IRRI

INTERNATIONAL RICE RESEARCH INSTITUTE

DAPO Box 7777, Metro Manila, Philippines

Report of the Director General 2001-2002 Volume 12

Contents

A message from the director general's office

Financial and staffing adjustments to be made because of funding cuts

Financial and staffing adjustments at the Institute will be necessary in view of unavoidable funding cuts. Management anticipates a 25 percent drop in unrestricted funding mainly because of reductions in support announced by the Government of Japan, a major investor.

Immediate steps to address the funding shortfall included a mid-2001 budget reduction of 10 percent and a reduction in internationally recruited staff (IRS) positions as well as unrestricted general operating cost (GOC) expenditures when opportunities occurred. Eight vacant—or about to be vacated—IRS positions were frozen. Since more changes are necessary, we have proposed a model for undertaking these adjustments. It is based essentially on reducing costs on items that will allow us to reach the goal of reducing our expenses by US$5 million annually. These expenses are personnel costs for both IRS and nationally recruited staff (NRS) and the GOC in research, research support, technical support, and management services.

Management has carefully studied options to come up with this proposed model that will provide the framework for taking steps to achieve a balanced budget by 2004. We believe the model will

- achieve efficiencies in operation of the Institute;
- optimize human, financial, and physical resources to reduce overhead costs;
- retain as many activities in the current medium-term plan (MTP) as possible;
- observe relevant legal requirements for personnel adjustments;
- maintain IRS compensation and benefits at CGIAR levels; and
- strengthen fund-raising activities and identify new funding sources.

We can package research in ways to recover more money from restricted funding. We'll look at untraditional donors and donors who can pick up some of our in-country costs. We receive very little money from our developing country partners in Asia—they are our future. We'll work to help those countries see the purpose of investing in agricultural research and see its impact on the stability of Asia. And we'll look at charging for some of the products we produce—but not for germplasm or other public goods produced or managed by IRRI.

We hope to minimize the negative effect of the declining core funding and to improve efficiency in management and resource use so we can proceed with the core agenda that is built into a continuum of strategic-to-applied research activities. We believe that the proposed cost-saving strategy and the model will provide a basis for the Institute to get through this difficult period of reductions in core funding.

The IRRI of the future will have fewer IRS and NRS, but we can downsize without capsizing. This will require efforts on the part of all, but we can do it!

Key changes for IRRI staff and BOT

Since the last *DG Report*, some key IRRI staff members have departed—or are about to—to take on new assignments: **Michael B. Cohen**, entomologist in the Entomology and Plant Pathology Division (1994-2002); **James E. Hill**, head of

Crop, Soil, and Water Sciences Division and leader of Research Program 2 (1999-2002); **Paul Marcotte**, head of the Training Center (2000-2002); **John M. Schiller**, team leader of the Lao-IRRI Research and Training Project (1990-2001); **Harry Nesbitt**, leader of the Cambodia-IRRI-Australia Project (1988-2001); **Guy Kirk**, soil chemist in CSWS (1988-2001); **Pierre Siband**, agronomist/crop physiologist in CSWS (1999-2001); **Moon-Hee Lee**, IRS in PBGB seconded from the Rural Development Administration, Korea (1999-2001); **Erik Sacks**, affiliate scientist in PBGB (1999-2001); **Sadiqul Bhuiyan**, water scientist and most recently liaison scientist for Bangladesh (1977-2001); **Robert R. Bakker**, affiliate scientist in the Agricultural Engineering Unit (1999-2002), **Bart Cottyn**, affiliate scientist in EPPD (1994-2001); **P.M. Reddy**, an affiliate scientist in CSWS (1999-2001); and **Kazuko Morooka**, librarian, IRRI library office in Japan (1971-2001).

With Dr. Hill's departure on 30 April 2002, **To Phuc Tuong**, a water management engineer who began his career at IRRI in 1991, will assume leadership of CSWS and will automatically become a member of IRRI's Management Committee. Likewise, **Roland Buresh**, a respected soil scientist in CSWS, will assume research program leadership for Enhancing Productivity and Sustainability of Favorable Environments. With Dr. Marcotte's departure, **Mark Bell** assumed leadership of the Training Center effective 10 March. Given Dr. Bell's continuing responsibilities as head of IPMO, the operational structure of the Training Center will be modified. While the search is still on for an entomologist to replace Dr. Cohen in EPPD, **J.K. Ladha** has been tapped to assume his other important role as editor-in-chief of the *International Rice Research Notes* (*IRRN*).

With the departure of Dr. Schiller in Lao PDR, **Karl Goeppert** has been named IRRI representative to the country. With the departure of Dr. Bhuiyan, **Hamid Miah** has been named liaison scientist for Bangladesh. In IRRI's new country office in Korea, **Kshirod Jena** has been named temperate rice breeder and IRRI representative. With the departure of Dr. Lee, **Ho-Yeong Kim** is the new IRS in PBGB seconded from the Rural Development Administration, Korea. And, in addition to his duties as head of PBGB, **David Mackill** has been named program leader of Genetic Resource Conservation, Evaluation, and Gene Discovery.

We also welcome to the IRRI community **Albert Dean Atkinson**, who has joined the Training Center as a training and courseware specialist with the task of building the Center's distance learning capacity, and **Conrad Stevens**, who joined EPPD as a molecular biologist/pathologist for the Seed Health Improvement Program under the Poverty Elimination Through Rice Research Assistance (PETRRA) in Bangladesh.

On 1 May 2001, **Michael Jackson** was named to the newly created management position of Director for Program Planning and Coordination. With **Mercy Sombilla**'s appointment as policy economist in Social Sciences, the Liaison, Coordination, and Planning Unit was replaced by this new office, which is responsible for planning and managing IRRI's project development and resource mobilization. Other responsibilities of the new director include organizing and coordinating the timely reporting of projects to donors and submission of IRRI's Medium-Term Plan and assisting in the monitoring and evaluation of IRRI's projects. Dr. Jackson, who had been head of the Genetic Resource Center (GRC) for nearly 10 years, now reports to the deputy director general for research. The new director is a permanent member of the Management Committee.

After an intensive search to replace Dr. Jackson as GRC head, **N.R. Sackville Hamilton** has been appointed to the position, effective 1 August 2002. A geneticist by training, Dr. Sackville Hamilton is currently biodiversity group leader and head of the Genetic Resources Unit at the Institute of Grassland and Environmental Research (IGER) in Aberystwyth, Wales, U.K., with responsibility for an important collection of forage grasses and legumes.

An active search has been initiated to fill the position of Director for Finance after **Gordon MacNeil** announced his resignation effective in July 2002.

On 31 August, **Gurdev Khush** retired as principal plant breeder after 34 years of outstanding and dedicated service to the Institute, the rice research community, and rice farmers and consumers worldwide. In October, the IRRI community officially recognized his transition to retirement by offering its heartfelt congratulations for a body of work that has touched the lives of millions and has been an inspiration to all.

On 2 January 2002, **Angeline Kamba** of Zimbabwe began her term as IRRI BOT chair. She is the first woman, and the first African, to chair IRRI's Board. We bid farewell to departing BOT members in 2001: outgoing chair **Sjarifudin Baharsjah** of Indonesia (1996-2001), **Makiko Arima-Sakai** of Japan (1996-2001), **Lene Lange** of Denmark (1996-2001), and **Siene Saphangthong** of Lao PDR (1996-2001). We welcome new BOT members **Kay Beese** of Germany, **Achmad Mudzakkir** Fagi of Indonesia, **Eun-Jong Lee** of Korea, and **Keijiro Otsuka** of Japan.

For a complete listing of staff arrivals and departures for 2001, see page 81.

IRRI's perspectives are appearing in the recent scientific press

The milestone publication in the 5 April 2002 issue of *Science* of not one, but two, draft genome sequences of rice prompted CIMMYT Director General Timothy Reeves and me to write a joint perspective titled *The Cereal of the World's Poor Takes Center Stage*. We discuss the importance of these accomplishments by Syngenta and the Beijing Genomics Institute. We point out that IRRI, CIMMYT, and the other 14 Future Harvest Centers of the CGIAR have long relied upon the sharing of genetic information and seed stocks to develop technology and products for the developing world. We also agree that the sequencing of the rice genome will benefit many other plant genomics initiatives that rely upon publicly available genome sequence data.

In the same issue of *Science,* IRRI Plant Pathologist Hei Leung and UC Davis Scientist Pamela Ronald add that the publication of these two draft sequences provides a rich resource for understanding the basic biological processes of plants and promises to positively affect cereal crop production. They say that the availability of the rice genome sequences will now permit identification of the function of every rice gene and that a greater challenge will be to analyze the behavior of the encoded proteins in particular contexts and to determine their interactions with relevant cellular machinery to "generate function at a higher level."

And just last month, in the March issue of *Trends in Plant Science* [7(3) 2002: 139-142], IRRI was featured in this journal's Institute Profile section in the article *International Rice Research Institute: roles and challenges as we enter the genomics era*. In it, we emphasize IRRI's role as a producer of knowledge and a broker in technology development and transfer among various public institutions—and increasingly between the public and private sectors.

Research highlights

This *DG report* provides the first listing of achievements for the 12 new projects in IRRI's MTP for 2002-2004. Although the point summaries, by project, begin on page 9, some highlights include

- *Project 1:* We unveiled the International Rice Information System (IRIS) at www.iris.irri.org, a database system that provides integrated management of global information on rice genetic resources and on rice improvement and evaluation.
- *Project 2:* We produced an extensive collection of introgression lines with chromosome segments of wild species (*Oryza rufipogon, O. nivara, O. glaberrima, O. longistaminata*) and diverse germplasm and incorporated them into common genetic backgrounds (e.g., IR64 and

the new plant type). These lines are now available for phenotype evaluation and molecular analysis to extract useful alleles from the diverse rice gene pool.

- *Project 3:* We characterized more than 100 cytoplasmic male sterile (CMS) lines developed at IRRI for agronomic traits, outcrossing rate, combining ability, grain quality, and disease/insect resistance. CMS lines IR68897A, IR70369A, and IR70328A were found to be commercially acceptable (much like popular IR58025A) and are ready for registration. We are sharing these CMS lines with public and private institutions in the NARES to enable them to develop locally bred rice hybrids. For example, Bangladesh has released hybrid IR69690H (derived from IR58025A) as BRRI Dhan Hybrid 1.
- *Project 4:* We established that the use of seedlings of up to 5 weeks old for transplanting has no effect on yields, but does have significant effects on snail damage. This information is potentially useful to farmers who are transplanting 2-week-old seedlings, which suffer significant snail damage.
- *Project 5:* In a 2-year experiment at two sites in China, we found that alternate wetting and drying (AWD) reduced irrigation water, did not reduce yield significantly, and increased water productivity with respect to irrigation water up to 30%. AWD did not need N-fertilizer management different from conventional flooded irrigation.
- *Project 6:* We initiated six workgroup activities under the governance of the Irrigated Rice Research Consortium: hybrid rice, reaching toward optimum yields, weed ecology, saving water, rodent ecology, and impact assessment.
- *Project 7:* The lowland Farmer Participatory Breeding Project released its 3-year research report (1998-2000) involving work conducted by IRRI and six universities and research institutions in eastern India. We found that farmers use selection criteria determined by biophysical conditions, livelihood uses and needs, compatibility with existing cropping systems, socioeconomic status of farmers, and gender-specific roles. Extensive farmer-managed trials appear to reduce the effects of random variability and increase gains from selection.
- *Project 8:* We diagnosed socioeconomic factors affecting land-use changes in Vietnam and found that upland rice is an important component of food security in the northern uplands of Vietnam. Some communities obtained up to 80% of their rice supply from the uplands. We found upland rice yields to be low in communities that practice short fallow periods. These results show that improved access to markets is essential to raising farmers' incomes and lifting them out of bare subsistence production.
- *Project 9:* We established a variety-testing network for the Southeast Asian acid uplands and began planning for two other networks, one serving the drought-prone eastern Indian plateau region and the other serving aerobic rice and favorable upland environments. Such multi-environment testing in appropriate target regions will increase the rate of yield improvement in these upland environments and will enhance germplasm exchange among national programs. In the rainfed lowlands, we conducted G x E experiments in different locations and conditions to define target subecosystems. For example, in Ubon, Thailand, we found that drought stress conditions at various sites were different in water deficit severity. There was no significant relationship to grain yield between environments to indicate that genotypes performed differently under different growing conditions.
- *Project 10:* We completed an ex ante assessment of the potential impact of Golden Rice on vitamin-A deficiency in the Philippines. We found that Golden Rice will probably be less important in improving vitamin-

A intake than pending mandatory fortification of wheat flour and other foods. However, because vitamin A intake is so low, both Golden Rice and food fortification have important roles to play in improving nutritional status. Golden rice may also be substantially more cost-effective than food fortification, and has the potential to make a large impact for people who consume very little fortified food or live in countries where fortification programs do not exist.

- *Project 11:* In the Red River Basin of Vietnam, we developed new partnership mechanisms across scales, disciplines, and institutions for the benefit of natural resource management (NRM) research and development in the region. For example, we completed and updated the Bac Kan Project Information Database System and distributed it in digital and hard copy forms to key national and international agencies involved in NRM in Bac Kan Province.
- *Project 12:* We conducted farmer participatory experiments on the effects of seed quality on rice yield and pest pressure for the PETRRA-funded Seed Health Subproject in Bangladesh. In partnership with different institutions including many NGOs, we completed the assessment of rice seed health problems and needs of resource-poor farmers in Bangladesh.

Changes in IRRI's publications array

This installment of the *Report of the Director General* is an expanded version that reflects important changes in the way IRRI is now doing its reporting. The Institute has had a long and successful history in the publishing arena involving both technical and popular reporting. IRRI publications have received international recognition for their technical quality, accuracy, writing, and design and have played a major role in achieving the Institute's mandate to disseminate its research findings to scientists, policy and decision makers, and donors worldwide. But no publishing effort should be static as audience needs change and budgets shrink. During 2001, in consultation with staff in Communication and Publications Services (CPS) and Visitors and Information Services (VIS), IRRI management approved the following changes in the Institute's publications.

- With the printing of the 2000 edition of the annual program (technical) report, this 38-year-old series ceased publication. By maintaining and improving various other IRRI publication series (Discussion Paper, Technical Bulletin, and Limited Proceedings)—in addition to the availability of refereed journal articles, the possible compilation of certain sets of journal articles, articles in formal IRRI workshop and symposium proceedings (five or six annually), and dozens of proceedings from other institutions—technical research reporting to other rice scientists will be adequately covered.
- After the printing of the 2000-2001 annual (popular) report (*Rice Research: The Way Forward*), this 12-year-old series was terminated and replaced by a popular biannual magazine called *Rice Today.* Debuting the first week of April 2002, the new periodical features lively, entertaining news and information on IRRI, rice, and rice research from all rice-producing nations.
- The contents of <u>this</u> annual *Report of the Director General* (April) have been revamped to contain a concise list of accomplishments and next-step activities of the 12 research projects currently in the 2002-2004 MTP. The new *DG report* also includes the annual staff lists and awards, publications and seminars, donor contribution details, and other necessary information for the annual record that used to be in either the popular Annual Report or the technical Program Report. See the table of contents on page 1.

- Because of budget cuts in 2001, the *International Rice Research Notes* (*IRRN*) and the *Rice Literature Update* became biannual publications (June-December for both).

Some significant events in 2001 and early 2002

IRRI-India office inaugurated and ICAR-IRRI Workplan for 2001-2004 approved: On 15 February 2002 in New Delhi, the Indian Council of Agricultural Research (ICAR), the Indian Agricultural Research Institute (IARI), agricultural universities, IRRI, sister CGIAR centers, and the press and media attended the inauguration of the IRRI-India office. Located at the National Agriculture Science Center, the new IRRI office joins those of other CGIAR centers (including CIMMYT and ICRISAT) and is in close proximity to IARI, the National Bureau of Plant Genetic Resources (NBPGR), the National Academy for Agricultural Sciences (NAAS), and the National Seeds Development Corporation. The center is described as a model to be duplicated in other countries for the synergy that is expected from the integration across centers and disciplines located at the site. Under the new ICAR-IRRI Workplan approved the same day, 33 ongoing projects will continue and eight new projects will begin. The research covers the full spectrum of biotechnology, field delivery, and impact assessment. India continues to account for the highest number of collaborative projects and activities with IRRI.

IRRI signs new 25-year lease with UP: In September, IRRI signed a new 25-year lease with the University of the Philippines (UP) for the approximately 230 hectares of land housing its headquarters and experimental station in Los Baños. The lease is retroactively effective from 1 July 2000 and shall be for a period of 25 years or up to 30 June 2025, renewable upon mutual agreement of the parties. At the same time, IRRI also renewed its close ties with UP Los Baños (UPLB) through the signing of a memorandum of agreement (MOA) that maps out key areas of cooperation.

Philippine president unveils first modules of growing rice online: After being taught to literally thousands of rice researchers, government officials, and farmers for almost three decades, the very first electronic modules of the *Rice Production Training* series were released in 2001 by IRRI. On 2 August, Philippine President Gloria Macapagal-Arroyo helped unveil them during a visit to the Institute. The ceremony was seen as especially appropriate by those who recalled that it was the father of President Macapagal-Arroyo, former Philippine President Diosdado Macapagal, who formally inaugurated IRRI in 1962 and so launched the very first *Rice Production Training* course soon after.

CARDI and IRRI sign MOA: On 28 June, an MOA on scientific and technical collaboration in rice and rice-based farming research and training between the Cambodian Agricultural Research and Development Institute (CARDI) and IRRI was co-signed by Men Sarom, director of CARDI, and William Padolina, IRRI deputy director general for partnerships. The signing of the MOA formalized the new era of IRRI's partnership with and support to CARDI as a newly established research and development institute. IRRI, through the Cambodia-IRRI-Australia Project (CIAP), has been in Cambodia for more than 12 years of fruitful collaboration, resulting in Cambodia's self-sufficiency in rice and the creation of CARDI as a fully independent institution with the national responsibility for applied agricultural research and development.

NCES/RDA and IRRI sign MOA: On 21 September, an MOA between the National Crop Experiment Station (NCES) of the Rural Development Administration (RDA) and IRRI was signed during a special ceremony in Suwon, Korea. NCES Director General Seok-Dong Kim and IRRI Representative William Padolina were the cosigners of the 5-year agreement that calls for IRRI and NCES to collaborate in developing improved rice germplasm for temperate environments and in exchanging and training scientists.

Visitors to IRRI on the increase

In 2001, IRRI welcomed 61,325 visitors, up by 22% from 49,759 in 2000. These included Philippine President Gloria Macapagal-Arroyo (see above), Vietnamese President Tran Duc Long, six ambassadors, various members of the diplomatic community, and 20 representatives of donor countries and international, academic, and nongovernment organizations. See the table on page 94, which provides the details on 24 regional and international conferences, workshops, and symposia hosted or co-hosted by IRRI and attended by more than 700 representative delegates from at least 34 countries.

Organizational activities continue for 1st International Rice Congress

IRRI, the Chinese Academy of Engineering (CAE), and the Chinese Academy of Agricultural Sciences (CAAS) are organizing the inaugural *International Rice Congress 2002* to be held 16-20 September in Beijing, China. Billed as the “first comprehensive event for the world’s most important crop,” this Rice Congress will have simultaneous conferences, symposia, workshops, and exhibitions based on the theme *Innovation, Impact, and Livelihoods*. The latest information on the Congress as well as on the 24th International Rice Research Conference, which is an integral part of the overall event, can be found on the Congress Web site at www.irri.org/irc2002.

Awards and honors

IRRI was the only CG center to pick up two *Excellence in Science Awards* during the CGIAR’s Annual General Meeting (AGM) in Washington in October. The Institute’s hybrid rice breeding team won the award for the Outstanding Scientific Support Team, and the paper *Genetic diversity and disease control in rice* was chosen as the Outstanding Scientific Article. And, as in every year, numerous IRRI IRS and NRS received various awards and honors. Gurdev Khush received additional accolades during his last year at IRRI including the China International Scientific and Technological Cooperation Award in Beijing and the International Cooperation Award from the Deputy Prime Minister of Egypt. See the complete listing of staff awards and honors beginning on page 65.

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Project summary and highlights

Genetic resources conservation, evaluation, and gene discovery

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

THE PROJECT

Since its foundation, IRRI has been at the forefront of international efforts to collect and conserve the genetic resources of rice, now held in trust in the International Rice Genebank (IRG). Furthermore, the Institute also maintains a significant collection of biofertilizer germplasm—*Azolla*, blue-green algae, and N_2-fixing bacteria, among other organisms. Plant breeders and researchers worldwide use these genetic resources to develop new rice varieties. Effective use requires characterization and evaluation. Significant opportunities now exist to describe allelic diversity using molecular techniques to explore the germplasm collection for important traits. Knowledge of the diversity of wild and cultivated rice germplasm will enhance its value to rice improvement programs.

One of the keys to meeting the challenges of productivity and profitability in rice production is the availability to farmers of high-yielding, pest-resistant, and well-adapted rice varieties. The organized 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 high-yielding rice varieties (into which have been incorporated useful traits from many sources) that have been tested and released through INGER. This safe delivery of germplasm among NARES and international centers increases the diversity of rice in modern rice production systems, offering different choices for rice farmers.

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). The success of IRIS requires a strong and unambiguous link between information and germplasm and the understanding of rice researchers to make use of both components through knowledge-intensive crop development strategies.

RESEARCH PROGRESS IN 2001

Output 1: Conserve and characterize rice and biofertilizer genetic resources

- Through molecular analysis using RAPD and SSR markers, showed the divergence of *O. meridionalis* populations according to their geographic distribution in Irian Jaya, Indonesia, and the Northern Territory and Queensland in northern Australia. This divergence is accompanied by partial to complete reproductive isolation in terms of sterility of F_1 hybrids obtained from crosses among accessions with different geographic origins. This suggests that gradual speciation is underway in *O. meridionalis*.
- Received 917 samples of cultivated rice and 13 wild rice samples.
- Added 4,133 newly registered accessions to the present holdings, which are now available for use in research.

- Distributed 16,015 seed samples to 31countries and IRRI scientists for research purposes.
- Restored 1,663 previously lost accessions to the Philippines.
- Responded to 86 requests from 27 countries for information on 43,737 germplasm accessions.

