[1]
Lorenzo C. Santos, *BS, marketing assistant*[1]
Reynaldo L. Stevens, *printer*
Romeo R. Dimapilis, *BS, sales assistant*[1]
Rogelio R. Quintos, *BS, secretary II*
Cynthia C. Quintos, *BS, secretary I*
Reynaldo G. Patulot, *office clerk*[1]
Arleen A. Rivera, *office clerk*

Library and Documentation Service

Mila M. Ramos, *MLS, head librarian*
Carmelita S. Austria, *MLS, assistant librarian (bibliographer)*
Rene B. Manlangit, *BLS, assistant librarian (reference)*[1]
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 C. Salinas, *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

Paul O'Nolan, *MS, IT manager*
Rogelio P. Alvarez, *BS, assistant manager*
Loreto R. Puyod, *BS, assistant manager*
Wilbert Almoro, *BS, assistant manager*
Ildefonso B. Cosico, *AB, systems administrator*
Sheila Verdan, *BS, computer programmer/analyst*
Ma. Christina A. Visperas, *BS, systems analyst/programmer*[1]
Marlene M. Chang, *telecoms administrator*[1]
Anna Christine A. Doctolero, *BS, training assistant*[6]
Bayani N. Perido, *computer technician*[1]
Ignacio Nevado, *BS, computer technician*
Analiza Q. de Roxas, *BS, secretary II*
Rizza A. Escondo, *BS, telecoms operator*
Arminda Laluz, *BS, telecoms operator*

Visitors and Information Services

Duncan Macintosh, *BS, head*
John Peter Fredenburg, *MA, editor/writer*
Olivia Sylvia O. Inciong, *MS, manager*[1]
Mario M. Movillon, *MS, manager*[1]
Bita S. Avendano, *MS, visitors supervisor II*
Johnny S. Goloyugo, *MM, public awareness specialist*
Joselito A. Platon, *BS, community project officer*
Estrella Castro, *BS, administrative coordinator*[1]
Zorayda T. Menguito, *BS, VECS assistant*
Evangeline A. Yecyec, *BS, VIS data assistant*[1]
Frances Tesoro, *BS, secretary II*
Arvin A. Benavente, *BS, audiovisual technician*
Harris L. Tumawis, *Riceworld assistant*

Training Center

Paul L. Marcotte, *PhD, head*[1]
Mark A. Bell, *PhD, head*
Vethaiya Balasubramanian, *PhD, agronomist*
Madeline B. Quiamco, *PhD, senior associate scientist/manager*[1]
Albert Dean Atkinson, *PhD, ICT specialist*
Rogelio V. Cuyno, *PhD, visiting scientist*[1]
Pompe Sta. Cruz, *PhD, project scientist*[1]
Abdul Karim Makarim, *PhD, project scientist*[1]
Zahirul Islam, *PhD, project scientist*
David Shires, *MEd, consultant*[4]
Shawn Golinowski, *BS, consultant*[4]
Oscar A. Garcia, *BS, training specialist*[1]
Rogelio T. Rosales, *MS, training specialist*[1]
Eugenio C. Castro, Jr., *MS, assistant scientist II*
Gina E. Zarsadias, *MM, assistant manager I*
Ma. Teresa A. Clabita, *BFA, training assistant*
Irvin M. Panganiban, *BS, training assistant*[1]
Benjamin J. Nunez, Jr., *BS, training assistant*[1]
Sergio R. Magadia, *BS, training assistant*
Ma. Socorro S. Arboleda, *BS, training assistant*
Dennis Ian L. Gavino, *BS, training assistant*
Rita B. Luna, *BS, training assistant*

Eric John F. Azucena, *BS, training assistant*
Reah Benedicta C. Clavio, *BS, training assistant*[1]
Ma. Estela F. Hernandez, *BS, training assistant*[1]
Ivan Roy D. Mallari, *BS, training assistant*
Rina P. Coloquio, *BS, administrative coordinator*
Divina M. Marinay, *BS, administrative coordinator*[1]
Macario B. Montecillo, *training logistics assistant*
Melanie M. Quinto, *BS, secretary II*
Lorenzo D. Ocampo, Jr., *BS, secretary I*[1]
Priscilla P. Comia, *BS, secretary I*
Jennifer D. Hernandez, *BS, secretary I*