Output 2: Exchange rice germplasm and evaluate it internationally

- Sent 20 sets of yield and observational nurseries to East Timor for evaluation in irrigated, upland, and rainfed lowland sites. There is a high probability that high yielding, adapted varieties are in these sets.
- Sent 252 outstanding INGER entries to North Korea upon request and an additional 235 such entries to requestors in 12 other countries.
- Distributed 311 sets of regular INGER nurseries (803 breeding lines from 35 NARES 5 IARCs) to 29 countries.
- INGER entries in Papua New Guinea (9), Indonesia (7), China (6), Cambodia (5), Bangladesh (2), and Pakistan (1) were introduced directly as varieties.
- In China, 38 hybrid rice varieties were released whose restorers were produced using INGER entries as parents.
- Using INGER entries as parents, 41 pureline varieties were developed and released in India (17), China (15), Malaysia (6), and Bangladesh (3).
- Developed and distributed the *INGER Code of Conduct*, which covers general guidelines on partnership with NARES, germplasm exchange, and germplasm utilization.
- The Philippines (50), Surinam (5), China (4), and IRRI (551) contributed materials to the INGER system for worldwide sharing.
- Held an INGER Training-Workshop on Intellectual Property Rights and an INGER Technical Advisory Committee Meeting on 17-20 July at Bangkok with 34 participants from 16 NARES, ARI, UPOV, WARDA, and IRRI. Developed a material transfer agreement (MTA) for germplasm exchange that can be used by NARES.

Output 3: Develop IRIS and facilitate its use by rice breeders and researchers

- Held the 2001 ICIS Workshop at IRRI, 14-18 May attracting 39 participants from 7 NARES, 7 ARIs, and 7 IARCs. Participants reaffirmed the goals of ICIS but revised the philosophy and methodology. It was decided to adopt an open-source approach concentrating on database interoperability at the abstract biological entity level, rather than achieving consensus at the database schema level. Also discussed technologies for Internet access—resulting in online access to IRIS at www.iris.irri.org.
- Catalyzed the establishment of an International Plant Ontology Consortium and coordinated a workshop on *Controlled Vocabularies (CV) and Ontologies (O)*. CV/Os enhance interoperability and data exchange of related plant databases and allow powerful database queries within and between databases.
- Integrated ICIS with the NCGR system bus and a prototype comparative mapping tool under evaluation.

Next step activities in 2002

Output 1: Conserve and characterize rice and biofertilizer genetic resources

- Continue monitoring viability of accessions, dispatching accessions to researchers in NARES and IARCs, characterizing material and processing new accessions into the Base Collection.
- Improve scope and quality of germplasm information and develop access to it through integration with SINGER and IRIS. This will include testing and debuging the finished modules, training users, and preparing the Users' Guide and Technical System Documentation.

- After identifying a core collection in the International Rice Genebank at IRRI, initiate allele mining of this valuable resource. This will include establishing primers for 250 candidate genes for abiotic/biotic stresses and grain micronutrients.

Output 2: Exchange and evaluate rice germplasm internationally

- Receive nominations from INGER members, compose ecosystem and stress oriented nursery sets, and distribute trial sets to collaborating partners.
- Identify promising INGER entries for yield potential, adaptation, and resistance to abiotic/biotic stresses.

Output 3: Develop IRIS and facilitate its use by rice breeders and researchers

- Develop plans for consolidation of IRRI germplasm databases. This will include choosing a primary relational database platform for IRIS after an Institute-level technical review.
- Enhance the ICIS structure, applications, and integration with other databases. This will include linking the GIS tool with the ICIS structure to retrieve performance and environment information and fully integrating the first generation NCGR ISYS comparative mapping tool with genetic and genomic mapping data in ICIS databases as well as other repositories.
- Enhance the Web interface to IRIS to allow specialist views of the common database. This will include designing a Web query interface to IRIS and commissioning it for external public Internet access.
- Deploy IRIS database and applications to NARES partners to manage genetic resources data, breeding projects, and national testing programs. This will include developing links with DRR India for the integration of information on lines in the All India Coordinated Testing Program and collaborate with CNRRI in China on the integration of information on modern Chinese rice varieties.

Partner institutions

- ***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; University of Birmingham, UK; NSSL, USA; University of Adelaide, Australia; CCLF (CIDA)-funded Canadian project.
- ***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.

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Project summary and highlights

Genetic resources conservation, evaluation, and gene discovery

Project 2: Functional genomics

THE PROJECT

Phenotypic expression of plant traits is determined by interactions among genes, developmental processes, and the environment. Future rice research must rely on a thorough biological understanding of the rice plant and the complex interactions between the plant and the environment. Genomics, the science of deciphering DNA sequence structure, variation, and function in totality, is expected to become the engine that drives discovery of traits and to help solve intractable problems in crop production. Through genomics, we will discover every rice gene, the functional diversity of genes in germplasm, and the overall architecture of genetic, biochemical, and physiological systems in rice. Such knowledge will lead to new genetic improvement strategies to meet future targets in rice production.

Recent progress in the rice genome sequencing have made the functional genomics agenda ever more timely and relevant. In October 2001, the Beijing Genomics Institute announced the results of the sequencing of *indica* rice and made the sequence data publicly accessible. The International Rice Genome Sequencing Project will deliver a highly accurate genome sequence by December 2002. As of March 2002, 62% of the rice sequence is in the public database. Experiments with rice gene chips at Syngenta show that a majority of rice genes can be used to understand gene expression in major cereals, demonstrating the utility of rice sequence information to other agricultural crops.

A completely sequenced rice genome will represent an enormous pool of information for rice improvement through marker-aided selection or genetic transformation. Yet, a full exploitation of this wealth of information will not be possible until we understand the biological functions encoded by the sequenced DNA. Therefore, a parallel effort is needed to produce the genetic resources through which biological functions can be assigned to the DNA sequences. Furthermore, IRRI needs to play a key role in improving public access to rice genetic information at a time when access to such information is becoming increasingly restricted due to intellectual property rights. IRRI is well positioned to undertake this important task on behalf of the rice research community. IRRI has excellent capacity to generate genetic resources, the expertise to identify important traits, and an extensive collaborative network to evaluate newly found traits in multiple environments.

The overall goal of this project is to develop the genetic resources and research capacity to apply information and tools provided by structural genomics to understand complex biological functions. A genome-wide experimental approach will give us unprecedented power to find new genetic information and dissect metabolic pathways important for increasing rice productivity. By creating the genetic resources for trait discovery, IRRI can be in a strong position to use genomic databases and promote accessibility of these resources to the rice-growing world.

RESEARCH PROGRESS IN 2001

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

- Produced an extensive collection of introgression lines with chromosome segments of wild species (*Oryza rufipogon, O. nivara, O. glaberrima*, and

O. longistaminata) and diverse germplasm incorporated them into common genetic backgrounds (e.g., IR64 and the new plant type). These lines are now available for phenotype evaluation and molecular analysis to extract useful alleles from the diverse rice gene pool.
- IRRI participated in the International Rice Microsatellite Initiative (IRMI) and contributed to the evaluation of more than 650 simple sequence repeat (SSR) markers on parental lines used in genetic mapping and breeding. Together with results from other collaborators, the IRMI has developed more than 1,500 SSRs for genotyping in rice.
- Systematically screened a mutant library of IR64 (~27,000 lines) for conditional mutants under various biotic and abiotic stresses. We have identified novel mutants with gain and loss of resistance to brown planthopper and mutants showing differential response to anaerobic and aerobic conditions. More than 30 disease-response double mutants have been constructed, some of which showed enhanced resistance to multiple diseases (blast, bacterial blight, and sheath blight). These mutants will contribute to the dissection of the stress response pathways that form the basis for trait improvement.

Output 2. Establish high-throughput gene array facilities for genotyping and expression analysis of desirable agronomic traits
- Established a microarray facility to support IRRI research and our collaborations with NARES and ARIs. A collection of ESTs of defense genes (~1,000) was developed through collaboration with Kansas State University, USA. These genes have been used to produce the first generation of microarrays for experimentation at IRRI and with our collaborators. The collection of defense genes established at IRRI provides a steady supply of marker genes to NARES without IP restriction.
- Developed a critical mass of IRRI staff who can extend training in microarray techniques to our NARES partners. This has provided a focal point for collaboration with ARIs and NARES. Furthermore, IRRI's facility and capability have attracted donation of resources (e.g., gene collection) from ARIs.

Output 3. Identify candidate genes, favorable alleles, and metabolic pathways for tolerance of abiotic and biotic stresses and for nutritional enhancement
- Through proteomics analysis, identified leaf proteins as indicators of drought response in genotypes (CT9993 and IR62266) with different degree of tolerance to water stress. Understanding the roles of some of these new proteins (e.g., S-like RNase, actin depolymerizing factor, IRL protein, GSH dehydroascorbate reductase) could lead to identification of novel drought-responsive mechanisms in rice.
- Identified QTLs for constitutive root traits (such as deep root and root thickness) in different genetic backgrounds, and showed that some of these traits are specifically expressed under aerobic or anaerobic conditions. The protein, physiological, and phenotype data provide the first essential step to associate specific genes to characters important in stress response in the relevant physiological conditions and environments.

Output 4. Develop databases and bioinformatic support for functional genomics
- Established an IR64 Mutant Web site (www.irri.org/genomics/database/IR64.htm) and initiated a mutant trait ontology to provide one-stop rice mutant information site for international collaborations in functional genomics.
- Established a StressGenesDb database and extended it to biotic stress genes. A prototype intranet Web site has been established with analytical tools and access to databases including trait database (traitdb) for project data integration.

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

- IRRI's position in both strategic and applied research has leveraged investment through collaboration and participation in competitive grant programs in the USA (NSF, USDA). IRRI participated as a co-principal investigator in a NSF-funded consortium on production of activation insertion lines for rice functional genomics. IRRI has been an active partner in the initiation of Cereal Genomics Initiative being considered by USAID.
- IRRI is viewed by ARIs as a center for depositing and disseminating the public resources to NARES. For example, IRRI serves as receptacle for the donation of defense gene libraries.
- Started discussions with funding agencies and scientists in China and India on concepts and logistics of national and international consortia on rice functional genomics.

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

- ARBN continues to serve as a pipeline to deliver tools and products to NARES. A series of disease resistant elite lines developed by marker-aided selection by four ARBN NARES collaborators were field-tested in multiple locations. In the Philippines, MAS-improved elite lines carrying different combinations of *Xa4/xa5/Xa21* genes showed a yield advantage of 12-66% in multiple-location yield trials. In Indonesia, two advanced MAS products with IR64 quality have been named as varieties: Angke (*Xa4/xa5*) and Sonde (*Xa4/Xa7*).
- Held an ARBN workshop on "Proteomic analysis of abiotic stress responsiveness in rice," cosponsored with BMZ/GTZ, in Iran, 28 April-10 May, 2001. Fifteen participants from Bangladesh, China, India, and Iran were trained in proteomic analysis, bioinfromatics, and cDNA isolation.
- With the new microarray facility in place, IRRI held the first ARBN training workshop on Microarray and Bioinformatics 3-7 December 2001. More than 70 researchers, 25 of which were from NARES, participated.

Next step activities in 2002

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

- Nearly complete a nontransgenic mutant bank consisting of both deletions and point mutations (~40,000 lines).
- Genetically define mutants for gain and loss of resistance to insect and virus, tolerance against salinity, seedling vigor, and submergence.
- Develop and characterize 800 advanced IR64 and NPT backcross progenies with introgressed chromosomal segments from diverse donors.
- Establish high-throughput screening methods for mutants and introgression lines with known relationship to field performance under reproductive stage drought stress.

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

- Establish high-throughput system for genotyping and allele mining.
- Establish a reverse genetics system for IR64 mutants and identify >10 mutations (with a focus on transcription factors) using TILLING and PCR deletion screen.
- Produce panicle cDNA library of 10,000 clones from drought-stressed and control plants of IR64, and apply ~5000 EST for microarray analysis.

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

- Validate function of broad-spectrum resistance genes against multiple pathogens, and establish the phenotypic contribution of disease resistance

candidate genes through comparison of field performance and gene expression of selected mutants and advanced breeding lines.
- Compare expression profiles in genotypes differing markedly in impact of reproductive-stage drought and salinity stress on yield components;
- Develop physiological (trait-based) assays to test short-listed candidate genes for drought tolerance, and apply candidate genes from proteomics analysis to determine association with QTL for drought and salinity tolerance.

Output 4. Develop databases and bioinformatic support for functional genomics
- Develop the International Rice Information System (IRIS) into a comprehensive repository of rice germplasm, field evaluation, and functional genomics data. Particular emphasis will be on developing a Web portal and specific high-priority datasets: 1) Rice genetic mutants, integrated with rice genome mapping information, and b) a gene catalog of trait-associated candidate genes integrated with DNA microarray and proteomic data.
- Integrate Laboratory Information Management Systems (LIMS) with high-throughput genotyping, DNA microarray, allele mining, and proteomics laboratories.

Output 5. Establish an international working group to provide a public resource platform and broaden access to genetic resources and genomic technologies
- Conduct a functional genomics working group meeting in conjunction with the International Rice Congress in September in Beijing.
- Develop a consortium with research teams in China and India to develop national consortia as part of International Workshop Group.

Output 6. Disseminate resources and information to NARES through the Asian Rice Biotechnology Network (ARBN) and training workshops
- Conduct microarray experiments using NARES genetic materials (e.g., disease-resistant and drought-tolerant advanced germplasm).
- Evaluate performance of MAS-improved lines in local disease hotspot areas in Indonesia, the Philippines, India, and China.
- Distribute candidate genes as needed to MAS breeding programs at NARES.

Partner institutions

- ***ARIs:*** Agropolis-France, CAMBIA, Clemson University, Cold Spring Harbor Laboratory, Cornell University, Fred Hutchinson Cancer Research Center, Huazhong Agricultural University, Iowa State University, Japan Rice Genome Program and National Institute of Agrobiological Sciences-Japan, Japan International Research Center for Agricultural Science, Tsukuba University, Japan National Institute of Genetics, John Innes Center, Kansas State University, McGill University, Nagoya University, National Center for Genome Research, National Research Council Plant Biotechnology Institute-Canada, Ohio State University, Oklahoma State University, Purdue University, Stanford University, the Institute for Genomic Research, Tottori University, University of Arizona-Tucson, University of California-Davis, University of California, Riverside, University of Georgia, University of Illinois, University of Missouri, University of Washington, University of Wisconsin.
- ***CGIAR centers:*** CIMMYT, CIAT.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

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

THE PROJECT

The demand for rice continues to increase because of unabated population growth. Demand for high-quality rice is increasing with rising living standards. Deficiency of micronutrients such as iron, zinc, and vitamin A affects millions of poor rice consumers. In the irrigated ecosystem that produces 70% of the world's rice, the adoption of improved varieties that have a yield potential of 10 t/ha is almost complete. Yield at the farm level is approaching a plateau. 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 use of pesticides. Therefore, we will have to produce more rice from less land, with less water, less labor, and less chemicals. To meet the challenge of increased rice production and alleviation of hidden hunger, we need varieties with higher yield potential, multiple resistance to diseases and insects, superior grain quality, tolerance of some abiotic stresses, and higher micronutrient content.

This project will use conventional breeding and biotechnological approaches to develop new plant type (NPT) cultivars and rice hybrids with about 20% higher yield than the existing high-yielding varieties. There are opportunities to develop even higher yielding rice cultivars and hybrids. Yield-enhancing quantitative trait loci (QTLs) from exotic germplasm and wild species will be introgressed through molecular breeding. The introgressed lines will be useful as such and as parents for developing hybrids with stronger heterosis. Pest resistance of varieties and hybrids will be improved by incorporating genes for resistance through conventional and genetic engineering approaches. To increase the durability of resistance, several genes will be pyramided through molecular marker-aided selection. The palatability of rice varieties will be enhanced and germplasm with higher micronutrient content such as iron, zinc, and vitamin A will be developed through conventional breeding and genetic engineering. The ultimate aim of the project is to develop rice varieties and hybrids with all the desirable features. Agronomic management practices for the new plant types and hybrids will be developed and the economic impact of rice hybrids and new plant types on high-yield and high-income environments will be studied.

RESEARCH PROGRESS IN 2001

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

- Found 14 NPT lines to out yield the check varieties: IR72/PSBRc 18 (5-6 t/ha) by a margin of 12-30% in replicated yield trials.
- In field experiments, found that stem borer infestation on improved NPT lines was similar to that of indica lines and lower than that of the original NPT lines.

- Identified 16 improved NPT lines possessing either *Xa4* or *xa5* genes for bacterial blight (BB) resistance. NARES are now evaluating elite lines with various *Xa* and *xa* genes.
- More than 20 improved NPT lines are now being evaluated by NARES. One NPT line, IR64446-7-10-5, was released in China.
- Through sensory evaluation, found that IR68144 (a high-iron rice) has high quality in both raw and cooked forms.
- Found that micronutrient-dense traits in rice have no negative effect on grain quality and consumer acceptability and preference.
- Identified additional elite lines possessing resistance to tungro virus and BB. IR69726-29-1-2-2-2, resistant to tungro virus, was released as a stopgap variety for tungro hot spots in the Philippines. Another tungro-resistant line, IR73885-1-4-3-2-1-6 derived from crosses involving *O. rufipogon,* was recommended for release as a stopgap variety. Three elite lines, IR31892-100-3-3-3-3-3, IR59552-21-3-2-2, and IR60819-34-2-1, were released as varieties in Indonesia. Transgenic IR64 and IR72 have been made available to interested NARES.
- Found that resistance to rice tungro bacilliform virus (RTBV) to be quantitative in inheritance. Knowledge of the genetics of RTBV resistance will help in gene mapping and selection strategies including marker-aided selection.
- Found the rice tungro resistance of *O. rufipogon* to be due to resistance to RTBV, not to the insect vector.
- Three improved aromatic rice lines (IR71732-72-3, IR70422-44-3-3, and IR67415-228-2-1-1) performed exceedingly well under alkaline soils (pH 10.5). IR71732-72-3 performed very well in farmers' fields.

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

- Characterized more than 100 CMS (cytoplasmic male sterile) lines developed at IRRI for agronomic traits, outcrossing rate, combining ability, grain quality, and disease/insect resistance. CMS lines IR68897A, IR70369A, and IR70328A, found to be commercially acceptable (much like the popular IR58025A), are ready for registration. These CMS lines are being shared with public and private institutions in the NARES to enable them to develop locally bred rice hybrids. For example, Bangladesh has released hybrid IR69690H (derived from IR58025A) as BRRI Dhan Hybrid 1.
- Used Mt DNA-specific probes to differentiate two sources of CMS, i.e., *O. perennis* and *O. glumaepatula,* from seven other CMS sources. Mt DNA probes are very useful in helping to characterize some CMS sources. However, additional probes are needed to characterize other commercially usable CMS sources.
- Introgressed *Xa* genes in selected maintainer lines to help develop BB-resistant CMS lines.
- Found that, with Soil and Plant Analyzer Development (SPAD)-based N management, the threshold value is one unit less in hybrids than in IR72. This indicates that the N management strategy of rice hybrids should be different from that of inbred HYVs. This better understanding of N management for hybrid rice will be useful as farmers adopt the technology.
- Found that over-dominant epistatic loci are the primary genetic basis for inbreeding depression and heterosis in rice. This confirms that the development of parental lines for breeding rice hybrids should be done independently of breeding for inbred lines.

Next step activities in 2002

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

- Develop an agronomic management package for NPT lines by comparing the yield potential of the NPTs and the indica controls, growing NPT lines under direct-seeded conditions, developing and conducting N management experiments, and through the use of 15N identifying the effect of root physiology on sink and source capacity of the NPTs.
- Incorporate resistance to stem borer in NPT lines using transgenic approaches.
- Evaluate NPT-*Bt* rice in the screen house and the field.
- Evaluate wide cross progenies for stem borer resistance.
- Evaluate the effectiveness of pyramid lines containing *Xa7* and individual component lines deployed at two sites (BB hotspots) in farmers' fields.
- Conduct field-testing of *Bt* and *Xa21* transgenic rice in India under a material transfer agreement.
- Replace the old strain of RTBV in the agroinoculation system with recently isolated strains to perform more accurate evaluation of RTBV resistance.
- Develop an agroinoculation system for rice tungro spherical virus (RTSV) to evaluate RTSV resistance that is independent of the insect vector.
- Conduct focus group discussions to assess the perceptions of different stakeholders on the importance of the micronutrient deficiency problem and the acceptability of genetically modified rice.
- Screen released varieties and elite NPT lines for salinity tolerance at the seedling stage and for P-deficiency in the field.
- Test the yields of from 5 to 10 NPT lines that have shown improved submergence tolerance as well as good anaerobic germination capability.

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

- Analyze results obtained in identifying heterotic groups and heterotic gene blocks.
- Evaluate new CMS lines for outcrossing rate and grain quality.
- Conduct crop management experiments for F_1 seed production.
- Conduct N management experiments for hybrid rice cultivation.
- Evaluate farmers' experience in the adoption of hybrid rice in Vietnam and Philippines (in collaboration with Project 10). Will analyze the sample household survey data and prepare reports.

Partner institutions

- ***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.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

Project 4: Managing resources under intensive rice-based systems

THE PROJECT

Favorable rice production environments have the potential for high and sustainable productivity, and nearly 70% of the world's rice is grown in irrigated areas. In Asia, rice-rice and rice-wheat production systems each cover about 24 million hectares. Production growth in these systems due to improved varieties, irrigation, and additional use of fertilizer was the major impetus behind the doubling of aggregate rice production in Asia in the past 30 years. In recent years, however, yield growth has stagnated, and it may be difficult to produce enough rice in the future to satisfy continued population growth and the nutritional needs of the urban poor and rural landless. Furthermore, there are concerns regarding environmental problems in these intensive production systems relating to misuse and overuse of pesticides, water, and nitrogenous fertilizers. Postharvest losses and labor scarcity are also high in many areas. Current irrigated yields of about 5 t/ha are well below the estimated average climatic potential of about 8 t/ha with current varieties, and farmers will require new knowledge, tools, and machines to bridge this yield gap and increase productivity. Knowledge is also the key to reducing environmental damage, which now affects the health of both farmers and those outside the agricultural sector.

Productivity in favorable environments can be enhanced and sustained through the use of new knowledge-based technologies (and machinery) that are environmentally sound, socially acceptable, and profitable to farmers. These technologies will need to integrate diverse facets of crop management to manage soil, water, fertility, and pests in different weather situations, paying particular attention to conserving biodiversity and maintaining and improving ecological health. To fully develop these technologies, it will be critical to conduct research on crop physiology, the chemistry of nutrient cycling, the ecology of the rice crop and the flora and fauna in and around it, and mechanization systems. More important, understanding farmers' current management decisions and adoption constraints will be crucial to enhancing adoption.

RESEARCH PROGRESS IN 2001

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

- Simplified the site-specific nutrient management (SSNM) approach. This included the use of the leaf color chart (LCC) to determine need based N management decisions.
- Introduced the LCC to about 160,000 Vietnamese farmers through local scientists. Surveys showed that farmers benefited from the use of the LCC reducing fertilizer and pesticide use.
- Developed methods for measuring concentrations of phenolic acids, which may be indicators of yield decline.
- Established that the use of seedlings of up to 5 weeks old for transplanting has no effect on yields, but does have significant effects on snail damage.

This information is potentially useful to farmers who are transplanting 2-week-old seedlings, which suffer significant snail damage.

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

- Quantified growth dynamics of rice and the weed *Echinochloa*, which showed the importance of using flooding regimes in weed management.
- Analyzed yield stability in wet-seeded rice in relation to eight herbicide regimes. Found that interspecific selections of weed species can be linked to the serial use of a single herbicide regime. This information will greatly aid researchers in developing sustainable weed management systems.
- Isolated slow-growing fungal species from red stripe disease lesions. This may be an important step in identifying the causal agents of the red stripe (sometimes called the yellow leaf disease)—an effort that has shown slow progress over the last 10 years.
- Nine provinces in China have experimented with the use of mixed planting of rice cultivars to reduce blast infestations. This practice, which now covers some 100,000 ha in Yunnan Province, can potentially reduce fungicide use.
- Determined *Bt* toxin combinations that would delay the evolution of stem borer resistance. The Cry1A+cry2A combination was found to be excellent followed by Cry1Aa+cry1B and cry1Ab+cry1C. This information is important for transformation research to develop *Bt* rice.
- Found that the dispersal of predatory crickets between rice and nonrice habitats occurs on a diurnal cycle and that they move as far as 80 meters into rice fields. This shows that conserving the nonrice habitats to preserve natural biological control agents such as crickets is an important IPM strategy.
- Introduced a nonchemical method for rat control, called the trap barrier system (TBS), to farmers in Vietnam. This method, which was rapidly adopted by farmers introduced to it, will be promoted by the government in a nationwide campaign next year.
- On World Environment Day 2001, Thailand's minister of agriculture launched a media campaign to encourage farmers to reduce early season insecticide use.
- Found that insecticide use by Lao farmers is low but that it could potentially increase because their beliefs and attitudes have the same characteristics as farmers in Vietnam and the Philippines. This information has important implications in the Lao PDR for developing rice intensification policies and strategies to avoid pesticide misuse.

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

- Developed standard test protocols for plows, seeders, transplanters, grain dryers, and grain storage bags, which are being used by scientists in Bangladesh.
- Developed and used in training programs a video on direct wet seeding methods.
- Identified the major storage insect pests and evaluated a chemical-free seal storage system to control them.
- Developed a Web site containing technology information and machinery evaluation reports: www.irri.org/Aed/aedhome.html.

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

- Built and installed laser leveling buckets in Ghaziabad, India.
- Quantified soil nutrient supply capacity in farmers' fields in Bangladesh, India, Nepal, and Pakistan and used the information to develop nutrient management recommendations.

NEXT STEP ACTIVITIES IN 2002

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

- Conduct on-farm experiments to compare N management by LCC and fixed timing.
- Calibrate the LCC for six common rice varieties in Bangladesh.
- Determine long-term relative performance of crops using LCC and fixed N timing.
- Compare K requirements in inbred and hybrid rice in China.
- Analyze N, P and K balances in long-term experiments.
- Conduct a planning workshop to develop research methods for analyzing nutrient-pest interactions.
- Develop N management options for hybrid rice.
- Analyze farmers' knowledge, attitudes, and practices in nutrient management.
- Conduct a farmer participatory evaluation of the LCC.

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

- Determine effects of cultivar x fertilizer on pest biology in the laboratory.
- Conduct a comparative analysis of *Echinochloa* life cycles and develop integrated control measures.
- Develop strategies for managing herbicide resistance.
- Determine the causal agents of the red stripe disease and establish its etiology.
- Determine the relationship between habitat biodiversity and pest control function.
- Determine the mechanisms of blast control provided by gene diversification.
- Determine the effects of gene diversification on arthropod populations.
- Integrate microbial biocontrol agent (MBA) with gene diversifications to control multiple diseases in rice.
- Implement the community trap barrier system (CTBS) in two provinces in Vietnam.
- Determine pest management decisions and dissemination of new information through participatory methods.
- Quantify relationship between yield components, morphology, and stem borer injuries.
- Evaluate rice-weed competition in relation to nutrient and water management.
- Evaluate the use of the mass media to motivate farmers to reduce insecticide use in Thailand.

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

- Publish standardized criteria and evaluation techniques for farm equipment.
- Develop linkages between IRRI and commercial equipment manufacturers.
- Develop a training video on the wet seeding technique.
- Develop guidelines for improved spray application practices.
- Develop improved grain and seed storage methods.

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

- Analyze yield trends at 33 rice-wheat sites.
- Develop crop establishment methods and improved N and water management methods for rice-wheat systems.
- Conduct training of national scientists in laser leveling techniques.

- Establish a database of diverse biochemical C and N parameters from rice-wheat soils with a wide range of soil organic matter (SOM) contents and management practices.

Partner institutions

- ***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: Univ. 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: Univ. of Kyoto, KNAES, Kumamoto; Netherlands: WAU; Switzerland: ETH Zurich; USA: UC Davis, NC State, Ohio State Univ., Univ. 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.

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

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

THE PROJECT

The present and future food security of Asia depends largely on the irrigated rice production system. This system is a major consumer of freshwater resources: in Asia, irrigated agriculture accounts for 90% of total diverted freshwater, and about 50% of agricultural water is used to irrigate rice. Because of its genetic inheritance (semiaquatic plant) and particular production process (continuously flooded), irrigated lowland rice requires substantially more water to produce the same amount of grain than any other major crop. The amount of water available for irrigation, however, faces competition worldwide from industrial and domestic uses. This situation is aggravated by dramatically increasing costs for irrigation development over the past decades. The declining water supply, emerging water markets (e.g., in India and Bangladesh), and increasing costs for water availability (e.g., due to volumetric water pricing or groundwater pumping costs) will force farmers to use less water in rice production. To avoid food shortages for lack of irrigation water, new irrigated rice-based systems and technologies are urgently required to save water and increase water productivity (i.e., grain yield over water input, in g grain/kg water).

Substantial progress has already been made in developing water-saving irrigation techniques, such as allowing the soil to dry out to a certain level before reapplying irrigation water, aimed at reducing the amount of water outflow by percolation and seepage from the rice fields. Investigation in this area will continue to identify the socioeconomic and biophysical environments where these techniques can be adapted by farmers. But combating the looming water crisis requires exploring other technologies that entail a more radical change in crop management techniques such as the cultivation of rice on raised beds under saturated soil and the cultivation of rice as irrigated upland rice (aerobic rice).

Saving water in the field is important for the farmers but may be of little importance to the hydrology of the irrigation system or basin. This is because the water “loss” from a field may be recovered for irrigation use at another point downstream. Interactions among different water balance components of an irrigation system require that we look beyond the field level. A recent CGIAR workshop on integrated natural resource management (INRM) in Penang, Malaysia, stressed the importance of understanding the scale effects for INRM. It is important that our research results in increased water productivity from the farm to system level.

RESEARCH PROGRESS IN 2001

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

- A two-year experiment at two sites in China showed that alternate wetting and drying (AWD) reduced irrigation water, did not reduce yield significantly, and increased water productivity with respect to irrigation water up to 30%. AWD did not need N-fertilizer management different from conventional flooded irrigation.

- A farmers' survey in Hubei indicated that alternate wetting and drying does not affect farm management practices substantially, nor does it affect profitability and yield in farmers' fields.
- In the Philippines, manufactured and tested implements and procedures for fully mechanized bed-formation on different soil types and hydrology (including in wet puddled soil). This drastically reduces the labor needs for forming beds.
- An experiment comprising of three N and three water input levels under a regime of alternate wetting and drying irrigation (AWDI) was carried out at Philrice during the dry season. The experiment confirmed our findings in China that there was no nutrient by water interaction. And there were no significant yield differences among the AWDI input levels.
- Developed a new nitrogen subroutine and coupled it to the modules of the ORYZA model for potential production and water-limited production, thus creating the ORYZA2000 model. The model was satisfactorily tested for all three production situations. Completed the draft scientific description and user manual.
- At Chang Ping Station, Beijing, during the summer of 2001, developed a field experiment on the hydrology of aerobic rice (compared with lowland rice). Initial results indicate that as little as 600-700 mm of water are needed on soils that have up to 75% sand and only 5% clay and with groundwater tables more than 25 m deep.
- Among management treatments that varied soil fauna, stubble load, pre-rice soil flooding, and pre-rice crop, destruction of soil fauna by methyl bromide fumigation resulted in the highest yield among four lowland and upland varieties grown in an irrigated aerobic soil. The differences in plant growth between fumigated and nonfumigated plots were apparent right from emergence.
- Compared rice yield, water use, and water productivity among farmers using canal water (low cost) with those using pumps (high-energy cost) in the Sta. Cruz River Integrated Irrigation System of Central Luzon, Philippines, over four seasons. Preliminary results show that farmers with pumps use less water in irrigation but they have lower yields. Pump users have higher water productivity than those who use canal water. The results indicate that when the water cost is high, farmers will save on irrigation costs, aiming at increasing the amount of rice produced with one unit volume of water, even to the extent of sacrificing some yield.

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

- In a study on long-term trends in water use and water productivity in Hubei, China, confirmed that water for agriculture faces severe competition from other sectors. Water allocations to agriculture declined in favor of allocations to industrial and domestic uses. Rice production declined, but water productivity in agriculture increased.
- Employed the SEBAL algorithm (secured via cooperation with IWMI) to estimate evapotranspiration in District 1 of the UPRIIS irrigation system in central Luzon, Philippines, using remote sensed data. Collected satellite imagery and conducted groundtruth collection campaigns during in the 2001 dry season. The results indicate that the methodology is promising.

Next step activities in 2002

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

- Print and distribute the updated ORYZA model (book and accompanying CDROM) for potential, water-limited, and nitrogen-limited production.
- Set up experiment to compare water-saving technologies (alternate wetting and drying, bed planting, and aerobic rice cultivation) at two contrasting sites in China.

- Complete analysis of the effects of water scarcity on farm management and profitability in central Luzon, Philippines.
- Complete study on water x nitrogen interactions under alternate wetting-drying irrigation regime in the Philippines.
- Initiate water x N interaction measurements in aerobic rice systems in the Philippines (at IRRI).
- Organize an 8-12 April workshop at IRRI headquarters: Water-wise Practices in Rice Production.
- Start the farmer participatory knowledge transfer of AWD in Tarlac and Nueva Ecija, Philippines.
- Continue the experiment on the IRRI farm to investigate the effect of bed size on water use and crop performance.
- Conduct farm surveys on farmer adoption of aerobic rice in China and raised bed cultivation in India.
- Conduct a survey to examine the effect of tube well irrigation on the underground aquifer near the Mekong River in southern Cambodia.

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

- Prepare a report that quantifies the water balance, reuse, and productivity at various scales at UPRIIS (Philippines) and Cu Chi (Vietnam).
- Complete development of an empirical model to assess the effects of El Niño-induced water scarcity on rice production in the Philippines.

Partner institutions

- ***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 (IWMI).

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Project summary and highlights

Enhancing productivity and sustainability of favorable environments

Project 6: Irrigated Rice Research Consortium (IRRC)

THE PROJECT

The IRRC advances international research and outreach partnerships between IRRI and the national agricultural research and extension systems (NARES) in irrigated rice. The Consortium is active in all of the major irrigated rice countries and its steering committee consists of policymakers from seven countries: Bangladesh, China, India, Indonesia, Malaysia, the Philippines, and Vietnam. Through this leadership, the Consortium has the underlying support of local governments and the national agricultural institutions needed to address and accomplish its objectives. The IRRC is organized through a series of workgroups designed to address important problems of sustainability and productivity. The workgroups are coupled to a technical advisory panel to ensure that appropriate new research is identified. The workgroup for impact assessment provides farmer participatory appraisals and monitors and evaluates adoption and impact. Strengthening NARES capacity for research, delivery, and implementation is the objective. The Consortium partners include not only farmers and the NARES, but also interested NGOs and private sector groups.

RESEARCH PROGRESS IN 2001

Only progress related to governance is reported here which facilitates the accomplishments of the workgroups. The workgroup accomplishments are reported in projects 2, 4, 5, and 12.

- Appointed the steering committee from the NARES of seven countries.
- Initiated six workgroup activities under the governance of the IRRC: hybrid rice, reaching toward optimum yields (RTOP), weed ecology, saving water, rodent ecology, and impact assessment.
- Completed farmer participatory appraisals for the RTOP (nutrient management) workgroup.

NEXT STEP ACTIVITIES IN 2002

- Hold inaugural IRRC meeting during which the principles of the Consortium's governance will be established.
- Workgroups will report on Phase II directions based on needs and assessment analysis.
- The impact assessment workgroup will continue to identify needs, opportunities, and assessments.
- Identify and prioritize new research and extension initiatives to be reviewed by the technical advisory panel and approved by the steering committee.

PARTNER INSTITUTIONS

- ***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.

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Project summary and highlights

Improving the productivity and livelihood for fragile environments

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

THE PROJECT

More than 700 million of the poor in Asia obtain 50–80% of their calories from rice produced in fragile environments—the rainfed lowlands and uplands, and the deepwater and coastal areas. Farmers in these environments often adopt a risk-aversion strategy that minimizes inputs but produces low yields: less than 2 t/ha on average compared with more than 5.5 t/ha in irrigated lowland environments. The potential gains to food security, human nutrition, poverty reduction, and environmental protection from increases in the efficiency and value of rice production in these areas are immense. In addition to providing more calories from higher yields, there is potential to incorporate in the improved varieties micronutrients such as vitamin A, lysine, iron, and zinc needed to counter human malnutrition. Rice, because of its prominence in the Asian diet, its low cost, and its ease of storage, is an ideal vehicle for enhancing access to micronutrients. The focus of this project is on the genetic enhancement of rice to achieve these gains.

Farmers in fragile environments are confronted by drought and submergence, diverse pests and diseases, and poor soils. Over the past 25 years, potential solutions to many of these problems have been discovered in cultivated and wild rice germplasm, making genetic enhancement a viable strategy for improving the livelihood of the rural poor. Reduction of risk in rice cultivation in fragile environments requires enhanced seedling vigor, increased tolerance or avoidance of drought and submergence, and better tolerance of sodium, iron, and aluminum toxicity and phosphorus and zinc deficiency, combined with resistance to biotic stresses, especially the blast fungus. Additional financial and health benefits will come from improvements in the milling and cooking qualities and micronutrient content of the grain.

Scientific advances over the past decade in biochemistry, physiology, and biotechnology, including structural and functional genomics and bioinformatics, are providing new molecular understanding and new breeding and phenotyping tools. For many traits, these tools have already produced promising genetic materials and a clear breeding strategy that can now be tapped for genetic enhancement of varieties in the fragile environments. The probability of research success is now much higher in developing varieties with high levels of iron, zinc, and provitamin A and varieties that are tolerant of drought, submergence, and saline soils. IRRI has the unique position of playing a catalytic role in bridging the upstream basic research done in advanced research institutes and the private sector in industrialized countries and work to develop varieties for rice farmers in the NARES in developing countries.

The impact of this project will be facilitated by NARES-IRRI shuttle breeding, farmer participatory breeding and selection, and linkage with INGER and research consortia at key lowland and upland sites (Project 9, Research consortia for the fragile environments). The Asian Rice Biotechnology Network facilitates the development and dissemination of germplasm and databases for NARES, and 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 have begun and need to be continued. Women who are more heavily involved in rice production than men need to be involved in both farmer participatory breeding and studies on human nutrition.

Research progress in 2001

Output 1. Develop superior germplasm for rainfed lowlands

- Lines with good grain quality and submergence tolerance were released in Uttar Pradesh for areas of medium-to-deep water. Line NDR8002 (IR67493-M-2) was submitted to the UP government for formal release to farmers. The significant yield advantage of this cultivar will contribute to increases in farmers' income due to better grain quality and enhanced submergence tolerance.
- Proteomic analysis conducted in Project 2 provided insight into drought response strategies of upland cultivar CT9993 and lowland cultivar IR62266 at the mid-tillering stage. Forty-two proteins responded reversibly to drought and re-watering. The proteins fell into four major behavioral groups: up-regulated by drought stress in both cultivars, down-regulated by stress in both cultivars, up-regulated in CT9993 but unresponsive in IR62266, and down-regulated in IR62266 but unresponsive in CT9993. These patterns were consistent with a generally more active response of CT9993 to stress in the field. Doubled haploid lines derived from a CT9993/IR62266 cross are being examined to determine how these patterns correlate with superior and inferior levels of drought tolerance.
- Bacterial blight (BB) and blast, the most serious diseases of the rainfed rice ecosystems, are genetically diverse across South and Southeast Asia. The interaction of major and partial resistance genes provides the best chance of developing broad-spectrum, durable resistance to these pathogens. We discovered 26 quantitative trait loci (QTLs), involved in four pathways leading to partial resistance to BB and characterized their race-specificity. The gene-for-gene system for hypersensitivity and QTLs for partial resistance to blast were also evaluated. Cross-resistance between these sets of genes is being assessed, in part through consortium activities in Project 9.

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

- Better seed germination and growth are needed for both rainfed lowland areas prone to early flooding and irrigated areas were seedling submergence is used for weed control. We screened 5,000 genebank accessions and breeding lines for anaerobic seedling establishment with direct dry seeding. Thirty-four lines showed 70 to 90% survival. These lines will be confirmed at IRRI and in Bangladesh.
- Coastal and inland salinity occur on more than 5 million ha of rice-growing land in South and Southeast Asia. We evaluated five improved salinity tolerant lines in the Philippines through national cooperative testing. Line IR61920-3B-20-1 was recommended for release as a variety. It yields up to 4.8 t/ha and is acceptable to farmers because of its improved grain quality. Fifty-four salinity-tolerant lines with multiple stress resistance were tested in India and nine were nominated for national testing.
- Through the International Molecular Breeding Program, introduced novel major genes and QTLs for salinity tolerance into elite genetic backgrounds by advanced backcrossing with >100 diverse lines as nonrecurrent parents. More than 400 salinity-tolerant BC2F2 plants in the IR64, Teqing, and NPT genetic backgrounds were identified. Some of the selected BC2F3 lines were genotyped to locate genes/QTLs for salinity tolerance.

Output 3. Develop superior germplasm for infertile uplands

- Evaluated candidate genes for blast resistance using the Vandana/Moroberekan mapping population at five sites in Eastern India and Southeast Asia. We determined the relative phenotypic values of six candidate defense genes and their allelic contributions to quantitative blast resistance. Individual alleles of three defense-response genes (oxalate oxidase, ion channel regulator, thaumatin), and three NBS-LRR loci (homologs of maize resistance genes) contribute 14-29% reduction in disease severity. Backcross lines in Vandana background carrying favorable combinations of defense genes showed ~90% disease reduction in blast nursery in the Philippines. Two backcross lines selected by breeders will provide a good source of blast-resistane genes. At least, six favorable alleles have been tagged. Stable quantitative resistance is now amenable to selection in upland breeding, through the Upland Rice Research Consortium in Project 9.

- *Oryza glaberrima* and other wild species of rice are valuable donors of drought tolerance genes. Advanced backcross (AB) lines with superior performance under managed drought were evaluated at two water levels in the DS and WS. Several introgression lines yielded more than the recurrent parent and can immediately be tested in target environments. No relationship was observed between field yield under stress and osmotic adjustment measured in the standard greenhouse test. Near-isogenic lines (NILs) derived from residual heterozygosity differed significantly in yield, indicating a direct effect of very small gentic differences on a complex trait.
- Identified molecular markers associated with perenniality and drought tolerance in *O. sativa*/*O. longistaminata* populations. The populations have up to seven alleles from the *O. sativa* parent and four from the *O. longistaminata* parent. These can now be used to enhance breeding for these traits. QTL software originally designed for animal systems was able to model this population.

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

- Initiated a breeding program for high-yielding, input-responsive aerobic rice cultivars. Elite upland germplasm was screened for yield potential. Growth analysis indicated that contrasting aerobic cultivars accumulated similar biomasses but differed in the partitioning of biomass to the grain. Improved aerobic rice lines with high yield potential and moderate drought tolerance will be available for evaluation by NARES in 2004. These lines will permit intensification of upland rice production in favorable environments and will provide new options for farmers in water-short production environments.

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

- Genetically modified rice is being prepared to combat malnutrition in Asia and Africa. Transformation methods and plasmids were refined for enhancing provitamin A, lysine, and iron contents of grain. Transgenic variants of IR64, BR29, Nang Hong Cho Dao, and other diverse cultivars have been developed with 1-3 genes for b-carotene biosynthesis. Transgenic rice with ferritin and FRO2 genes have been developed and are now being evaluated to understand iron uptake and enhancement in seeds.
- Identified major genes and QTLs for high Fe and Zn traits in rice using molecular markers. Three QTLs for high Fe concentration in the grain were mapped on Chromosomes 7, 8, and 9 explaining 30.3, 21.3, and 19.0% of the variation. One major QTL associated with high zinc in the grain was mapped on Chromosome 5, flanked by markers OSR35 and RM207. These results are the starting point for enhancing Fe and Zn contents in grain by molecular breeding.
- Established that milling, parboiling, and storage of rice grains reduce the micronutrient content. This knowledge can influence national policies on post-harvest processing and guide nutritionists in educating people how to minimize loss of nutrient.