International Programs Management Office

Headquarters-based

Mark A. Bell, *PhD, head*
Vethaiya Balasubramanian, *PhD, agronomist*
Julian A. Lapitan, *MS, senior associate scientist and manager*
Ma. Angeles Quilloy, *MS, assistant scientist II*
Margaret Ann S. Jingco, *BS, administrative coordinator*
Cecilia V. Lopez, *BS, administrative coordinator*
Edna R. Reyes, *secretary II*

Country-based

Bangladesh
Noel P. Magor, *PhD, project manager, PETRRA*
M.A. Hamid Miah, *PhD, liaison scientist*
Conrad Stevens, *PhD, consultant, Seed Health Improvement Project*
Roucksana Begum, *MS, project facilitator, PETRRA*
M.A. Ghani, *project research management officer, PETRRA*
Bazlur Rahman, *research officer*[4]
Salim Ahmed, *BA, office manager, IRRI Bangladesh Office*
Jamila Khandekar, *BS, finance officer, IRRI Bangladesh Office*
Ahmad Salahuddin, *MS, project officer, PETRRA*
Tapash Kumar Biswas, *MS, monitoring and evaluation officer, PETRRA*[1]
AKM Azad Chowdhury, *BS, technical/research officer, IRRI Bangladesh Office*[1]
Shaila Arifa Nabi, *MS, researcher, PETRRA*[1]
Tahmina Banu, *MS, accounts assistant, IRRI Bangladesh Office*[1]
Alphonse Prodip Bashu, *MS, accounts assistant*[1]
Shahjadi Parvin, *BA, administrative assistant, PETRRA*
Shamima Sultana, *MA, administrative assistant, PETRRA*[1]
Fouzia Sultana, *MS, receptionist-cum-inventory assistant*[1]
Mohammad Samad, *office assistant*
S.M. Sujat, *office attendant*[1]
Mohammad Jamal, *driver*
Mohammad Ahsanullah, *driver*
Mohammad Naseem, *driver*
Mr. Jopin Bazi, *driver*[1]
M. Mazid, *guard*
Fazlu Miah, *guard/gardener*
M. Alimullah, *guard*

Cambodia
Lorelei Domingo, *BS, administrative coordinator*[1]
Marie Kim Leng, *BS, administrative coordinator*[4]

China
Shengxiang Tang, *PhD, IRRI representative*
Zhongqiu Wang, *BA, administrative coordinator/accountant*
Li Ding, *BS, secretary/cashier*

India
R.K. Singh, *PhD, IRRI representative*
Jamal Pervez Noor, *BCom, finance and administrative coordinator*
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
Mahyuddin Syam, *MPS, communication specialist and IRRI representative*
Francisca Herjati, *Dipl, executive secretary*[1]
Juanita Bawolye, *BA, secretary*[4]
Bambang Soewilanto, *BS, administrative coordinator*
Iwan Adidharmawan, *BS, accounting supervisor*
Diah Wurjandari, *BS, researcher*
Darman, *driver*

Japan
Hiroyuki Hibino, *PhD, liaison scientist*

Korea, Republic of
Kshirod Kumar Jena, *PhD, temperate rice breeder and IRRI representative*
Ji-Ung Jeung, *PhD, senior research scientist*[4]
Seung-Hee Han, *BS, administrative coordinator*[4]

Lao PDR
Karl Goeppert, *MS, agriculturist (tropical)*
Bruce Linquist, *PhD, upland agronomist*
Renate Braun, *PhD, agronomist/junior program officer*
Bouchanh Keopha, *administrative officer*
Sansai Samounty, *accountant*
Ouanheaune Phouthachit, *administrator/accountant*
Sone Mosky, *BS, training officer*
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*

Myanmar
Ohnmar Tun, *BAg, administrative officer*
Myint Soe, *driver*[1]

Thailand
Boriboon Somrith, *PhD, IRRI representative*[1]
Dome Harnpichitvitaya, *MS, researcher*[1]
Manoch Kongchum, *MS, researcher*[2]
Jutharat Somnoey Prayongsap, *MS, researcher*
Aranya Sapprasert, *MS, administrative coordinator*
Punjama Tasana, *BA, senior accountant*
Vitchu Chowanapong, *BS, office clerk*