Output 6. Enhance NARES-IRRI partnerships in rice breeding

- The lowland Farmer Participatory Breeding (FPB) project released its report of research over 3 years (1998-2000) conducted by IRRI and six universities and research institutions in eastern India. Farmers were found to use selection criteria determined by biophysical conditions, livelihood uses and needs, compatibility with existing cropping systems, socioeconomic status of farmers, and gender-specific roles. Among the three lines that were adopted by farmers in Faizabad, NDR96005 (IR66363-M-10-1-1-1) was the most popular. In Siddathnagar, eastern U.P., of the six rice lines adopted in farmers' fields, NDR9730020 (IR66883-18-2B-M-1-1-1) was the most popular. Extensive farmer-managed trials appear to reduce the effects of random variability and increase gains from selection.
- Using PVS methodology research in Laos, the Philippines, and eastern India, demonstrated the feasibility of scaling up farmer participation in plant varietal selection (PVS). Large-scale PVS programs will be conducted in these countries in 2002 to increase the effectiveness of cultivar evaluation in fragile environments, leading to increased adoption of improved cultivars, increased productivity, and improved food security.

Next step activities in 2002

Output 1. Develop superior germplasm for rainfed lowlands.

- Release lines with good grain quality, submergence tolerance, and bacterial blight resistance in West Bengal, Uttar Pradesh, and Orissa.
- Seed increase of the line NDR8002 by state governments in U.P, Orissa, and West Bengal.
- Analyze drought response strategies of doubled-haploid lines at the reproductive stage using physiological, genomic, and proteomic approaches.
- Characterize genotypic adaptation for direct seeding in IRRI's germplasm collection.

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

- Evaluate elite germplasm with enhanced submergence tolerance (12–14 days underwater) for high yield.
- Evaluate marker-aided selection (MAS) for salinity tolerance in breeding populations in Bangladesh.
- Analyze salinity response strategies of doubled-haploid lines at the vegetative and reproductive stage using physiological, genomic, and proteomic approaches.

Output 3. Develop superior germplasm for infertile uplands

- Develop advanced backcross (AB) progenies and near-isogenic lines (NILs) with multiple mechanisms of blast resistance for the uplands of South and Southeast Asia.
- Initiate shuttle breeding with CRURRS in India to demonstrate the efficacy of dry-season screening for reproductive-stage drought tolerance.
- Demonstrate the efficacy of vegetative-stage screening for weed competitiveness using germplasm derived from *O. sativa*/*O.glaberrima* crosses.

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

- Cultivars selected at IRRI for high yield potential in aerobic conditions will be further evaluated by NARES.
- Evaluate IR64 lines containing chromosome segments from aerobic-adapted lines for yield in major target environments in South and Southeast Asia.
- Develop a conceptual model for partitioning dry weight into the grain during aerobic growth and assess the role of root signals in partitioning.

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

- Determine the level of provitamin A in grains of transgenic IR64 using high-performance liquid chromatography.
- Report data on the bioavailability of iron in micronutrient-rich rice upon completion of a long-term human feeding trial conducted in the Philippines.
- Develop a database on the micronutrient content of the grain of diverse rice germplasm.

Output 6. Enhance NARES-IRRI partnerships in rice breeding

- Several Indian NGOs have developed ways of working with farmers in rainfed ecosystems. Some of these NGOs will be involved in lowland farmer participatory breeding (FPB).
- Conduct participatory multi-environment trials in three upland villages in India to compare farmer- and breeder-selected cultivars and the criteria used.
- To further the adoption of rice cultivars selected during the lowland FPB project in India, introduce pilot production of certified seed for improved cultivars Vandana and Kalinga III.

Partner institutions

- ***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, Tottori University; 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, USDA Salinity Laboratory, University of Arizona, University of

California at Davis; University of California at Riverside; University of Illinois at Urbana, University of Missouri, University of South Florida, University of Utah.

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Project summary and highlights

Improving productivity and livelihood for fragile environments

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

THE PROJECT

Rainfed lowland and upland rice ecosystems are associated with position in toposequences and are defined by the water regime encountered. The lowlands include both drought- and submergence-prone ecosystems. Water ponding and soil submergence can occur and rice is typically established by transplanting although dry seeding can be an alternative. In the uplands, soils remain aerobic throughout the season and crop establishment is by dry seeding. Soil conditions and crop establishment method have enormous consequences for nutrient availability and management, weed competition, extraction of soil water, and the adaptive strategies required by the rice plant for successful performance. Water stress is frequently the main limitation to rice productivity and yield stability. Spatial and seasonal variability in the timing, duration, and intensity of water stress complicate the development of natural resource management practices, which increase and stabilize yields while increasing farmer income and reducing risk.

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. Farmers are discouraged from investing in alternative rice production and resource management technologies by the risks that arise from erratic water supplies, crop diseases and pests, and problem soils. Unsustainable farm practices often lead to degradation of the natural resource base, and so threaten to send farmers spiraling ever deeper into poverty. Ethnic minorities, who are often socially and politically disadvantaged, frequently inhabit these areas, especially the uplands.

If we are to develop and transfer improved farm-level resource management strategies, we must understand the risks and constraints at the farm level, as well as the interactions of soil, crop, water, and pests. Then we must integrate knowledge into management options for on-farm evaluation and refinement. IRRI's goal is to develop, and provide to national agricultural research and extension systems, sustainable natural resource and crop management strategies that are ecologically sound, economically efficient, and socially acceptable.

RESEARCH PROGRESS IN 2001

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

- Improved the understanding of the interactions that affect rice production in eastern India through farm surveys, together with analysis of district-level data covering 28 years. A resulting review paper on the dynamics of eastern Indian rice production systems reported that harvests have improved in areas with access to supplemental irrigation and fast-maturing modern varieties. Land reform and public investment in irrigation and other infrastructure are also important.
- Made major progress in ensuring seed health in Bangladesh. We improved farmers' awareness and understanding of the benefits of using quality seeds as a component of pest and crop management. In addition to helping

farmers select and sort seeds correctly, we evaluated post-harvest technologies, particularly regarding the drying and storage of seed and assessed the impact of seed quality on pest pressure and rice yield. We documented farmers' perceptions, knowledge, and practices in seed health management, as well as the role of women in this crucial task.

- On-farm studies in Bangladesh quantified large rice yield gaps between weed-free fields and those under typical farmer weed management. Discussions in farmer focus groups showed that farmers recognize the importance of timely weeding but are constrained by a lack of available labor. Research trials indicate that a range of cost-effective weed-control practices—including the use of herbicides and inexpensive, locally made mechanical weeders—have the potential to reduce labor inputs. We also found that yields of dry-seeded rice similar to those obtained by labor-intensive hand weeding can be achieved by integrating a pre-emergence herbicide with inter-row weeding using a hand-pushed weeder.
- In selected rice-based cropping systems, conducted an initial characterization of the ecology and biology of major weeds. Results indicate that short-duration flooding selectively suppresses certain broad-leaf weed species. This work continued the development of a database on responsiveness of weeds to water management.
- Studied the impact of nutrient management on early seedling establishment in unfavorable conditions and found that seedling survival in submergence-prone areas could be improved by avoiding excessive nitrogen application at seeding.
- Studied crop establishment methods in the Philippines, Indonesia, and Nepal and found that the plant establishment rate in farmer's fields is only 50-55% effective, on average, and as low as 20% in direct-seeded fields. This provides impetus to improve establishment methods and seed quality at the farm level.

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

- Diagnosed socioeconomic factors affecting land-use changes in Vietnam and found upland rice to be an important component of food security in the northern uplands of Vietnam. Some communities obtained up to 80% of their rice supply from the uplands. We found upland rice yields to be low in communities that practice short fallow periods. The results show that improved access to markets is essential to raising farmers' incomes and lifting them out of bare subsistence production.
- Focused research on weeds, which are a major biological constraint to upland rice production. Research on rice-weed competition, to identify traits that give rice the edge, showed that productivity in competition depended largely on shoot traits affecting leaf-area development. Results support the idea that selection of competitive rice lines can be done with early evaluations of height, cover, and leaf color.
- Assessed the production potential of upland rice systems in Philippine environments enjoying a long growing season and well-distributed rainfall. Upland rice-based rotations can be highly productive in such rainfall-favorable, erosion-free uplands, when supplied with only moderate inputs of N and P fertilizers in moderately acid uplands and lime, N, and P in highly acid uplands. Using improved cultivars with a high harvest index (grain representing a high percentage of total plant weight), upland rice yields of about 3 t/ha—as compared to the current average of about 1 ton per hectare—can be sustained in rotations involving maize, legumes, and other crops.
- Compiled and reported information on long-term P dynamics in upland rice systems in India, Indonesia, Philippines, Thailand, and Vietnam. Findings indicate that P fertilization of upland rice boost yields under a

broad range of conditions, especially when applied to improved varieties with a high harvest index. We infer from this that increasing upland rice yields in Asia will require genotypes with a high harvest index in addition to P fertilization. Evidence from long-term experiments that upland rice yields decline over time, even under best nutrient management practices, has raised new awareness of the need to immediately address sustainability in upland rice-based systems.

Next step activities in 2002

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

- Develop appropriate extension and experiential learning messages for dissemination of improved seed health management in Bangladesh. Continue farmer participatory research, including seed storage as a means to extend and disseminate seed health management; evaluate low-cost dryer and improved seed storage technologies, and train national staff in Bangladesh on diagnostic tools for pathogen identification.
- Assess the impact of rice bug on yield, grain quality, and seed through laboratory studies establishing the relationship of grain damage to rice bug numbers and determining the effect of N management on rice bug fecundity. Continue field monitoring of grain loss and grain quality as related to rice bug infestation in the Philippines, and establish research in Lao PDR on the spatial and temporal distribution of rice bug.
- Evaluate alternatives to traditional rice establishment practices, including direct-line sowing of rice for crop establishment in drought-prone lowlands in India. Initiate studies in India on the impact of different seed sources and seed selection methods.
- Assess plant need-based N and P management for drought-prone rainfed lowland rice in farmers' fields in India. Use findings to develop preliminary guidelines for site-specific nutrient management, which dynamically adjusts nutrient additions to environmental conditions in drought-prone lowlands.
- Assess in India crop management practices to optimize the residual benefits of food legumes on a subsequent rice crop and effectively manage P in the rice-based production system.
- Test methodologies for screening the competitiveness of rainfed lowland rice cultivars against weeds and use field competition trials in the Philippines and in Thailand to test selection criteria for identifying rice lines that are more competitive against weeds.
- Determine the effects of toposequence position in Indonesia on soil and water availability, weed communities, yield, and the yield gaps due to weeds and nutrients. Use findings to validate a simulation model.
- Develop a farmer decision-making model to analyze the effect of risk on technology choice.
- Review policies on drought management in eastern India, and complete associated farm-level surveys.
- Evaluate the impacts of nutrient inputs and management on seedling survival under submerged and saline conditions in the Philippines and India.

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

- Conduct a diagnosis of socioeconomic factors affecting land-use changes for eastern India.
- Conduct and analyze farmer surveys of contrasting agricultural production systems in Indonesia and Lao PDR.
- Evaluate upland rice cultivars and lines for improving rice competitiveness against weeds. Test methodologies for improving rice competitiveness

against weeds, continue evaluation of upland rice lines at multiple locations, and conduct competition trials with several species of weeds.

- Develop a model for analyzing technology adoption by upland farmers.
- Conduct on-farm field trials to measure yield gaps due to weeds and nutrients in Lao PDR.

Partner institutions

- ***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, MMSU, Philippines; DOA, Ubon Rice Research Station, Chumpae Rice Research Station, Phimai Rice Research Station, Surin Rice Research Station, Thailand; Thai Nguyen Univ., Vietnam.
- ***ARIs:*** Hokkaido Univ., Japan; Wageningen Univ., Netherlands; Natural Resources Institute (NRI), UK; Univ. of Hawaii, NIFTAL, USA.
- ***IARCs:*** CIAT, ICRAF.

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Project summary and highlights

Improving productivity and livelihood for fragile environments

Project 9: Research consortia for fragile environments

THE PROJECT

The fragile rice environments comprise the rainfed lowland and upland systems. Because of the variable and heterogeneous nature of these environments, where water regimes fluctuate and problem soils are prevalent, rice yield is low (1.0–2.3 t/ha). Poverty and population density are high in rural and urban areas. Research gains have been low because of the variable and difficult conditions, the absence of a well-structured strategic research approach to address key constraints, and the magnitude of the problems that are difficult to tackle. In rainfed lowlands, soil conditions fluctuate from anaerobic to aerobic and plants may be exposed to submergence or drought. In uplands, soils remain aerobic throughout the season. Thus, the constraints of the rainfed lowland and upland systems are different and require distinct research approaches and rice germplasm.

In the rainfed systems, the magnitude of the challenge is to increase and stabilize productivity and sustain the resource base in the face of great diversity, the demand for multidisciplinary approaches, and the presence of strong national research programs (NARES). The Rainfed Lowland Rice Research Consortium (RLRRC) and the Upland Rice Research Consortium (URRC) are the frameworks to address these concerns and to facilitate collaboration and cooperation in research and development between NARES and IRRI. Strong NARES collaborate with IRRI through joint planning to identify strategic research issues through collaborative research at NARES sites. This decentralized approach is essential, as IRRI headquarters at Los Baños does not have situations representative of the diversity and complexity of rainfed lowland and upland environments. The consortia represent a facilitation and exchange mechanism by which the research priorities identified in collaboration with NARES and in IRRI's MTP are implemented in appropriate target environments in collaboration with appropriate NARES partners, with matching funds provided by the sites.

RESEARCH PROGRESS IN 2001

- Conducted the joint steering committee meeting of the Rainfed Lowland and Upland Rice Research Consortia.

Upland Rice Research Consortium

- Established a variety-testing network for the Southeast Asian acid uplands. Initiated planning for two other networks, one serving the drought-prone eastern Indian plateau region and the other serving aerobic rice and favorable upland environments. Such multi-environment testing in appropriate target regions will increase the rate of yield improvement in these upland environments and will enhance germplasm exchange among national programs.
- Summarized research achievements of Phase III and identified new research needs and opportunities. These include:

    Documenting the contribution of upland rice to the food security of the rural poor. Upland rice remains critical to the food security of large populations in Asia. Research reported in Project 8 and conducted through the URRC in Vietnam and other member countries has shown that upland rice can be a bridge through "hungry months" immediately before the harvest of lowland crops, and that improvements in the yield of upland rice can have a positive impact in reducing poverty, especially for the lowest income groups. These messages are being disseminated through policy briefs and workshops to NARES and are having an impact on policy development in hilly Southeast Asia. Policies, designed to reduce erosion and environmental degradation in upland areas, are increasingly recognizing the food security needs of upland communities.

Developing and exchanging improved cultivars. Several cultivars developed by IRRI and NARES members of URRC or introduced from other breeding programs through the URRC breeding network have been released by URRC members. IR55423-01, a stress-tolerant, input-responsive, IRRI-developed cultivar, has been released under the name of 'Apo' in the Philippines. B6144-MR-6-0-0, developed by the Indonesian national program, has been released in Yunnan, China. IRAT 112 and IAC 25 have been released under the names of 'Kalimootoo' and 'Gajah Monkur', respectively, in Indonesia. These cultivars were selected for their stress tolerance and responsiveness to favorable conditions and are the result of improved breeding methods and more extensive germplasm exchange achieved through the URRC Breeding Network.

Identifying resistance to rice blast (*Magnaporthe grisea*). Genes contributing to qualitative (major) and quantitative resistance (defense) have been identified in collaboration with NARES. Research teams in India and Indonesia and IRRI researchers have developed breeding lines carrying various gene combinations contributing to broad-spectrum resistance and will be able to link these efforts directly to cultivar development within the next 3 years. NARES researchers in Indonesia have combined major blast resistance genes in upland germplasm that are effective against the predominant pathogen population in Indonesia. Furthermore, marker-aided improved lines carrying major resistance genes are being evaluated in farmers' fields in the blast-prone upland areas. These lines should contribute to yield increases as well as yield stabilization through genotype diversification in the next 2-3 years.

Introducing participatory breeding methods. Participatory breeding and varietal selection methods for rainfed rice have been studied and scaled up by URRC partners in India, Lao PDR, Indonesia, and the Philippines. The introduction of these methods has helped breeders and agronomists gain a greater understanding of farmers' needs and preferences, and is likely to greatly increase the impact of upland rice breeding in fragile upland environments in the next 2 to 3 years.

Reducing weeding loads through improved cultivar competitiveness, higher plant densities, and other cultural practices. Research findings reported in Project 8 point the way to the development of upland rice technology packages with reduced labor requirements for weed control within 3 to 5 years. This could permit substantial labor diversion, particularly by women who tend to do the bulk of the weeding, to activities that provide cash income.

Rainfed Lowland Rice Research Consortium

- G x E experiments in different locations and conditions to define target subecosystems for rainfed lowland rice: In Ubon, Thailand, it was found that drought stress conditions at various sites were different in water deficit severity. There was no significant relationship to grain yield between environments to indicate that genotypes performed differently under different growing conditions. In Batac, Philippines, initiated GxE studies by establishing a crop at one site during the onset of the 2001 rainy season.
- Nutrient management experiments: In Faizabad, found that incorporating FYM into the soil produced significantly higher amounts of rice grain and straw.
- Shuttle breeding: In Cuttack, produced promising candidates among elite breeding lines under normal and delayed planting situations.
- Blast resistance studies: In Ubon, showed that different rice lines give remarkably different reactions to rice blast, which formed the foundation for future studies.
- Gender studies: Investigated the incidence, nature, and perceived consequences of male labor migration in Eastern Uttar Pradesh. Initial research results show implications for the on-farm systems performance of women who are left behind to manage the farm.

Next step activities in 2002

- Following the recommendation of a center-convened external review, the consortia will be restructured to address the linkage of germplasm improvement and natural resource management. During a joint steering committee meeting held 7-10 December 2001, there was a general consensus that the suggested changes in the consortia should be organized early in 2002. This will be accomplished during meetings of senior representatives of the NARES partners, steering committee members, and IRRI staff with significant activities in the consortia. The general activities of both the URRC and RLRRC will be in full operation after completion of their restructuring.
- Develop new proposals to link with priorities of Projects 7 and 8 and NARES partners.
- Discuss research progress at the sites during the annual individual site planning meetings.
- Conduct regional site planning meetings in the sites that will be chosen in the new consortia.

Upland Rice Research Consortium

- Hold a planning workshop, including IRRI, NARES, and outside experts, on research needs and progress for Asian upland rice-based cropping systems. Derive recommendations and plan and initiate experiments.
- Conduct regional site planning meetings in India, the Mekong region, Philippines, and Indonesia.
- Conduct an international workshop, jointly sponsored by the DFID Plant Sciences Research Program, on advances in participatory plant breeding.

Rainfed Lowland Rice Research Consortium

- In Ubon, continue blast and drought experiments to come up with solutions for the drought-prone environment.

Partner institutions

- **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.

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Project summary and highlights

Strengthening linkages between research and development

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

THE PROJECT

The avowed goal of international agricultural research supported by the CGIAR is to contribute to sustainable food security and alleviation of poverty by increasing the productivity of scarce resources and sustaining the natural resource base. Planning and prioritization of rice research to achieve that goal requires an in-depth 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. An understanding of farmers' current practices and knowledge of the use of resources, the interface among different components of farming systems and livelihood strategies, and farmers' criteria for evaluation of scientific knowledge would help assess the demand for and potential of specific technology interventions to improve people's livelihood. Information and databases on biophysical, socioeconomic, and policy variables and an understanding of constraints to the adoption of improved technologies for different agroecosystems can help improve the formulation of research strategies and policies.

Research managers and policymakers need to evaluate the ex post impact of technologies on the well-being of different socioeconomic groups, the reduction of poverty, and sustainability of the natural resource base, to assess the extent to which the goals and objectives of rice research are being met. This requires the generation and analysis of data at the micro level on determinants of changes in the rural household economy. At the macro level, monitoring developments in the rice sector regarding changing patterns of production, consumption, and trade; input use and pricing policies; and overall socioeconomic conditions can shed light on emerging rice demand-supply balances, competition for resources in alternative economic activities, and constraints to growth in rice production, and their implications for the balance required in productivity enhancement and natural resource management research for various countries and ecosystems.

RESEARCH PROGRESS IN 2001

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

- Completed revision of data and country write-ups for 3rd edition of the *Rice Almanac*.
- Organized an international workshop on developments in the rice sector of the economy. The workshop reviewed recent developments in the rice sector of major Asian countries and assessed emerging trends in the rice supply-demand balance.
- Completed studies on comparative advantage in rice production for India and Bangladesh. An important finding of the Indian study is that the technologically progressive states that have achieved higher yields do not necessarily have better comparative advantage in rice cultivation. The Bangladesh study showed that, except for a few import-competing crops,

such as sugarcane, oilseeds, chili, and onion, Bangladesh has a comparative advantage in production of most agricultural crops.

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

- Completed survey and data analysis from 32 randomly selected villages for the study on assessing impact of rice research on the livelihood of the poor for Bangladesh (jointly with IFPRI). Using DFID's sustainable livelihood framework, the study shows that land is an insignificant source of livelihood for nearly half of the rural households whose major assets are health, social networks, and trust with the employers. Nearly 40% of the rural households are poor and most are marginal landowners or without land altogether. These households did not gain directly from the productivity-raising effects of the improved rice varieties that have spread to two-thirds of the rice land. However, the poor households have gained from: a) changes in the agricultural labor market from daily wage to piece-rated contracts as the labor market became tight, b) changes in tenancy markets from sharecropping to fixed-rent contracts and increase in the area under tenancy, and c) an increase in more remunerative employment in the rural nonfarm activities stimulated by the growth in agricultural productivity. The growth in rice production that has been faster than demand has contributed to a decline in the real price of rice (compared to the rate of inflation), which has helped increase the food entitlement of the poor.
- Jointly organized a planning workshop with ICAR, India, on the incidence of migration of men and its impact on gender roles and efficiency in farm management. Based on the baseline findings on the incidence of labor out-migration, follow- up surveys of farming households in five states in eastern India will be conducted to examine the impact of male labor out-migration on rice farming organization and changes in gender roles.
- Developed a research methodology for assessing impact of migration of men on gender roles, women's livelihood, and efficiency in farm management. About 2,000 farming households with and without migrants will be interviewed in this study. Information will be collected through qualitative and quantitative methods such as formal surveys using a pre-tested questionnaire.

Output 3. Assess constraints to adoption of improved rice technologies

- Evaluated farmers' experience with the adoption of hybrid rice for Bangladesh and published the report. The study aimed at evaluating the farm-level experiences with the adoption of two hybrid rice varieties, Alok 6201 and Sonar Bangla (CNSGC 6), which were introduced during the 1998-99 Boro season in Bangladesh. Grain yields of hybrids were 15% higher than those of the HYVs, but input costs of hybrids were 23% higher. Constraints to hybrid rice adoption were identified as external dependence and higher seed cost, higher need for management skill, input intensity, higher incidence of pests and diseases, inadequate yield gain, and lower head-rice recovery.
- Completed sample household surveys for Vietnam and Philippines for evaluating factors affecting the adoption of hybrid rice technology. In 2001, we initiated this study in collaboration with the respective NARES of the two countries. In Vietnam, household surveys were conducted to collect farm level data from a sample of about 380 farmers in eight villages representing major agroclimatic conditions of the country's north, south, and central regions. Similarly, field surveys were organized in about 10 villages of Region 2 in the Philippines.

- Completed sample household surveys in eastern India for studying the determinants of adoption of modern rice varieties in rainfed lowlands and uplands of eastern Uttar Pradesh. The data are being analyzed.

Output 4. Assess impact of rice research on poverty alleviation and sustainable management of natural resources
- Completed the CGIAR-sponsored study on the impact of germplasm enhancement research for rice in Asia. IRRI's overall contribution to the improved germplasm released by NARES was highest in the Philippines, Bangladesh, and Indonesia and lowest in Thailand, Cambodia, and Laos where farmers are still growing mainly traditional varieties.
- Completed an ex ante assessment of the potential impact of golden rice on vitamin-A deficiency in the Philippines. It was found that golden rice will probably be less important in improving vitamin-A intake than pending mandatory fortification of wheat flour and other foods. However, because vitamin-A intake is so low, both golden rice and food fortification have important roles to play in improving nutritional status. Golden rice may also be substantially more cost-effective than food fortification, and has the potential to make a large impact for people who consume very little fortified food or live in countries where fortification programs do not exist.

Next step activities in 2002

Output 1. Conduct rice-sector analysis and maintain rice statistics database and share with NARES
- Publish 3rd edition of *Rice Almanac*, including a hardback version copublished with CABI for greater distribution.
- Publish *World Rice Statistics 2000* and post selected data on the IRRI Web site.
- Develop and apply RSDA model to explore scenarios for balancing rice supply and demand for the Philippines.
- Publish proceedings of the international workshop on *Developments in the Rice Economy in Asia*.
- Review recent research completed in this field and prepare a synthesis paper.
- Hold a workshop on the effects of potential trade liberalization in the Philippines on cropping patterns and the livelihood of landless laborers.

Output 2. Study rural livelihood systems and analyze the interface among technology, infrastructure, and institutions
- Complete household surveys on the impact of male migration on rice efficiency and gender roles and present results during the International Rice Congress in China in September.
- Complete surveys on rural livelihood systems in West Bengal and Uttar Pradesh, India.
- Hold focus group discussions in the Philippines and Bangladesh, and Indonesia to generate qualitative data on determinants of changes in rural livelihood.
- In the northern Vietnam uplands, report on crop-livestock-forestry interactions at the provincial level, propose policies for integrated development of the activities of these competing resources, and develop a method for rapid appraisal of NRM issues related to crop-livestock-forestry interactions. Facilitate conflict resolutions through negotiation among stakeholders.
- Make the first attempts at modeling changes in crop-livestock interactions in the livelihood systems of northeastern Thailand.

Output 3. Assess constraints to adoption of improved rice technologies
- Complete studies on the adoption of hybrid rice in Vietnam and the Philippines.

- Improve pesticide use policy decisions in Zhejiang Province, China, through a participatory approach.
- In studying the constraints to increase in rice productivity in the Bihar plateau in eastern India, do econometric modeling of household survey data and integrate with the biophysical data.
- Complete the analysis of varietal adoption data for eastern Uttar Pradesh.
- Hold focus group discussions in Bangladesh and Philippines to study stakeholders' perceptions on the problem of micronutrient deficiency and acceptance of genetically modified micronutrient-dense rice.

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

- Integrate socioeconomic and biophysical data with GIS tools for poverty mapping in Bangladesh.
- Organize a regional consultation on the World Bank's rural development strategy for poverty alleviation (jointly with project 12)
- Complete the study of the impact of rice research on reduction for Bangladesh.

Partner institutions

- ***NARES:*** Bangladesh: Bangladesh Rice Research Institute, Bangladesh Institute of Development Studies; 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, TNAU, Coimbatore, PAU, Ludhiana, NDUAT, Faizabad, IGAU, Raipur, RAU, Pusa Bihar, Birsa Agricultural University, Ranchi, Rajendra Agricultural University, Pusa, BCKV, Kalyani, West Bengal, OAU, Bhubneswar, CRURRS, Department of Agriculture, Government of West Bengal, Indian Statistical Institute, Calcutta; Indonesia: Center for Socioeconomic Research, Bogor, Suramandi Research Institute; Malaysia: MARDI; Myanmar: Myanmar Agricultural Service; Thailand: Kasetsart University, Khon Kaen University, Chiang Mai University, Ubon Ratchathani University, Rice Research Institute, MOAC; 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.

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Project summary and highlights

Strengthening linkages between research and development

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

THE PROJECT

The CGIAR's triple goals of alleviating poverty, increasing food security, and protecting the environment recognize that human well-being depends on the well-being of the systems in which people earn their living. In the agrarian context, this means recognizing that the livelihood concerns of farmers are closely linked with the status of the natural resource base on which they depend—the water, soil, and biotic resources—and their ability to use and manage these resources. This also means having to link research efforts to improve resource-use efficiency for crop production at the plot/field level with concerns of resource use and allocation at the agroecosystem level. Since 1995, IRRI has been mandated by the CGIAR to convene the Ecoregional Initiative for the Humid and Subhumid Tropics of Asia, Ecor(I)Asia, which is one of eight ecoregional programs aimed at tackling complex natural resource management (NRM) issues at the regional scale.

This project continues IRRI's commitment to ecoregional research in integrated natural resource management (INRM) and aims at improving rural livelihoods by attaining economic viability of agricultural production, through enhancing the ecological sustainability of the supporting agroecosystem. We will adopt a systems perspective, drawing upon a broad range of expertise to tackle the various dimensions of integration in NRM—across disciplines, across geographical and time scales, and across the research-development-policy continuum. Our main research challenge is to generate INRM knowledge, including the tools for using the knowledge, and to promote its free exchange among researchers, policymakers, managers, and users of the natural resource base.

While building upon solid NRM research at lower (field/farm) levels of integration, we will also develop additional tools for modeling and analyzing interactions among different levels of biological, physical, and social organization. The basic premise for successful INRM is the empowerment of stakeholders at various levels to make informed decisions on how they use and manage their resources by improving their access to knowledge and their capability to articulate their objectives and negotiate their demands. The researcher's role is to facilitate this empowerment; hence, we will place as much emphasis on developing the research and operational methodologies and on involving stakeholders in the process as on the research products that are delivered to users.

We will conduct our research in pilot regions representative of the different agroecosystems where rice is a major crop, with emphasis on the low-productivity and ecologically fragile environments. Within each pilot region, we will establish strategic partnerships among national and international institutions that have important and complementary roles along the research-development continuum, given their respective mandates and pools of resources and expertise.

RESEARCH PROGRESS IN 2001

Red River Basin, Vietnam. New partnership mechanisms were developed across scales, disciplines, and institutions for the benefit of NRM research and development in the region.

- Completed and updated the Bac Kan Project Information Database System (PIDS) and distributed it in digital and hard copy forms to key national and international agencies involved in NRM in Bac Kan Province.
- Completed a comprehensive study of land use changes at multiple scales and developed indicators for rapid identification of key interventions and action plans for improving the livelihood of resource-poor farmers in dynamic and diverse environments.
- Developed and applied the role game and multi-agent simulation tools to engage farmers in highly interactive role playing of livelihood strategies to help them to understand the cumulative environmental impacts of their decisions.
- Developed a Land Use Planning and Analysis System (LUPAS) for Bac Kan Province to explore scenarios and options of land and resource allocation, subject to development objectives specified by provincial authorities.

North and Northeast Thailand. The emphasis has been on capacity building of researchers to use interactive and integrative analytical and simulation tools to better understand and identify means of tackling complex natural resource management problems in agricultural production.

- Conducted structured and in-service training on multi-agent systems for prospective collaborating scientists from various Thai institutions (as well as from other Asian countries)
- Used the MAS (multi-agent systems) tool to develop a prototype model on land use changes in a highland agro-ecosystem in North Thailand.

Mekong River Delta. The project team worked closely with local authorities to tackle the issue of accommodating the requirements of shrimp and rice farming through interdisciplinary study of the problems, hydraulic modeling, and monitoring of environmental and socioeconomic impacts.

- Quantified and determined the relationship between phased salinity protection measures, water quality and land use/rice cropping systems changes, and socioeconomic impacts of farmers belonging to different wealth groups.
- Used hydraulic model to explore combinations of sluice operation that would accommodate the water quality needs of shrimp raisers and rice farmers in different locations of the study area.

Eastern India. An ecoregional site was initiated with broad-base partnerships for addressing the technology needs of farmers engaged in rainfed rice-based cropping systems.

- Conducted a dialogue with research leaders, public sector extension officials, leaders of development projects, and NGOs to identify priority research issues and assess farmers' technology needs for rainfed rice-wheat system in eastern Uttar Pradesh, India.
- Compiled an inventory of best practices in rice-based farming systems under rainfed conditions

NEXT STEP ACTIVITIES IN 2002

Red River Basin

- Document methodology on implementing ecoregional approach to INRM and publish monograph on the experience of the Bac Kan pilot site.
- Organize an ecoregional conference together with the MARD to take stock of 5 years of research activities on RRB ecoregional pilot site.
- Produce six publications on accessibility, land allocation processes, and agriculture /livestock/forest interactions and their impact on livelihood systems in the uplands of Bac Kan Province.
- Write report on the process of adoption of SAM (Mountain Agrarian System) project innovations and impact on poverty alleviation and natural resources management in Bac Kan Province.

North and Northeast Thailand

- Develop a MAS- and GIS- based coordination/negotiation support tool for managing crops diversification/risk of land degradation on sloping land in North Thailand.
- Conduct stakeholders' interviews and field surveys on farmers' rice variety and water and soil management systems in the Korat Basin.
- Review existing information to gain understanding of interactions between sugarcane expansion and upper paddy production in the Northeast.
- Initiate surveys on the impact of male labor migration on gender roles and farming efficiency for the Northeast.
- Publish research findings on land use changes on steep land in the upper north.
- Develop prototype MAS models to simulate current patterns and define possible scenarios in the Northeast for:
  - Sugarcane-rice systems,
  - Farmers' rice variety and grain quality management, and
  - Crop-livestock interactions for various parts of the Korat Basin.
- Develop a LUPAS model for exploring scenarios for water management of rainfed rice in Ubon Ratchathani Province.

Mekong River Delta

- Update database on changes in agro-hydrology, land use, and farmer livelihoods.
- Analyze data and complete report on assessing incidence and impact of male migration on gender roles and farm efficiency.
- Determine effect of different scenarios of sluice operation on hydrology and water quality, particularly salinity, in the study site.
- Conduct broad scale survey of 280 hamlets to identify large-scale impact of the salinity protection scheme and to delineate resource management domains.
- Work with local government to revise land use zoning maps.
- Assemble knowledge base for developing model for exploring the sustainability of various scenarios of water management and agricultural production.

Eastern India

- Analyze data and complete report from surveys on:
  - identifying determinants of rural livelihood systems in eastern Uttar Pradesh,
  - assessing the incidence and impact of male labor migration on gender roles and farming efficiency,
- Develop a profile of selected technologies through a workshop involving all stakeholders, and
- Field test selected technologies through on-farm research.

Multi-agent systems applications to support ecoregional INRM efforts

- Conduct a series of training courses on MAS and INRM, focusing on social sciences, GIS integration, and application to watershed management.
- Provide support for ongoing projects with NARES partners in Vietnam and Thailand, including PhD and masters students.

Partner institutions

- ***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.

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Project summary and highlights

Strengthening linkages between research and development

Project 12: Facilitating rice research for impact

THE PROJECT

To reduce drudgery, raise income, and protect the environment, rice farmers need access to knowledge about improved technologies. However, technologies are becoming increasingly complex and thus more difficult to present to farmers for their consideration. Reaching the hundreds of millions of rice farmers with complex, knowledge-based technologies is an enormous challenge to researchers, extension workers, development agencies, and policymakers. To succeed, technology dissemination systems need to be reoriented to improve the transfer of information and best-bet practices while also collecting feedback to better meet client needs.

This project seeks to meet this challenge by understanding the "what," "who," and "how" of dissemination. "What" refers to the problems and opportunities faced by farmers, "who" refers to the target group and other partners active in dissemination, and "how" refers to message distillation and presentation. Thus, we need to understand technology dissemination pathways and knowledge assimilation patterns. This understanding is achieved through problem and opportunity analysis, followed by the identification, validation, adaptation, and promotion of promising technologies using farmer participatory experiments. Feedback through the process becomes important for maintaining research relevance and efficiency. Integral to this process are partnerships with national research systems, extension and development organizations, NGOs, and private-sector specialists. Focused training for national partners will be required throughout. This collaboration will involve using farmer focal sites, developing tools, conducting training activities, using electronic media and information technology in disseminating knowledge and training materials, and assessing needs.

RESEARCH PROGRESS IN 2001

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

- Developed a Need and Opportunity Analysis (NOA) methodology with significant farmer and researcher interaction and participation for enhanced problem-cause analysis of constraints and for selection of options/ solutions. NOAs were then used with national program colleagues and farmers to identify primary constraints and options for research and/or delivery at seven sites in Indonesia (14 villages), Thanjavur District, Tamil Nadu, India, Omon District, South Vietnam, Tarlac, Iloilo, Philippines, and specifically for the RTOP (Reversing Trends of Declining Productivity) project in Vietnam.
- Held an expert consultation in Thailand to identify priority-training needs (both course and skill areas) for Asian countries.
- Held a dialogue on research and development linkages at Lucknow, Uttar Pradesh, India, to identify the ecoregional research and development issues in rainfed areas. Participants represented the State Department of Agriculture, the State Agricultural University, NGOs, private sectors, department corporations, and IRRI.

- Developed a reformatted beta version of the IT-based rice crop management tool (TropRice), revised a number of old modules (e.g., rice by-product uses), and added new modules added (e.g., grain quality management). See www.irri.org/Troprice/.
- Developed a draft version of the IT-based RiceDoctor for enhanced field diagnosis. Held workshops to conceptualize and develop the framework and the project and to collect initial feedback on target group requirements.
- Developed strategies for improving grain quality and milled rice recovery. Completed a retail market survey (Philippines) and Rice Mill performance study in Cambodia and identified intervention points.
- Developed knowledge acquisition flows in focal group discussions with Iloilo farmers to identify mechanisms for enhanced knowledge delivery to farmers (e.g., farm walk). The methods were introduced and field-tested to enhance farmer to farmer knowledge flow in Iloilo.
- Developed the training materials to package the SSNM (site-specific nutrient management) principles for wide-scale evaluation and promotion. Developed a draft pocket guide on 'Nutrient management and nutrient disorders' in collaboration with PPI (Potash and Phosphate Institute)-PPIC (Potash and Phosphate Institute of Canada) ESEA (East and Southeast Asia Programs), Singapore, which is currently under review. Developed a Nutrient Decision Support System (NuDSS) including profitability analysis, which is currently under review.
- Initiated a survey on information technology capacity, connectivity, and capability of NARES and other partners in Thailand, Philippines, and Vietnam.

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

- Based on problems identified through NOA, developed and evaluated Integrated Crop Management (ICM) options in 14 villages in Indonesia. ICM options were evaluated in 4-ha blocks in each village. Also conducted superimposed trials on new options. Currently collecting (for analysis and interpretation) farmers' reactions and opinions on ICM options, which initially seem very positive.
- Assessed options to address farmers' problems of rice tungro virus (RTV), rat damage and soil-stresses in Iloilo (Philippines). Twelve RTV-resistant rice lines have now been evaluated over three seasons. A gene deployment (biodiversity) study for the management of RTV was also tested over two seasons. Seed quality (purity) maintenance was conducted side by side with the evaluation of the RTV-resistant lines. The Community Trap Barrier System (CTBS) for rat management was demonstrated and evaluated over two seasons. A *farmers'* workshop involving farmers, researchers, and extension workers was held to jointly identify problems, causes, constraints, and options. The farmers present evaluated the options for feasibility and they then committed to undertake on-farm demonstrations of practices of their choice. Implementation of the demonstrations was nearly 100%; only in a few cases weather conditions did not allow the farmers to proceed.
- Established and tested a HAM radio network at two research stations and five villages in India for interactive communication between researchers and farmers. Regular operation started on 1 October.
- Established a participatory research program focusing on upland rice-based systems in Laos. A collaboration network of several national and international organizations responding to a range of farmer needs became operational with assistance and input from IRRI staff.
- Conducted on-farm validation and local adaptation of SSNM and crop management strategies in 20 pilot villages at RTOP sites. In addition, evaluated the leaf color chart (LCC) at the village level in An Giong

Province, Vietnam. Completed baseline surveys on nutrient management for 300 farmers in three villages. Conducted a farmers' field day to review results and exchange experiences among farmers. The LCC was also evaluated at the village level in Pangasinan, Philippines.

- Studied, introduced and disseminated a new double cropping system for local varieties in the northern Philippines. Sixty farmers determined the effectiveness of the system. Held a concluding workshop to discuss issues related to the new cropping pattern. About 100 people (mostly farmers) attended, but representatives from the private sector, extension, and the media were present as well.
- Conducted farmer participatory experiments on the effects of seed quality on rice yield and pest pressure for the PETRRA-funded Seed Health Subproject in Bangladesh. The subproject in partnership with different institutions including many NGOs has completed the assessment of rice seed health problems and needs of resource-poor farmers in Bangladesh. To produce additional information, farmer participatory experiments are continuing at seven sites. Farmers were trained on pest diagnosis and seed processing by physical seed sorting and seed selection before harvesting. Farmer participatory experiments on seed storage using botanical and farm-level evaluation of postharvest technologies, particularly on drying and storage, were also initiated to improve the quality of seed. Established the molecular seed pathology laboratory was at the Bangladesh Rice Research Institute for pathogen identification. The subproject is also providing support to develop the capacity of scientists from partner institutions and to 18 MS and PhD students in Bangladesh.
- Conducted farmer participatory experiments for validation and adaptation of technologies in the flood-prone ecosystem in collaboration the NARES, NGOs, and private organizations in Bangladesh, India, Vietnam, and Sri Lanka. Identified promising technologies on germplasm; seed, nursery, and seedling management; crop establishment techniques; nitrogen and water management; and suitable cropping systems for the respective conditions of these countries. Prepared technology advisory notes for wider application of the most promising technologies.
- Completed a study on changes in the agriculture and the economy in the flood-prone rice ecosystem of Bangladesh for the IFAD-funded project through a sample household survey of 16 villages.
- Initiated a sample survey for Thailand to generate two-point panel data for 1993 and 2001 to study changes in agriculture and economy in the country's flood-prone rice ecosystem.

Output 3. Human capital development of NARES rice professionals

- Trained hundreds of national researcher and farmer collaborators in a variety of Los Baños-based and courses provided in-country (including in Bangladesh, Laos, India, Myanmar, Papua New Guinea, Vietnam, Philippines, Thailand, Indonesia, and Nepal). Subject matter included farmer participatory research; grain preference analysis; practical field training on NOA; priority setting; option evaluation; farmer technology selection; design, installation, management, and data collection of ICM demonstrations; site-specific nutrient management; HAM radio operation; LCC methodology and on-farm evaluation of the technology; the research-delivery continuum; rice quality; seed drying; developing modules for the Principles and Practices of Farm Management Training course; and Multi-Agents Systems for Natural Resources Management..
- The Training Center facilitated more than 20 courses in Los Baños (a complete listing is available on the new TC Web site at www.training.irri.org); has, or is in the process, of updating and digitalizing all training modules; offered an online course; produced CD-based

modules; and began working on the Knowledge Bank, which will contain more than 10,000 reusable learning objects.
- IRRI accommodated 78 scholars in Ph D and masters programs and 41 on-the-job trainees.
- Conducted a workshop with the PETRRA uptake pathway subproject partners to share uptake lessons learned and to ensure product focus and adoption.
- Established monitoring and evaluation of training for long-term impact analyses. Developed various types of evaluation questionnaires.
- Finished 25 summary analyses of training events. This included several farmer workshop evaluations.
- Participated in the first online distance course called EDDA-online. Conducted focus-group evaluations with participants and trainers at the end of the course.
- Facilitated impact of agricultural engineering research by forming collaborative networks and strategic alliances with the continued participation in the Philippine Rice Post-production Consortium. Co-organized a workshop for training development for farmer cooperatives.
- Conducted two training courses on rice seed selection, storage, and management for 70 tribal women at Raipur, India.