Leelagud Laddawan, *office clerk*[1]
Phikul Kitprasong Leelagud, *BS, office clerk*[1]
Amporn Sookyong, *utility person*
Pipat Buntham, *BS, field technician*
Chusak Kartipatee, *field technician*[1]
Charoenchai Morakotkheaw, *field technician*[1]
Sompong Pachanapool, *field technician*
Chaiporn Soising, *field technician*
Gaisorn Tanupant, *field technician*
Pramote Tanupant, *BS, field technician*
Thavil Sukrak, *driver*[1]

Vietnam
Nguyen Thanh Huyen, *BS, administrative coordinator*
Nguyen Hoai An, *BS, accountant*
Nguyen Huu Hai, *driver/office assistant*[1]

Director General's Office

Sylvia R. Arellano, *BS, DG assistant*
Maura K. Lago, *BS, secretary II*[1]

Office of the Deputy Director General for Research

Adonna M. Robles, *MS, assistant manager II*
Lucia V. Gamel, *AB, executive secretary*
Ana Lyn Genil, *BS, secretary I*

Office of the Deputy Director General for Partnerships

Thanda Wai, *PhD, intellectual property rights specialist*
Ramon A. Oliveros, *MS, assistant manager II*
Alma Bernardo, *BS, administrative coordinator*[1]
Carolyn N. Wangdi, *BS, secretary I*

Office of the Director for Program Planning and Coordination

Corinta Q. Guerta, *MS, manager*
Monina S. La'O, *BA, assistant manager*[1]
Eric B. Clutario, *BS, database administrator*
Zenaida M. Federico, *BS, executive secretary*
Marisol P. Camasin, *BS, office clerk*[1]

Finance

Elisa S. Panes, *BS, senior manager*
Loriza E. Dagdag, *BS, senior manager*
Mario F. Ocampo, *MBA, senior manager*[1]
Melba M. Aquino, *BS, senior manager*
Leonisa M. Almendrala, *BS, assistant manager II*
Nestor C. Lapitan, *BS, assistant manager II*
Baby Ruth A. Rillo, *BS, accounting supervisor II*[1]
Edelisa M. Bardenas, *BS, accounting supervisor II*[4]
Helen R. Aquino, *BS, accounting supervisor II*
Imelda S. Silang, *BS, accounting supervisor II*
Mirriam M. Telosa, *BS, accounting supervisor II*
Reymunda C. Labuguen, *BS, accounting supervisor II*
Julie C. Carreon, *BS, treasury supervisor II*
Rolando T. Ramos, *BS, treasury supervisor II*
Nestor D. Marcelo, Jr., *BS, systems supervisor II*
Leny M. Medenilla, *BS, budget supervisor II*
Eleah R. Lucas, *BS, budget supervisor I*
Ailene R. Garcia, *BS, accountant II*
Alvin C. Leal, *BS, accountant II*
Betty Sarah R. Carreon, *BS, accountant II*
Catherine Buena, *BS, accountant II*
Charlene F. Dalmacio, *BS, accountant II*
Christina D. Cassanova, *BS, accountant II*
Clarissa B. Mateo, *BS, accountant II*
Gemma N. Corcega, *BS, accountant II*
Jonalyn R. Gumafelix, *BS, accountant II*
Judith E. Dionisio, *BS, accountant II*[4]
Leonor R. Herradura, *BS, accountant II*
Lily R. Go, *BS, accountant II*
Maria Judy M. Anicete, *BS, accountant II*
Rodelita D. Panergalin, *BS, accountant II*
Tony Deza, *BS, accountant II*[1]
Vilma T. Ramos, *BS, executive secretary*
Grace P. Abanto, *BS, accountant I*
Ma. Theresa A. Sevilla, *BS, treasury assistant*[1]
Maria Zenaida V. Borra, *BS, accountant I*
Mary Grace R. Bautista, *BS, accountant I*
Paulito J. Oleta, *BS, accountant I*
Flordeliza Lopez, *BS, data encoder*[1]
Malaya Salas, *BS, data encoder*[1]
Marilyn I. Villegas, *data encoder*
Michelle Coligado, *BS, secretary I*
Noel T. Lantican, *BS, property and assets assistant*
Roderick B. Maligalig, *AB, accounting assistant*
Vilma C. Maligalig, *BS, secretary I*[1]