Next step activities in 2002

Output 1. Strategies and devices for enhanced dissemination of information and knowledge-based technologies
- Give additional NOA training at selected sites (e.g., Myanmar) and also conduct NOAs in additional villages by trained NARES staff. Findings will be used to package technology (e.g., SSNM along with critical limiting factors) for evaluation in key sites in each country. ICM components as a part of this whole farm system will be refined for evaluation by farmers (14 villages in Indonesia plus in other countries). An NOA manual will be developed.
- Pre-evaluate, release, and distribute the revised TropRice decision support tool (www.irri.org/Troprice). Release RiceDoctor for NARES evaluation.
- In Cambodia, conduct a follow-up to the needs assessment with training on various factors including post-harvest. Identify and deliver whole farm management practices.
- In Laos, develop a needs assessment and a master plan for training and delivery.
- In Vietnam, connect marginal farming communities in a mountainous province to an agricultural extension system.
- Develop a draft ICM manual for Indonesia.
- In India and the Philippines, facilitate dialogue among rice researchers, extension agencies, and NGOs on technology needs of farmers and their criteria for evaluation of improved technologies.
- Conduct a rice mill survey in Cambodia and Philippines.
- Refine and simplify SSNM methods and tools and develop messages for training of NARES staff and village-level evaluation.
- Complete analysis and reports for the yield gap project and conduct a final workshop in Dhaka, Bangladesh.
- Translate the technology advisory notes in local languages/dialects for India and Bangladesh.
- In India, help organize a women's seed cooperative at Raipur and train more women farmers on seed selection and management at Orissa and Bihar.

Output 2. Validation of technological and methodological options for matching priority needs with available options using farming participatory experiments and partnerships
- Refine and evaluate ICM options in 14 villages in Indonesia and assess and document farmers' feedback and opinions on adoption.

- Evaluate the LCC method at village level and collect farmers' feedback in India, Philippines, and Vietnam. Refine, simplify, and evaluate SSNM in pilot villages at the RTOP sites in five countries.
- In India, conduct HAM radio interactive communication between researchers of two research stations and farmers of five villages. Collect and document farmers' feedback on HAM radio interactive communication.
- In Iloilo and Infanta, Philippines, test farmer-selected technologies in participation with farmers and local lead groups.
- In India, test trash management through the rice-wheat systems. Develop improved seeders in collaboration with local private sector.
- Analyze data on livelihood systems survey and compile reports for flood-prone systems. Develop technology advisory notes on deepwater and boro rice farming, communicate them to partners, and test for flood-prone systems.
- Complete analysis of household survey data and prepare report on changes in agriculture and economy for the flood-prone ecosystem in Thailand and Vietnam.
- Assess impact of LCC in South Vietnam and Philippines (Pangasinan).
- In Bangladesh, promote and evaluate the spread of selected rice varieties having specific locally preferred quality traits through "mini-kit" distribution.
- Conduct multi-location demonstration of two selected "star technologies," which are particularly suitable for small and marginal farmers and women in each of the collaborative research sites involving more farmers.

Output 3. Human capital development of NARES rice professionals

- Establish and make available online the IRRI Knowledge Bank, which will consist of 400+ modules as reusable learning objects.
- Develop training folders that will include IT and training kits (especially for the LCC and NOA). Instruct trainees at IRRI on Web use and IT-based materials.
- Identify training institute networks across the region to ultimately lead to established networks feeding off the Knowledge Bank material that will dramatically increase the use of rice knowledge in the region.
- Train female farmer groups on seed management in Orissa and Bihar, India.
- Conduct training on direct seeding with the modified seeder at Can Tho University, Vietnam, for participants from Bangladesh, India, and Sri Lanka.
- Initiate an impact assessment study of the flood-prone project.
- Prepare templates for technology bulletins as training materials (Flood-prone).
- Develop a multimedia support for agroecological training course, Web based
- Enroll 78 postgraduate scholars.

Partner institutions

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

- ***NGOs:*** A range of NGOs are involved in the work, including BRAC, Proshika and CARE (Bangladesh); Population and Community Development Association (Thailand); Bangladesh Rural Advancement Committee; Center for Research and Development of Waste and Marginal Lands, Samata Vikas Mulak, R.K. Mission and Swaminathan Association (India); ICDAI and Process Foundation (Philippines), plus various NGOs in Cambodia.

- ***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).

IRRI CONTACT

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

MEMORANDA OF AGREEMENT: PARTNER INSTITUTIONS IRRI ENTERED INTO AGREEMENTS WITH IN 2001

Australia

- Australian Centre for International Agricultural Research (ACIAR). Deed of Agreement on the project Development of a diagnostic key for tropical rice disorders 1 Jan 2001-31 Dec 2002.
- Centre for Pest Information Technology and Transfer, University of Queensland (CPITT). Rice IPM CD ROM Publication Agreement between CPITT, the University of Queensland, and IRRI, 3 Mar 2001–indefinite.

Cambodia

- Ministry of Agriculture, Forestry, and Fisheries (MAFF). Letter of Agreement extending the MOU for Scientific and Technical Collaboration in Research on Rice and Rice-based Farming Systems. 13 Sep 2001-12 Sep 2006.

Canada

- Potash and Phosphate Institute (PPI)/Potash and Phosphate Institute of Canada (PPIC), East and Southeast Asian Programs (ESEAP). Memorandum of Agreement to carry out a joint project to produce, distribute, and market the rice nutrient handbook.30 Mar 2001-29 Mar 2005.

China

- China Agricultural University (CAU). Memorandum of Agreement on Development of Breeding and Management Technologies for Aerobic Rice. 31 Jul 2001-30 Jul 2005.
- Center for Chinese Agricultural Policy, Chinese Academy of Sciences (CCAP-CAS). Memorandum of Agreement to promote research, training, and exchange of information and technology between the two parties, in areas of mutual concern related to rice and rice-based farming systems.15 Feb 2001-14 Feb 2006.

Colombia

- International Centre for Tropical Agriculture (CIAT). Software Transfer Agreement between CIAT and IRRI. 21 Aug 2001-20 Aug 2003.

France

- Centre de cooperation international en recherche agronomique pour le developpement, for its Annual Crops Department (CIRAD-CA). Protocol of Agreement for Cooperative Project and Secondment of Dr. Trebuil to IRRI Thailand Office to strengthen linkages between agricultural research and development and enhancing ecological sustainability and improving livelihoods through ecoregional approaches to integrated natural resources management (INRM). 19 Apr 2001-18 Apr 2004.
- Institut de recherche pour le développement (IRD). Protocol of Agreement in extending the appointment of Dr. Jean-Christophe Castella. 5 Feb 2001-16 Dec 2002.

Germany

- Center for Development Research (ZEF). Agreement of Cooperation between IRRI and ZEF to promote an academic research for the project Systemwide water use efficiency in the Upper Pampanga River Integrated Irrigation System. 28 Feb 2001-27 Feb 2003.
- Center for Development Research (ZEF). Managing N fertilization through crop demand-driven field-specific application (PDF - Kyaw Kyaw Win). 1 Apr 2001-31 Mar 2003.
- German Federal Ministry for Economic Cooperation and Development (BMZ). Genetics and physiology of phosphorus uptake by rainfed rice (postdoctoral fellowship for Dr. Wissuwa). 1 Dec 2001-30 Nov 2004.
- German Agency for Technical Cooperation (GTZ). Trait and gene discovery to stabilize rice yields in drought-prone environments. 1 Jan 2001-31 Dec 2003.
- University of Bayreuth (UB). Memorandum of Agreement to promote research, training, and exchange of information and technology between the two parties, in areas of mutual concern related to rice and rice-based farming systems. 10 Jan 2001-9 Jan 2004.

India

- G.B. Pant University of Agriculture and Technology (GBPUAT). Memorandum of Agreement to promote and accelerate research on rice and rice-based farming systems and strengthen national and regional rice research programs. 1 Mar 2001-28 Feb 2006.
- University of Calcutta (UC). Memorandum of Agreement to support the conduct of thesis research at IRRI by Mr. Arindam Samaddar under the supervision of Dr. Morin. 23 Mar 2001-22 Mar 2003.

Indonesia

- Agency for Agricultural Research and Development (AARD). Memorandum of Understanding between AARD and IRRI concerning Scientific and Technical Collaboration in Rice Research and Training. 21 Jun 2001-20 Jun 2006.
- Agency for Agricultural Research and Development (AARD). Memorandum of Agreement between AARD and IRRI on the Development and evaluation of location-specific integrated crop and resource management packages for high rice yields. 23 Nov 2001-22 Nov 2003.

Italy

- International Plant Genetic Resources Institute (IPGRI). Memorandum of Agreement between IPGRI and IRRI to provide IPGRI with services in the Philippines and IPGRI to provide similar and reciprocal services in Italy. 1 Jan 2001-1 Jan 2004.

Japan

- Japan International Cooperation Agency (JICA). Contract of Agreement for the Minutes on the Counterpart Training Program under the Tripartite Agreement and the Agreement between JICA and IRRI relative to Ms. Damayanthi K. Edirisinghe's on-the-job training on wild rice. 6 Aug 2001-5 Dec 2001.

Korea

- National Crop Experiment Station-Rural Development Administration (NCES-RDA). Memorandum of Agreement for Scientific and Technical Collaboration in Research and Training on Temperate Rice. 21 Sep 2001-20 Sep 2006.

Nepal

- National Agriculture Research Center (NARC). Memorandum of Understanding for Scientific and Technical Cooperation in Research and Training on Rice. 19 Jan 2001–indefinite.

Philippines

- Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). Memorandum of Understanding for Institutional Cooperation between SEARCA and IRRI to collaborate in a number of areas in pursuing common educational, training, and research objectives. 6 Mar 2001-5 Mar 2006.
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Memorandum of Agreement relative to the joint project of IRRI and UPLBFI on Quality characteristics of raw and cooked IR68144-2B-2-2-3 and PSBRc 28 milled at different degrees using commercial mills and Comparative iron bioavailability of IR68144-2B-2-2-3 and PSBRc 28 using in vitro digestion/CaCO-2 cell culture model. 15 Sep 2001-30 Dec 2001.
- University of the Philippines Los Baños Foundation, Inc. (UPLBFI). Addendum to the MOA signed on 15 Sep 2001. 26 Nov 2001.

Singapore

- Minolta Singapore (PTE) Ltd. (Minolta). Memorandum of Agreement on the Measurement of spectro-signatures to describe the leaf color of major Asian rice cultivars. 23 Feb 2001-22 Feb 2002.

Switzerland

- Swiss Agency for Development and Cooperation (SDC). Irrigated Rice Research Consortium (Phase 2). 1 Jan 2001-31 Dec 2004.

- Swiss Agency for Development and Cooperation (SDC). Rice mutant bank and resource platform for functional genomics, Phase 1.1 Aug 2001-31 Jul 2004.

- Swiss Agency for Development and Cooperation (SDC). Letter of Agreement to assign Ms. Renate Braun to the Lao-IRRI Project (based in Lao PDR). 26 Jun 2001-25 Jun 2003.

United Kingdom

- Department for International Development (DFID). Dynamics of livelihood in rural Bangladesh: generation of information for facilitating dialogues on strategies and policies pertaining to elimination of poverty.1 Oct 2001-31 Jul 2004.
- LION Bioscience AG (LION). Non-Exclusive SRS License Agreement for Academic Research. 23 May 2001–indefinite.

United States

- International Service for the Acquisition of Agri-biotech Applications (ISAAA). Collaboration Agreement to develop intellectual property and technical property management capacity at IRRI. 1 Feb 2001-31 Jan 2004.
- The Regents of the University of California (The Regents). Non-Exclusive License and Bailment Agreement on Procedures and Materials for Conferring Disease Resistance in Rice (UC case no. 1995-032). 24 Feb 2001-23 Feb 2016.
- United States Department of Agriculture (USDA). Subrecipient contract for the project Participatory assessment of social and economic impacts of biotechnology. 15 Sep 2001-14 Sep 2005.

- United States Agency for International Development (USAID). Development, evaluation, and distribution of tropical rice with beta-carotene. 1 Nov 2001-31 Oct 2006.
- United States Agency for International Development (USAID). Agreement relative to the USAID grant awarded to IRRI to support the project Assessing the potential scale and impact of transgene outcrossing to wild and weedy rices in Vietnam.1 Oct 2001-30 Sep 2004.
- Washington University in St. Louis (Wus). Blast 2.0 University/Non Profit Organization License Agreement Case#CH0023-115. 15 Apr 2001–indefinite.

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SPECIAL-FUNDED PROJECTS: PROPOSALS APPROVED BY DONOR AGENCIES IN 2001

- *Australian Centre for International Agricultural Research*
  a. Development of diagnostic key for tropical rice disorders, A$54,600, 1 Jan 2001–31 Dec 2002.
  b. Growing rice with less water: increasing water productivity in rice-based cropping system, A$800,000, 1 Jul 2001–30 Jun 2005.

- *Canadian International Development Agency*
  Functional annotation of rice genomic sequences, $150,000, 29 Mar 2001–31 Mar 2004.

- *German Federal Ministry for Economic Cooperation and Development*
  a. Trait and gene discovery to stabilize rice yields in drought-prone environment, DM3,000,000, 1 Jan 2001–31 Dec 2003.
  b. Genetics and physiology of phosphorus uptake in rainfed rice, DM490,000, 1 Dec 2001–30 Nov 2004.

- *International Atomic Energy Agency*
  Integrated soil, water, and nutrient management for sustainable rice-wheat cropping systems in Asia, 1 Jan 2001–31 Dec 2005.

- *Korea/ Rural Development Administration*
  Establishment and operation of IRRI-Korea Office, US$200,000, 1 Dec 2001–30 Nov 2002.

- *Philippines/Department of Agriculture – Bureau of Agricultural Research*
  Assessing the impact of potential trade liberalization of the Philippine rice sector, PhP5,155,800, 1 May 2001–30 Apr 2004.

- *Portugal*
  IRRI-Portugal Research collaboration on rice improvement, US$70,000, 1 Jan 2001–31 Dec 2001.

- *Rockefeller Foundation*
  Increasing productivity and sustainability in rainfed rice: a focus on drought-prone environments, US$500,000, 1 Feb 2001–31 Jan 2004.

- *Systemwide Livelihood Program*
  Sustainable food feed systems and improved livelihoods of the poor in rainfed lowland areas: socioeconomic component, US$225,000, 1 Oct 2001–30 Sep 2004.

- *Swiss Agency for Development and Cooperation*
  a. The Irrigated Rice Research Consortium Phase II: Irrigated Rice Research Consortium coordination unit, US$2,910,470, 1 Jan 2001–31 Dec 2004.
  b. Junior professional officer (Dr. Braun), US$257,845, 1 Jun 2001–31 May 2003.
  c. Rice mutant bank and resource platform for functional genomics, US$975,398, 1 Aug 2001–31 Jul 2004.

- *United Kingdom/ Department for International Development*
  PETRRA–Dynamics of livelihood systems in rural Bangladesh: generation of information for facilitating dialogues on strategies and policies pertaining to elimination of poverty, US$612,269, 1 Oct 2001–31 Jul 2004.

- *United States Agency for International Development*
  a. Development, evaluation, and distribution of tropical rice enriched with β-carotene, US$900,000, 1 Jan 2001–31 Dec 2003.
  b. Assessing the potential scale and impact of transgenic outcrossing to wild and weedy rices in Vietnam, US$400,000, 1 Oct 2001–30 Sep 2004.

- *United States Department of Agriculture*
  Participatory assessment of social and economic impacts of biotechnology, US$120,000, 15 Sep 2001–14 Sep 2005.

- *ZEF–The Center for Development Research*
  Managing N–fertilization though crop demand-driven, field-specific application (PDF-Kyaw Kyaw Win), DM18,000, 1 Jan 2001–31 Dec 2003.

- *IFA/PPI/IPI*
  Reaching towards optimal productivity, US$432,000, 1 Jan 2001–31 Dec 2004.

- *Asian Development Bank/International Food Policy Research Institute*
  Breeding for iron-dense rice: a low-cost, sustainable approach to reduce anemia in Asia, US$229,700, 1 Jun 2001–31 Dec 2003.

- *Asia Pacific Network for Global Change Research*
  Workshop on land use/management change and trace gas emissions in East Asia, US$26,500, 5 Oct 2001–12 Jan 2002.

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Honors and Awards Received by IRS and NRS in 2001

- **Roland J. Buresh**, soil scientist, CSWS
  1) Named Fellow of the Soil Science Society of America, in Charlotte, North Carolina, October.

- **Ronald P. Cantrell,** director general
  1) Received the Crop Science Society of America Award for International Service, in Charlotte, North Carolina, October.

- **Carlos Casal, Jr., Reynaldo dela Cueva, Luisito Caracuel, Julito Talay, Rodolfo Toledo, Alejandro Manio, Juan Alzona, Oscar Gonzales, and Leonida Nazarea**, IRRI's hybrid rice breeding team.
  1) CGIAR Excellence in Science Award for The Outstanding Scientific Support Team, in Washington, D.C., October.

- **Mike Cohen,** entomologist, and **Remy Aguda**, assistant scientist, EPPD (with **E.P. Alcantara** of the National Institute of Molecular Biology and Biochemistry, University of the Philippines Los Baños, and **D. Dean** of the Ohio State University Department of Biochemistry)
  1) Received the Philippine Association of Entomologists' Best Poster Award during the 32nd Pest Management Council of the Philippines Conference, Pili, Camarines Sur, for the poster Bacillus thuringiensis *delta-endotoxin binding to the midgut receptors of rice stem borers,* May.

- **Peter Fredenburg**, writer/editor, VIS
  1) Named regional winner, Asia, of the 2001 IUCN-Reuters Environmental Media Awards for his magazine article, *The treasures of the Sierra Madre*, in Berlin, December.

- **Gene Hettel,** editor and head, CPS
  1) Received the Bronze Award for Writing (*Lao PDR-the "crown jewel" in rice biodiversity project*) in a specialized publication (the IRRI Web site) from the U.S.-based Agricultural Communicators in Education (ACE), in Toronto, July.

- **Joel D. Janiya**, assistant scientist, **Martin Mortimer,** weed ecologist, **James E. Hill,** agronomist, and **Carmelo O. Garcia,** researcher, CSWS (with **Collin M. Piggin** of the Australian Centre for International Agricultural Research)
  1) Received the Best Paper Award in Weed Science from the Weed Science Society of the Philippines, Inc., during the 32nd Pest Management Council of the Philippines Annual Scientific Conference, Pili, Camarines Sur, May.

- **Gurdev S. Khush**, principal plant breeder, PBGB
  1) Received a special award for his contributions to rice improvement from the Federation of Crop Science Societies of the Philippines (FCSSP) in Manila, April.
  2) Received the China International Scientific and Technological Cooperation Award in Beijing, June.
  3) Appointed honorary professor of the Chinese Academy of Agricultural Sciences, Beijing, June.
  4) Received the International Cooperation Award from the Deputy Prime Minister of Egypt, August.
  5) Appointed honorary professor of Uzbek Rice Research Institute, Tashkent, September.

- **Julian Lapitan**, manager, IPMO
  1) Given the Honorary Fellow Award by the Crop Science Society of the Philippines during the Asian Crop Science Congress, April.

- Zhu Youyong, Chen Hairu, Fan Jinghua, Wang Yungyue, Li Yan, Chen Jianbing, Fan Jinxiang, Yang Shisheng, Hu Lingping, **Hei Leung**, **Tom Mew**, Paul Teng, **Wang Zonghua**, and **Christopher Mundt,** EPPD.
  1) CGIAR Excellence in Science Award for the Outstanding Scientific Article, *Genetic diversity and disease control in rice,* published in *Nature,* in Washington, D.C., October.

- **Mary Grace A. Rayco**, General Accounting
  1) Named Girl Scout of the Philippines National Youth Achiever, GSP National Headquarters, Ermita, Manila, May.

- **Sant S. Virmani**, plant breeder, PBGB
  1) Received a Research Fellow Award from the Federation of Crop Science Societies of the Philippines (FCSSP), in Manila, April**.**
  2) Named Fellow of the Crop Science Society of America, in Charlotte, North Carolina, October.

- **Mariano Marcos State University (MMSU)-IRRI Collaborative Research Project**
  1) Received two AFMA (Agriculture and Fisheries Modernization Act) Outstanding R & D Paper Awards from the Bureau of Agricultural Research (BAR), Philippine Department of Agriculture, October. The award-winning papers were: *Rainfed lowland rice-based cropping systems of Ilocos Norte: show window for future diversified cropping systems* by **E.O. Agustin, R.K. Shrestha, M. Alam, B.P. Tripathi, D.S. Buccao, J.K. Ladha, M.P. Lucas**, and **S. Pandey**; and *On-farm trial on comparison of SPAD-based and farmer's nitrogen management in rainfed lowland rice* by **E.O. Agustin, M.C.P. Baga, M.P. Lucas, D.R. Culannay, A.C. Morales, and V. Balasubramanian**.

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Publications and seminars in 2001

Institute publications

Books

Program report for 1999. 2000. 175 p.
Rice nutrient disorders and nutrient management. 2001. 191 p.
Rice genetics IV. 488 p.
Methane emissions from major rice ecosystems in Asia. 2001. 394 p.
IRRI 2000-2001: Rice research—the way forward. 2001. 71 p.
Characterizing and understanding rainfed environments. 2000. 488 p.
Rice research for food security and poverty alleviation. 2001. 692 p.
Exploiting biodiversity for sustainable pest management. 2001. 241 p.
Rice research and production in the 21st century. 2001. 224 p.
A guide to Los Baños for IRRI international staff and families. 2001. 114 p.
Local tradition meets modern know-how. 37 p.
Rice-feeding insects of tropical Asia, Nepali edition.
Field problems of tropical rice, 10th English reprint.
Rice IPM CD-ROM. Pest management of rice farmers in Asia.

Periodicals/serials

International rice research notes, vol. 26, nos. 1 & 2
IRRI discussion paper series, nos. 41-43
IRRI limited proceedings series, nos. 6-8
IRRI technical bulletin series, nos.7 & 8
Rice literature update, vol. 9, nos. 1 & 2

Administration

Cantrell RP, Hettel GP. 2001. Contributions of molecular biology to breeding and issues associated with its application in developing countries. In: Yajima M, Tsurumi K, editors. Agricultural technology research for sustainable development in developing countries. JIRCAS International Symposium Series No. 9. Proceedings of the 7th JIRCAS International Symposium, 1-2 Nov 2001. Tsukuba (Japan): Japan International Research Center for Agricultural Sciences. p 9-20.

Analytical Service Laboratories

Ryan J, Smithson P, Mandac B, Uponi J. Role of international research centers' soil laboratories in agricultural development. In: Proceedings of the 7th International Symposium on Soil and Plant Analysis, 21-27 Jul 2001. Edmonton (Canada):Soil and Plant Analysis Council.