Office of the Director for Administration and Human Resources

Charito G. Medalla, *BS, executive secretary*[1]
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*
Eloisa V. Revilla, *BS, psychometrician*[1]
Sylvia P. Avance, *BS, HRS specialist*
Gladys Faith Tan, *BS, HRS specialist*
Joan L. Belsonda, *AB, gender and diversity assistant*
Alfredo R. Reyes, *BS, HRS benefits coordinator*
Aida A. dela Rea, *BS, medical technologist*[1]
Remedios J. Bondad, *BS, HRS assistant*[1]
Ma. Francisco R. Gallivo, *HRS assistant*[1]
Larry Montermoso, *HRS assistant*
Iluminada B. Oleta, *BS, secretary II*

Materials Management Services

Frisco L. Guce, *MS, manager*
Generoso San Felipe, *BS, MM assistant manager II*[1]
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*
Macario Beato, *documentation and cargo handling clerk*[1]
Francisco T. Quilloy, *materials expediter*
Dionisio Dumlao, *MM attendant*[1]
Delfin M. Lacandula, Jr., *MM attendant*
Edison Samonte, *MM attendant*[1]
Fred B. Angeles, *fuel attendant*
Jane Carlos, *data encoder*[1]
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*
Roberto T. Paz, *office clerk*[1]
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*
Aurea A. Delantar, *FHS supervisor I*[1]
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*
Warlito C. Mendoza, Sr., *AB, security supervisor I*[1]
Andres V. Mendoza, *BS, security supervisor I*
Bionico R. Malacad, *security investigator*
Salvador T. Zaragosa, Jr., *security investigator*
Antonio N. Gapas, *SSO coordinator*[1]
Crisanto P. Dawinan, *BS, nurse*
Rowena L. Natividad, *BS, secretary*[1]
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*
Nelson C. Tagle, *supervisor I*[1]
Reynaldo G. Elmido, *MPDS dispatcher*
Sesinando B. Guerta, *MPDS* dispatcher
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*
Reynaldo P. Martinez, *driver*[1]
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*
Alberto Adviento, *BS, PP supervisor II*[1]
Emmanuel Eusebio, *BS, BS, PP supervisor II*[1]
Jaime Fojas, *BS, PP supervisor II*
Fernando Madriaga, *BS, PP supervisor II*
Nestor Malabuyoc, *BS, PP supervisor II*
Nilo Barraquia, *BS, PP supervisor I*[1]
Domingo Escasura, *PP supervisor I*[1]
Jaime Angeles, *BS, PP supervisor I*[1]
Teodoro Carreon, *PP supervisor I*
Crisencio Custodio, *PP supervisor I*[1]
Tiburcio Halili, *PP supervisor I*[1]
Rodolfo Calibo, *lead PP technician*
Fidel Alvarez, *carpenter*
Rodrigo Castillo, *BS, carpenter*[1]
Levi Malijan, *carpenter*

Virgilio Verano, *carpenter*
Danilo Banasihan, *instrument and telephone technician*
Marcelino Navasero, Jr., *instrument and telephone technician*
Leandro Ortiz, *instrument and telephone technician*[1]
Domingo Ortiz, *telephone technician*
Alex Alumaga, *plumber*
Regalado Alcachupas, *plumber*
Melencio Tapia, *plumber*
Manolo de Guia, *refrigeration and AC mechanic*
Rolando Lapitan, *refrigeration and AC mechanic*[1]
Dionisio Ng, *refrigeration and AC mechanic*
Juancho Petrasanta, *refrigeration and AC mechanic*
Ricardo Tabilangon, *refrigeration and AC mechanic*
Roberto Escueta, *BS, electrician II*
Rufino Gibe, *electrician II*
Felix Halili, *electrician II*
Benjamin Libutan, *electrician II*
Sabino Ortiz, *electrician II*[1]
Cesar Padonan, *electrician II*
Rolando Simon, *electrician II*
Marissa Templanza, *BS, administrative coordinator*
Benita Pangan, *BS, office clerk*
Larry Salgado, *BS, drafting technician*
Manuel Alforja, *welder/tinsmith*[1]
Apolinario Armia, *welder/tinsmith*
Anito Mabalhin, *welder/tinsmith*
Percival Leon, *PP assistant*[1]
Francisco Ador, *mason*[1]
Roberto Tamio, *mason*
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]Transferred from the Office of the Director General.
[7]Transferred from Information Technology Services.
[8]Transferred from Genetic Resources Center.
[9]Died during the year.