Biometrics and Bioinformatics Unit

Lafitte HR, Champoux MC, McLaren CG, O'Toole JC. 2001. *See* **Crop, Soil, and Water Sciences.**
McLaren CG, White J, DeLacy I. 2001. International Crop Information System,Version 2, 3 CD set. Los Banos, Laguna (Philippines): International Rice Research Institute.
Sobral BWS, Mangalam H, Sopel A, Mendes P, Pecherer R, McLaren CG. 2001. Bioinformatics for rice resources. In: Goode J, Chadwick D, editors. Rice biotechnology: improving yield, stress tolerance, and grain quality. New York: John Wiley. p 59-84.

Communication and Publications Services

Cantrell RP, Hettel EP. 2001. *See* **Administration.**

Crop, Soil, and Water Sciences

Baltazar AM, Martin EC, Mortimer AM, Casimero MC, Obien SR, De Datta SK. 2001. Reducing *Cyperus rotundus* tuber populations using stale-seedbed techniques in rice-onion cropping systems. In: Proceedings of the 18th Asian-Pacific Weed Science Society Conference, Beijing, China. p 215-223.

Banziger M, Lafitte HR, Edmeades GO, Bertran FJ, Beck DL, Elings A. 2000. Development of maize varieties and hybrids tolerant to low nitrogen stress. In: Vasal SK, Gonzalez Ceniceros F, Fan XingMing, editors. Proceedings of the Seventh Asian Regional Maize Workshop, 23-27 Feb 1998, PCARRD, Los Banos, Philippines. p 207-217.

Barker R, Loeve R, Li YH, Tuong TP, editors. 2001. Water-saving irrigation for rice. In: Proceedings of an international workshop held in Wuhan, China, 13-25 Mar 2001. Colombo (Sri Lanka): International Water Management Institute.

Boissau S, Castella JC, Nguyen Hai Thanh. 2001. Distribution des terres de forêt au Nord Viêt Nam : sédentarisation et évolution des modes de production. Une étude de cas sur quatre villages du district de Na Ri, province de Bac Kan. SAM Pap. Ser. 1. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Boissau S, Castella JC, Nguyen Hai Thanh. 2001. La distribution des terres de forêt au Nord Viêt Nam : droits d'usage et gestion des ressources. SAM Pap. Ser. 9. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Boissau S, Hoang Lan Anh, Castella JC. 2001. SAMBA role-play in Xuat Hoa commune, Bac Kan province, northern Vietnam. SAM Pap. Ser. 3. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Bouman BAM, Kropff MJ, Tuong TP, Wopereis MCS, ten Berge HFM, van Laar HH. 2001. ORYZA2000: modeling lowland rice. Los Baños (Philippines): International Rice Research Institute, and Wageningen (The Netherlands): Wageningen University and Research Centre. 235 p.

Bouman BAM, Spiertz JHJ. 2001. Water and nutrient use efficiency of highly productive cropping systems. In: Promoting global innovation of agricultural science and technology and sustainable agricultural development. International Conference of Agricultural Science and Technology (ICAST2001), November 7-9, Beijing, China. Session: Sustainable Agriculture. p 267-275.

Bouman BAM, Tuong TP, Kropff MJ, van Laar HH. 2001. The model ORYZA2000 to simulate growth and development of lowland rice. In: Ghassemi F, McAleer M, Oxley L, Scoccimaro M, editors. Proceedings of MODSIM 2001, International Congress on Modelling and Simulation, Canberra, Australia, 10-13 Dec 2001. Vol. 4. p 1793-1798.

Bouman BAM, Tuong TP. 2001. Field water management and increase its productivity in irrigated rice. Agric. Water Manage. 49(1):11-30.

Bouman BAM, Tuong TP. 2001. Field water management to save water and increase its productivity in irrigated rice. Agric. Water Manage. 49(1):11-30.

Bousquet F, Castella JC, Trébuil G, Boissau S, Kam SP. 2001. The use of multi-agent simulations in companionable modelling approach for agro-ecosystem management. Proceedings of the International Conference on Integrated Natural Resources Management, August 2001, CIAT, Cali, Colombia.

Bousquet F, Trébuil G, Boissau S, Baron C, d'Aquino P, Castella JC. 2001. Knowledge integration for participatory land management: the use of multi-agent simulations and a companionable modelling approach. Proceedings of the International Conference on Participatory Technology Development and Local Knowledge for Sustainable Land Use in Southeast Asia, June 2001, Chiang Mai, Thailand. Organized by University of Hohenheim, Germany, and the Asia Committee of the European Science Foundation.

Bronson KF, Hussain F, Pasuquin E, Ladha JK. 2001. Use of ^{15}N-labeled soil in measuring N fertilizer recovery-efficiency in transplanted rice. Soil Sci. Soc. Am. J. 64:235-239.

Buresh RJ, Aduna J, Lantin RS, Bouman B, Wassmann R. 2001. Managing rice-based systems for efficient resource use and mitigating greenhouse gas emissions. Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA. (in CD-ROM)

Buresh RJ, Balasubramanian V, Witt C, Ladha JK, Peng S. 2001. Development and delivery of nutrient management innovations for lowland rice farmers. In: Proceedings of the International Workshop on Integrated Natural Resources Management, 28-31 Aug 2001, CIAT. Cali (Colombia): Centro Internacional de Agricultura Tropical.

Buresh RJ, Dawe D, Tuong TP, Ladha JK, Bouman B, Lantin R, Peng S, Mortimer M, Hill JE. 2001. Sustainable soil and water management of irrigated rice ecosystems. In: Proceedings of the International Workshop on Integrated Natural Resources Management, 28-31 Aug 2001, CIAT. Cali (Colombia):Centro Internacional de Agricultura Tropical.

Buresh RJ, Peng S, Witt C, Balasubramanian V, Laureles E. 2001. Improving nitrogen fertilizer-use efficiency for rice: How do management opportunities compare? Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA. (in CD-ROM)

Buresh, RJ, Balasubarmanian V, Witt C, Ladha JK, Peng S, Dawe D, Morin S. 2001. Development and delivery of nutrient management innovations for lowland rice farmers. Workshop on Integrated Management for Sustainable Agriculture, Forestry and Fisheries. 28–31 Aug 2001. Cali (Colombia): Centro Internacional de Agricultura Tropical.

Buresh, RJ, Dawe D, Tuong TP, Ladha JK, Bouman B, Lantin R, Peng S, Mortimer M, Hill JE. 2001. Sustainable soil and water management of irrigated rice ecosystems. Workshop on Integrated Management for Sustainable Agriculture, Forestry and Fisheries. 28–31 Aug 2001. Cali (Colombia): Centro Internacional de Agricultura Tropical. http://www.ciat.cgiar.org/inrm/workshop2001/docs/titles/2-2FpaperRBuresh.pdf

Cabangon RJ, Castillo EG, Bao LX, Lu G, Wang GH, Cui YL, Tuong TP, Bouman BAM, Li YH, Chen CD, Wang JZ. 2001. Impact of alternate wetting and drying irrigation on rice growth and resource-use efficiency. In: Barker R, Loeve R, Li YH, Tuong TP, editors. Water-saving irrigation for rice. Proceedings of an international workshop held in Wuhan, China, 13-25 Mar 2001. Colombo (Sri Lanka): International Water Management Institute. p 55-80.

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, 23-25 Mar 2001. Colombo (Sri Lanka): International Water Management Institute. p 55-80.

Cabangon RJ, Castillo EG, Bao LX, Wang GH, Tuong TP, Bouman BAM. 2001. Impact of alternate wetting and drying irrigation on rice growth and resource-use efficiency. II. In Jinhua, Zheijang, China. In: Proceedings of the International Workshop on Water Saving Irrigation for Paddy Rice, 23-25 Mar 2001, Wuhan China. ACIAR, IWMI, IRRI, WHU. Wuhan (China): China Rural Water and Hydropower. p 53-75.

Cabangon RJ, Castillo EG, Lu G, Cui YL, Tuong TP, Bouman BAM, Li YH, Chen C, Wang J, Liu X. 2001. Impact of alternate wetting and drying irrigation on rice growth and resource-use efficiency. I. In Tuanlin, Huibei, China. In: Proceedings of the International Workshop on Water Saving Irrigation for Paddy Rice, 23-25 Mar 2001, Wuhan China. ACIAR, IWMI, IRRI, WHU. Wuhan (China): China Rural Water and Hydropower. p 31-52.

Castella JC, Boissau S, Hoang Lan Anh, Husson O. 2001. Enhancing communities' adaptability to a rapidly changing environment in Vietnam uplands: the SAMBA role-play. In: Suminguit J, Caidic J, editors. Proceedings of the International Conference on Sustaining Upland Development in Southeast Asia: Issues, Tools, and Institutions for Local Natural Resource Management, May 2001, Makati, Metro Manila, Philippines. SANREM CRSP/Southeast Asia, multimedia CD-ROM.

Castella JC, Boissau S, Tran Ngoc Trung, Dang Dinh Quang. 2001. How allocation of lowlands affects upland agricultural dynamics in northern Vietnam mountains: from systems analysis to multi-agent model. SAM Pap. Ser. 4. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Castella JC, Gayte O, Do Minh Phuong. 2001. Entre exploitation familiale et région agricole une approche à l'échelle « méso » du bassin versant pour une gestion communautaire des ressources naturelles dans les hautes terres du Vietnam. SAM Pap. Ser. 6. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Castella JC, Kam SP, Hoanh CT. 2001. New partnership mechanisms for integrated natural resource management: the Red River Basin (Vietnam) pilot region for operational ecoregional approach. Int. J. Sustainable Dev. 4(4):351-367.

Castella JC, Tran Quoc Hoa, Husson O, Vu Hai Nam, Dang Dinh Quang. 2001. Dynamiques agraires et différenciation des exploitations agricoles dans la commune de Ngoc Phai, district de Cho Don, province de Bac Kan, Vietnam. SAM Pap. Ser. 8. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Caton BP, Foin TC, Hill JE, Mortimer AM. 2001. Measuring crop competitiveness and identifying associated traits in cultivar field trials. In: Proceedings of the Asian Pacific Weed Science Society, Beijing, China. p 139-145.

Caton BP, Foin TC, Hill JE, Mortimer AM. 2001. Measuring crop competitiveness and identifying associated traits in cultivar field trials. In: Proceedings of the 18th Asian-Pacific Weed Science Society Conference, Beijing, China. p 139-145.

Caton BP, Mortimer AM, Foin TC, Hill JE, Gibson KD, Fischer AJ. 2001. Weed morphology effects on competitiveness for light in direct-seeded rice. Weed Res. 41:155-163.

Caton BP, Mortimer AM, Foin TC, Hill JE, Gibson KD, Fischer AJ. 2001. Weed shoot morphology effects on competitiveness for light in direct-seeded rice. Weed Res. 41:155-163.

Chandra Babu R, Nguyen BD, Chamarerk V, Shanmugasundaram P, Chezhian P, Ganesh SK, Sadasivan S, Sarkarung S, Wade LJ, Nguyen HT. 2001. Association between physio-morphological traits and drought resistance in rice: a QTL approach. In: Abstracts of the Asian Agriculture Congress, Manila. p 286.

Confesor RB, Tuong TP. 2001. Modified Philip's cumulative infiltration equation for cracked soils. In: Preferential flow. Water movement and chemical transport in the environment. Proceedings of the 2nd International Symposium, 3-5 Jan 2001, Ala Moana Hotel Honolulu, Hawaii. Michigan (USA): American Society of Agricultural Engineers. p 245-248.

Dawe D, Dobermann A. 2001. Yield and productivity trends in intensive rice-based cropping systems of Asia. In: Yield gap and productivity decline in rice production. Rome: Food and Agriculture Organization. p 97-115

Eagle AJ, Bird JA, Hill JE, Horwath WR, van Kessel C. 2001. Nitrogen dynamics and fertilizer use efficiency in rice following straw incorporation and winter flooding. Agron. J. 93:1346-1354.

Edmeades GO, Cooper M, Lafitte R, Zinselmeier C, Ribaut J-M, Habben JE, Loffler C, Banziger M. 2001. Abiotic stresses and staple crops. In: J. Nosberger J, Geiger HH, Struik PC, editors. Crop Science. Wallingford (UK): CAB International. p 137-154.

Erout A, Castella JC. 2001. La riziculture de bas-fond: élément structurant des systèmes de production agricole de la province de Bac Kan, Vietnam. SAM Pap. Ser. 7. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Gami SK, Ladha JK, Pathak H, Shah MP, Pasuquin E, Pandey SP, Hobbs PR, Joshy D, Mishra R. 2001. Long-term changes in yield and soil fertility in a 20-year rice-wheat experiment in Nepal. Biol. Fertil. Soils 34:73-78.

George T, Magbanua R, Roder W, Van Keer K, Trebuil G, Reoma V. 2001. Upland rice response to phosphorus fertilization in Asia. Agron. J. 93:1362-1370.

George TS, Gregory PJ, Robinson JS, Buresh RJ, Jama BA. 2001. *Tithonia diversifolia*: variations in leaf nutrient concentration and implications for biomass transfer. Agrofor. Syst. 52:199-205.

Gibson KD, Breen JL, Hill JE, Caton BP, Foin TC. 2001. California arrowhead is a weak competitor in water-seeded rice. Weed Sci. 49:381-384.

Gibson KD, Gibson KD, Hill JE, Foin TC, Caton BP, Fischer AJ. 2001. Water-seeded rice cultivars differ in ability to interfere with watergrass. Agron. J. 93:326-332.

Gu S, Zhu Q, Yang J, Peng S. 2001. Analysis on grain filling characteristics for different rice types. Acta Agron. Sin. 27(1):7-14.

Gyaneshwar P, James EK, Mathan N, Reddy PM, Reinhold-Hurek B, Ladha JK. 2001. Endophytic colonization of rice by a diazotrophic strain of *Serratia marcescens*. J. Bacteriol. 183:2634-2645.

Gyaneshwar P, James EK, Natarajan M, Reddy PM, Reinhold-Hurek B, Ladha JK**.** 2001. Endophytic colonization of rice by a diazotrophic strain of *Serratia marcescens.* J. Bacteriol. 183:2634-2645.

Hagiwara M, Aragones DV**,** Nozoe T**,** Kondo M. 2001. Varietal difference in the relationship between root respiration and soil oxidation activity of root in rice *(Oryza sativa* L.) plant. In: Abstracts of the Asian Agricultural Congress-4th Conference of the Asian Crop Science Association, 4-6 Apr 2001, Manila Philippines. p 151.

Hagiwara M, Rodriguez R, Nozoe T, Kondo M. 2001. Estimation of rice root growth and activity by 'new root' sampling. In: Proceedings of the 6th Symposium of the International Society of Root Research. Nagoya (Japan): Japanese Society for Root Research and International Society of Root Research. November p 160-161.

Hill JE, Buresh RJ, Heong KL, Bell MA, Marcotte P. 2001. The Irrigated Rice Research Consortium (IRRC)æa model for impact with national programs. Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA. (in CD-ROM)

Hoanh CT, Tuong TP, Kam SP, Phong ND, Ngoc NV, Lehmann E. 2001. Using GIS-linked hydraulic model for managing water quality conflict for shrimp and rice production in the Mekong River Delta, Vietnam. In: Ghassemi F, McAleer M, Oxley L, Scoccimaro M, editors. Proceedings of MODSIM 2001, International Congress on Modelling and Simulation, Canberra, Australia, 10-13 Dec 2001. Vol. 1. p 221-226. http://www.ciat.cgiar.org/inrm/workshop2001/docs/titles/2-2FpaperRBuresh.pdf

Husson O, Castella JC, Ha Dinh Tuan, Naudin K. 2001. Agronomic diagnosis and identification of factors limiting upland rice yield in mountainous areas of northern Vietnam. SAM Pap. Ser. 2. Hanoi (Vietnam): Vietnam Agricultural Science Institute.

Ikerra ST, Maghembe JA, Smithson PC, Buresh RJ. 2001. Dry season sesbania fallows and their influences on nitrogen availability and maize yields in Malawi. Agrofor. Syst. 52:13-21.

Janiya JD, Mortimer M, Hill JE, Garcia CO, Piggin CM. 2001. Impact of crop establishment on weed dynamics: implication for weed management in upland rice. In: Proceedings of the 32nd Annual Scientific Meeting of the Pest Management Council of the Philippines, 2-4 May 2001, Pili, Camarines Sur, Philippines.

Jansen HGP, Azofeifa R, Bouman BAM. 2001. A decade of interdisciplinary land use research in Costa Rica by the Research Program on

Sustainability in Agriculture (REPOSA): achievements and lessons. In: Proceedings of the Third International Symposium on Systems Approaches for Agricultural Development, Lima, Peru, 8–10 November 1999 [CD-ROM]. Lima (Peru): International Potato Center.

Kamoshita A, Rodriguez R, Yamauchi A, Wade LJ. 2001. Response of rainfed lowland rice genotypes to prolonged drought and rewatering during the vegetative phase. In: Fukai S, Basnayake J, editors. Increased lowland rice production in the Mekong Region. Proceedings No. 101. Canberra: Australian Centre for International Agricultural Research. p 78-85.

Ladha JK, Dawe D, Yadav RL, Pathak H, Padre AT, Hobbs P, Gupta RK. 2001. Productivity and nutrient trends in long-term rice-wheat experiments in Asia. In: ASA/CSSA/SSSA Annual Meetings, 21-25 Oct 2001, Charlotte, North Carolina, USA.

Lafitte HR, Champoux MC, McLaren CG, O'Toole JC. 2001. Rice root morphological traits and relation to isozyme group and adaptation. Field Crops Res. 71:57-70.

Lafitte HR, Champoux MC, McLaren G, O'Toole JC. 2001. Rice root morphological traits are related to isozyme group and adaptation. 2001. Field Crops Res. 73:1-14.

Lafitte HR. 2000. Abiotic stresses affecting maize. In: Paliwal RL, Granados G, Lafitte HR, Violic AD, editors. Tropical maize improvement and production. Rome: Food and Agriculture Organization. p 93-104.

Lafitte HR. 2000. Breeding for abiotic stress resistance. In: Paliwal RL, Granados G, Lafitte HR, Violic AD, editors. Tropical maize improvement and production. Rome: Food and Agriculture Organization. p 191-210.

Lafitte HR. 2000. Tropical maize physiology. In: Paliwal RL, Granados G, Lafitte HR, Violic AD, editors. Tropical maize improvement and production. Rome: Food and Agriculture Organization. p 21-28.

Laza RC, Peng S, Sanico AL, Visperas RM, Akita S. 2001. Higher leaf area growth rate contributes to greater vegetative growth of F_1 rice hybrids in the tropics. Plant Prod. Sci. 4(3):184-188.

Mazid MA, Jabbar MA, Riches CR, Robinson EJZ, Mortimer AM, Wade LJ. 2001. Weed management implications of introducing dry-seeding of rice in the Barind tract of Bangladesh. In: Proceedings of the British Crop Protection Conference – Weeds II. British Crop Protection Council. p 211-216.

Miyamoto N, Steudle E, Hirasawa ET, Lafitte HR. 2001. Hydraulic conductivity of rice roots. J. Exp. Bot. 52:1835-1846.

Namuco OS, Dizon MA, Hill JE, Mortimer AM. 2001. A review of methods for Analyzing weed germination data. In: Proceedings of the Asian Agricultural Congress, 24-27 Apr 2001, Manila, Philippines.

Nieuwenhuis P, Amarante ST, Lales JS, Robles RP, Samonte HP, Ramos C, Yamauchi A, Wade LJ. 2001. Soil constraints to plant growth, root elongation and water extraction in rainfed lowland rice. In: Roots: the dynamic interface between plants and the earth. Nagoya: International Society of Root Research. p 518-519.

Nozoe T, Rodriguez R, Agbisit R. 2001. Effects of Fe(III) reduction on the growth of paddy rice in alkaline soil. Jpn. J. Trop. Agric. (extra issue 2) 45:129-130.

Nozoe T, Rodriguez R, Agbisit R. 2001. Relationship among soil management pH of soil and the growth of paddy rice in tropical area. In: Abstracts of the Annual Meeting, Japanese Society of Soil Science and Plant Nutrition (Kanto Branch). p 29.

Nozoe T, Rodriguez R, Agbisit R. 2001. Relationship between the amounts of Fe(II) and pH in alkaline paddy soil [in Japanese]. In: Abstracts of the Annual Meeting, Japanese Society of Soil Science and Plant Nutrition. p 151.

Nozoe T, Sekiguchi T, Inoue T. 2001. Effect of the application of Fe(0) material on the changes in Eh, Fe(II) content and pH in paddy soil [in Japanese]. In: Abstracts of the Annual Meeting, Japanese Society of Soil Science and Plant Nutrition. p 322.

Nozoe T, Sekiguchi T, Inoue T. 2001. Effects of the addition of Fe(0) on the reduction of Fe(III), in submerged rice soil. Soil Sci. Plant Nutr. 47:123-130.

Padre AT, Alumaga M, Ladha JK. 2001. Estimating soil labile C by $KMnO_4$ oxidation as an early indicator of changes in the soil organic matter pool. In: ASA/CSSA/SSSA Annual Meetings, 21-25 Oct 2001, Charlotte, North Carolina, USA.

Pampolino MF, Larazo W, Buresh RJ. 2001. Indigenous nitrogen supplying capacity in lowland rice cropping systems. Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA. (in CD-ROM)

Pampolino MF, Laureles E, Buresh RJ. 2001. Long-term dynamics of soil carbon in lowland rice cropping systems. Annual meeting abstracts. Madison, WI (USA): ASA-CSSA-SSSA. (in CD-ROM)

Pasuquin EM, Ladha JK, Regmi AP, Bueno CS. 2001. Changes in soil carbon, soil NPK contents and yields in a long-term rice-rice-wheat experiment in Nepal. In: Proceedings of the Asian Agricultural Congress, 24-27 Apr 2001, Westin Philippine Plaza, Manila, Philippines.

Patil SK, Singh U, Singh VP, Mishra VN, Das RO, Henao J. 2001. Nitrogen dynamics and crop growth on an Alfisol and a Vertisol under a direct-seeded rainfed lowland rice-based system. Field Crops Res. 70:185-199.

Ram S, Chauhan RPS, Singh BB, Singh RK, Singh VP. 2000. Effect of pre-transplanting submergence and farmyard manure application on yield and uptake, recovery and utilization of applied nitrogen by rice (*Oryza sativa*) under partially reclaimed sodic soils. Indian J. Agric. Sci. 70(12):856-859.

Reddy PM. 2001. Rice-rhizobial interactions: extent of genetic makeup of rice for forming symbiosis. In: Proceedings of the Symposium on Use of Novel Microbial Biotechnology Approaches for Agriculture, Industry and Environment, 10 Feb 2001, Bureau of Soils and Water Management Convention Hall, Quezon City, Philippines. Quezon City (Philippines): Philippine Society for Microbiology, Inc. p 7-12.

Reichardt W, Briones A, de Jesus R, Padre B. 2001. Microbial population shifts in experimental rice systems. Appl. Soil Ecol. 17:151-163.

Sadoulet D, Castella JC, Nam VH, Quang DD. 2001. Dynamiques agraires, gestion des ressources naturelles et différenciation des exploitations agricoles dans une zone de montagne du Nord Vietnam. Cahiers Agric. 10:307-318.

Samejima H, Kondo M, Ito O, Nozoe T, Osaki M. 2001. Relationship between stem sap exudation and other root characteristics in tropical rice. In: Abstracts of the Asian Agricultural Congress-4th Conference of the Asian Crop Science Association, 4-6 Apr 2001, Manila Philippines. p 24.

Sanico AL, Yang W, Peng S, Laureles E, Buresh R. 2001. Comparing three types of leaf color chart in estimating leaf nitrogen status. In: Abstracts of the Asian Agriculture Congress 24-27 Apr 2001. Manila (Philippines): Society for the Advancement of Breeding Researches in Asia and Oceania and Asian Crop Science Association. p 237.

Schipper RA, Jansen HGP, Bouman BAM, Hengsdijk H, Nieuwenhuyse A, Sáenz F. 2001. Integrated bioeconomic land use models: an analysis of policy issues in the Atlantic zone of Costa Rica. In: Lee DR, Barrett CB, editors. Tradeoffs or synergy? Agricultural intensification, economic development and the environment. Wallingford (UK): CABI Publishing. p 267-284.

Sekiya K, Siopongco J, Yamauchi A, Wade LJ. 2001. The role of root signals in rice. In: Roots: the dynamic interface between plants and the earth. Nagoya: International Society of Root Research. p 532-533.

Sheehy JE, Dionora MJA, Mitchell PL. 2001. Spikelet numbers, sink size and potential yield in rice. Field Crops Res. 71:77-78.

Sheehy JE. 2001. Will yield barriers limit future rice production? In: Nosberger J, Geiger HH, Struik PC, editors. Prospects and perspectives in crop science. Proceedings of the 3rd International Crop Science Congress 2000, Hamburg, Germany. Wallingford (UK): CAB International.

Shepherd G, Buresh RJ, Gregory PJ. 2001. Inorganic soil nitrogen distribution in relation to soil properties in smallholder maize fields in the Kenya highlands. Geoderma 101:87-103.

Shrestha RK, Ladha JK. 2001. Dynamics, balance, and recycling of nitrogen in a lowland rice-based cropping system. In: Proceedings of the XIV International Plant Nutrition-Food Security and Sustainability of Agroecosystems, 27 Jul-3 Aug 2001, University Mail Hall, Hanover, Germany.

Shrestha RK, Ladha JK. 2001. Nitrate pollution in groundwater and strategies to reduce pollution. In: Proceedings of the 5th International Conference on Diffuse/Nonpoint Pollution and Watershed Management, 10-15 Jun, 2001, Milwaukee, Wisconsin.

Shrestha RK, Ladha JK. 2001. Nutrient balances in a rice-vegetable system: a case study of an intensive cropping system in Ilocos Norte, Philippines. In: Proceedings of the International Workshop on Nutrient Balances for Sustainable Agricultural Production and Natural Resource Management in Southeast Asia, DOA Kasetsart University, 20-21 Feb 2001, Bangkok. Bangkok (Thailand): International Board for Soil Research and Management.

Siband P, Chantal L, Witt C, Dingkuhn M. 2001. Evaluer le staut azoté du riz irrigué. In: Eirc Malézieux et al, editors. Modélisation des agrosystèmes et aide à la décision CIRAD, INRA, coll repères. p 95-106.

Singh A, Singh US, Singh V, Zeigler RS, Hill JE, Singh VP, Duveiller ED, Sta Cruz P, Holdernes M. 2000. *Rhizoctonia solani* in rice-wheat system. J. Mycol. Plant Pathol. 30(3):343-349.

Siopongco J, Wade LJ, Yamauchi A. 2001. Maximum rooting depth of doubled-haploid lines of rice in response to drought and rewatering in rainfed lowland conditions. In: Roots: the dynamic interface between plants and the earth. Nagoya: International Society of Root Research. p 542-543.

Tan Z, Hurek T, Gyaneshwar P, Ladha JK, Reinhold-Hurek B. 2001. Novel endophytes of rice form a taxonomically distinct subgroup of *Serratia marcescens*. Syst. Appl. Microbiol. 24:245-251.

Tan Z, Hurek T, Vinuesa P, Muller P, Ladha JK, Hurek BR. 2001. Specific detection of *Bradyrhizobium* and *Rhizobium* strains colonizing rice (*Oryza sativa)* roots by 16S-23S ribosomal DNA intergenic spacer-targeted PCR. Appl. Environ. Microbiol. 67:3655-3664.

Taregyan MR, Mortimer AM, Putwain PD, Collin HA. 2001. Selection for resistance to the herbicide imazethapyr in somaclones of soyabean. Weed Res. 41:143-154.

Verma SC, Ladha JK, Tripathi AK. 2001. Evaluation of plant-growth promoting and colonization ability of endophytic diazotrophs from deep water rice. J. Biotechnol. 91:127-141.

Visperas R M, Moradi F, Peng S. 2001. Residual effects of nitrogen and cultivar on the succeeding rice crop. In: Abstracts of the Asian Agricultural Congress, 24-27 Apr 2001. Manila (Philippines): Society for the Advancement of Breeding Researches in Asia and Oceania and Asian Crop Science Association. p 205.

Wade LJ. 2001. The role of root traits in defining patterns of adaptation in rainfed lowland rice. In: Roots: the dynamic interface between plants and the earth. Nagoya: International Society of Root Research. p 142-143.

Wang GH, Dobermann A, Witt C, Dawe D, Sun QZ, Fu RX. 2001. Performance of site-specific nutrient management for irrigated rice in southeast China. Agron. J. 93:869-878.

Wang GH, Dobermann A, Witt C, Sun QZ, Fu RX. 2001. Analysis of the indigenous nutrient supply capacity of rice soils in Jinhua, Zhejiang Province. Chin. J. Rice Sci. 15:201-205.

White PF, Puthea S, Wade LJ. 2000. Deep placement of urea pellets compared with other nitrogen management strategies for lowland rice production in Cambodia. Cambodian J. Agric. 3:25-31.

Yang J, Peng S, Gu S, Visperas RM, Zhu Q. 2001. Changes in activities of three enzymes associated with starch synthesis in rice grains during grain filling. Acta Agron. Sin. 27(2):157-164.

Yang J, Peng S, Gu S, Visperas RM, Zhu Q. 2001. Changes in zeatin and zeatin riboside content in rice grains and roots during grain filling and the relationship to grain plumpness. Acta Agron. Sin. 27(1):35-42.

Yanni YG, Rizk RY, Abd El-Fattah FK, Squartini A, Corich V, Giacomini A, Bruijn Rademaker J, Maya-Flores J, Ostrom P, Vega-Hernandez MV, Hollingsworth R I, Molina EM, Mateos P, Velasquez E, Wopereis J, Triplett E, Garcia MU, Anarna JA, Rolfe, Ladha JK, Hill J.E, Mujoo R, Ng PK, Dazzo FB. 2001. The beneficial plant growth-promoting association of *Rhizobium leguminosarum* bv. *trifolii* with rice roots. Austr. J. Plant Physiol. 28:845-870.

Zhong X, Peng S, Sheehy JE, Liu H. 2001. Relationship between productive tiller percentage and biomass accumulation in rice (*Oryza sativa* L.): a simulation approach. Chin. J. Rice Sci. 15(2):107-112.

CREMNET

Balasubramanian V, Ladha JK, Gupta RK, Mehla RS, Bijay-Singh, Yadvinder-Singh. 2001. Technology options for rice in rice-wheat systems in South Asia. Annual Meeting Abstracts, 21-25 Oct 2001. Charlotte (USA): ASA-CSSA-SSSA.

Agustin EO, Baga MCP, Lucas MP, Culannay DR, Morales AC, Balasubramanian V. 2001. Comparison of SPAD-based and farmers' nitrogen management in rainfed lowland rice. Quezon City (Philippines): Bureau of Agricultural Research, Department of Agriculture.

Entomology and Plant Pathology

Baisakh N, Datta K, Oliva N, Ona I, Rao GJN, Mew TW, Datta SK. 2001. Rapid development of homozygous transgenic rice using anther culture harboring rice *chitinase* gene for enhanced sheath blight resistance. Plant Biotechnol. 18(2).

Barrion AT. 2000. Biodiversity of macro fauna (invertebrates) in rice fields. In: Ecological value of rice fields in the Philippines. Proceedings of the Asia Rice Foundation Workshop, March 22, 2000. Los Banos, Laguna: Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development.

Barrion AT. 2001. A new species of dried banana leaf spider, *Neobrettus* Wanless 1984 (Araneae:Salticidae) from the agricultural lowlands of Mt. Banahaw, Quezon Province, Philippines. Philipp. Entomol. 15(1):27-35.

Barrion AT. 2001. Spiders: natural biological control agents against insect pests in Philippine rice fields. In: Proceedings of the 25th Anniversary and 23rd Annual Scientific Meeting, Biological Sciences, National Academy of Science and Technology (NAST), July 11-12, 2001, Manila Hotel, Philippines. Manila (Philippines): NAST.

Barrion AT, Barrion AA, Barrion ALA. 2000. Checklist of Philippine spiders (Araneae: Arachnida). Los Banos, Laguna: UP Los Banos Museum of Natural History.

Cottyn B, Regalado E, Lanoot B, De Cleene M, Mew TW, Swings J. 2001. Bacterial populations associated with rice seed in the tropical environment. Phytopathology 91:282-292.

Datta K, Tu J, Oliva N, Ona I, Velazhahan R, Mew TW, Muthukrishnan S, Datta SK. 2001. Enhanced resistance to sheath blight by constitutive expression of infection-related rice *chitinase* in transgenic elite indica rice cultivars. Plant Sci. 160:405-414.

Islam Z, Way MJ, Heon, KL. 2000. Methods for sampling and monitoring ants in the rice environment. Bangladesh J Entomol. 10:97-114.

Jaeger P, Barrion AT. 2001. First description of the male of *Heteropoda cyperusiria* Barrion and Litsinger 1995 from the Philippines (Araneae:Sparassidae:Heteropodinae). Philipp. Entomol. 15 (1):37-43.

Lan NTP, E LV, Du PV, Kim PV, Mew TW. 2000. Current status of biological control research of rice sheath blight disease in Vietnam. In: Proceedings of the First Asian Conference on Plant Pathology, 25-28 August 2000, Beijing, China. 357 p.

Leach JE, Vera Cruz CM, Bai J, Leung H. 2001. Pathogen fitness penalty as predictor of durability of disease resistance genes. Annu. Rev. Phytopathol. 39:187-224.

Leach JE, Leung H, Wang GL. 2001. Dissection of defense response pathways in rice. In: Rice biotechnology: improving yield, stress tolerance, and grain quality. Goode J, editor. Wiley, Chichester: Novartis Foundation Symposium 236. p 190-204.

Mew TW, Vera Cruz CM. 2001. Bacterial blight of rice. In: Encyclopedia of plant pathology. Maloy OC, Murray TD, editors.New York: John Wiley & Sons, Inc. p 71-74.

Rapusas HR, Barrion AT, Sengsoulivong V, Inthavong S, Schiller JM, Schoenly KG, Heong KL. 2000. Arthropod communities of the lowland rice ecosystems in the Lao PDR. Vientiane: National Agriculture and Forestry Research Institute, National Rice Research Program and Lao-IRRI Project.

Shanti ML, George MLC, Vera Cruz CM, Bernardo MA, Nelson RJ, Leung H, Reddy JN, Sridhar R. 2001. Identification of resistance genes effective against rice bacterial blight pathogen in eastern India. Plant Dis. 85:506-512.

Shi ZX, Chen XM, Line RF, Leung H, Wellings CR. 2001. Development of resistance gene analog polymorphism markers for the *Yr9* gene resistance to wheat stripe rust. Genome 44:509-516.

Sigsgaard L, Tof, S, Villareal S. 2001. Diet-dependent fecundity of the spiders *Atypena formosana* and *Pardosa pseudoannulata* predators in irrigated rice. Agric. For. Entomol.3:285-295.

Toojinda T, Broers LH, Chen XM, Hayes PM, Kleinhofs A, Korte J, Kudrna D, Leung H, Line RF, Powell W, Ramsay L, Vivar H, Waugh R. 2000. Mapping quantitative and qualitative disease resistance genes in a doubled haploid population of barley (*Hordeum vulgare*). Theor. Appl. Genet. 101:580-589.

Wu JC, Xu JX, Liu JL, Yuan SZ, Cheng JA, Heong KL. 2001. Effects of herbicides on rice resistance and on multiplication and feeding of brown planthopper (BPH*), Nilaparvata lugens* (Stal.) (Homoptera: Delphacidae). Int. J. Pest Manage. 47(2):153-159.

Genetic Resources Center

Jackson MT. 2001. Broadening the genetic base of crop production. Ann. Bot. 88:332-333.

Loresto GC, Guevarra E, Jackson MT. 2000. Use of conserved rice germplasm. Plant Genet. Resour. Newsl. 124:51-56.

Pham JL, Morin SR, Sebastian LS, Abrigo GA, Calibo MA, Quilloy SM, Hipolito L, Jackson MT. 2001. Rice, farmers, and genebanks: a case study in the Cagayan Valley, Philippines. In: Rao RV, Brown AD, Engels JMM, Jackson MT, editors. Managing plant genetic diversity. Wallingford (UK): CAB International.

Rao RV, Brown AD, Engels JMM, Jackson MT, eds. 2001. Managing plant genetic diversity. Wallingford (UK): CAB International.

Shen L, Courtois B, McNally KL, Robin S, Li Z. 2001. Evaluation of near-isogenic lines of rice introgresed with QTLs for root depth through marker-aided selection. Theor. Appl. Genet. 103:75-83.

Library and Documentation Service

Allmand M, Ramos M, Soeripto Y, Goldberg E. 2001. Global agricultural knowledge sharing: the CGIAR Libraries Consortium. In: Development of agricultural information management and information technology. Proceedings of the International Conference on the Development of Agricultural Information Management, Technology, and Market in the 21st Century. Mei FQ, editor. Beijing (China): China Agricultural Scitech Press. p 241-247.

Ramos MM. 2001. The International Rice Research Institute Library: sharing knowledge in a web-based environment. In: Development of agricultural development management and information technology. Proceedings of the International Conference on the Development of Agricultural Information Management, Technology, and Market in the 21st Century. Mei FQ, editor. Beijing (China): China Agricultural Scitech Press. p 300. (abstr.)

Plant Breeding, Genetics, and Biochemistry

Ashida M, Imai K, Fukuta Y, Ishikawa R, Senda S, Akada T, Takeda T, Niizeki M. 2001. Nature of endogenous rice transposon, Rmu in rice genome and their polymorphic molecular structure. Breed. Res. 3 (suppl.2): 280.

Baisakh N, Datta K, Oliva N, Ona I, Rao GJN, Mew TW, Datta SK. 2001. Rapid development of homozygous transgenic rice using anther culture harboring rice *chitinase* gene for enhanced sheath blight resistance. Plant Biotechnol. 18(2):101-108.

Baisakh N, Datta K, Rashid H, Oliva NP, Datta SK. 2000. *Agrobacterium tumefaciens*-mediated transformation of an elite indica rice maintainer line IR68899B with a reconstructed T-DNA carrying multiple genes. Rice Genet. Newsl. 17:122-125.

Courtois B, Bartholome B, Chaudhary D, McLaren G, Misra CH, Mandal NP, Pandey S, Paris T, Piggin C, Prasad K, Roy AT, Sahu RK, Sahu VN, Sarkarung S, Shama SK, Singh A, Singh HN, Singh ON, Singh NK, Singh RK, Singh S, Sinha PK, Sisodia BVS, Thakur R. 2001. Comparing farmers' and breeders' rankings in varietal selection in low-input management: a case study of rainfed rice in eastern India. Euphytica 122:537-551.

Courtois B, Singh RK, Pandey S, Piggin C, Paris T, Sarkarung S,Singh VP, McLaren G, Baghel SS, Sahu RK, Sahu VN, Sharman SS, Singh S, Singh HN, Singh A, Singh ON, Sisodia BV, Mishra CH, Roy JK, Chaudhary D, Prasad K, Singh RK, Sinha PK, Mandal NP. 2001. Breeding better rainfed rice varieties through farmer participation: some early lessons from eastern India. In: Lilja N, Ashby A, Sperling L, editors. Assessing the impact of participatory research and gender analysis. Cali (Colombia): Centro International de Agricultura Tropical.

Datta K, Koukolíková-Nicola Z, Baisakh N, Oliva N, SK Datta. 2000. *Agrobacterium*-mediated engineering for sheath blight resistance of indica rice cultivars from different ecosystems. Theor. Appl. Genet. 100:832-839.

Datta K, Tu J, Oliva N, Ona I, Velazhahan R, Mew TW, Muthukrishnan S, Datta SK. 2001. Enhanced resistance to sheath blight by constitutive expression of infection-related rice *chitinase* in transgenic elite indica rice cultivars. Plant Sci. 160:405-414.

Datta SK. 2000. Transgenic rice: development and products for environment-friendly sustainable agriculture. In: Watanabe K, Komamine A, editors. Proceedings of the Workshop on Challenge of Plant and Agricultural Sciences to the Crisis of Biosphere on the Earth in the 21st Century. Georgetown (USA): Landes BioScience. p 237-246.

Datta SK. 2001. The need for genetically engineered food when enough is produced and unused. Brit. Food J. 103:791-795.

Datta SK. 2000. A promising debut for *Bt* hybrid rice. In: Insect resistance, information systems for biotechnology (ISB) news report. http://www/biotech-info.net/promising_debut.html OR www.gophisb.biochem.vt.edu/news/2000/news00.dec.html

Datta SK. 2000. Potential benefit of genetic engineering in plant breeding: rice, a case study. Agric. Chem. Biotechnol. 43:197-206.

Datta SK. 2001. Androgenesis in cereals. In: Bhojwani SS, Soh WY editors. Current trends in the embryology of angiosperms. The Netherlands: Kluwer Academic Publishers. p 471-488.

Datta SK, Bouis HE. 2000. The potential of biotechnology in developing nutrient-dense rice varieties. Food Nutr. Bull. 21:451-456.

Ebron LA, Fukuta Y, Imbe T, Kato H, Yanoria MJT, Khush GS. 2001. Development of near-isogenic lines for blast resistance with a genetic background of indica-type line, IR49830-73-1-2-2. Breed. Res. 3 (uppl. 2): 161.

Ebron LA, Fukuta Y, Yanoria MJT, Tsunematsu H, Imbe T, Kato H, Khush GS. 2001. Genetic analysis of rice blast resistance genes in IRRI varieties and lines. Asian Agriculture Congress Abstract. p 266.

Ford-Lloyd BV, Newbury HJ, Jackson MT, Virk PS. 2001. Genetic basis for co-adaptive gene complexes in rice (*Oryza sativa* L.) landraces. Heredity 87:530-536.

Fukuta Y, Nozoe T. 2001. What is new in IRRI? Introduction of new MTP and collaboration between IRRI and Japan [in Japanese]. Jpn. J. Crop Sci. 70:276-278.

Fukuta Y, Kobayashi S, Ebron LA, Umemoto T, Morita S, Sato T, Nagamine T, Fukuyama T, Sasahara H, Tamura K, Nemoto H, Maeda H, Hamamura K, Ogata T, Matsue Y, Ichitani K, Takagi A, Khush GS. 2001. Reaction pattern of QTL for heading date in rice (*Oryza sativa* L.). Asian Agriculture Congress Abstract. p 70.

Fukuta Y, Kobayashi S, Ebron LA, Sato T, Khush GS. 2001. Genetic and breeding analysis using molecular marker, 21. QTL analysis for harvest index in rice (*Oryza sativa* L.). Breed. Res. 3 (suppl. 1): 233.

Fukuta Y, Morita S, Kobayashi S, Ebron LA, Nagamine T. 2001. Genetic and breeding analysis using molecular marker, 21. QTL analysis for grain thickness using Milyang 23/Akihikari RI lines in rice (*Oryza sativa* L.). Jpn. J. Crop. Sci 70 (suppl. 1): 124-125.

Fukuta Y, Yanoria MJT, Ebron LA, Mercardo DM, Khush GS**.** 2001. Genetic and breeding analysis using molecular marker, 22. Reaction pattern of QTL for Philippine blast isolate. Breed. Res. 3 (suppl .2): 46.

Hossain M, Bennett J, Datta SK, Leung H, Khush GS. 2000. Biotechnology research in rice for Asia: priorities, focus, and directions. In: Qaim M, Kratigger AF, von Braun J editors. Agricultural biotechnology in developing countries: towards optimizing the benefits for the poor. The Netherlands: Kluwer Academic Publishers. p 99-120.

Imbe T, Tsunematsu H, Kato H, Khush GS. 2000. Genetic analysis of blast resistance in IR varieties and resistance breeding. In: Tharreau D et al, editors. Advances in rice blast research. The Netherlands: Kluwer Academic Publishers. p 1-6.

Iseki T, Fukuta Y, Yano M, Yamagishi M. 2001. Genetic analysis of albino plant generation in rice anther culture using a near isogenic line. Breed. Res. 3 (suppl. 1): 231.

Khush GS. 2001. Green revolution: the way forward. Nature Rev./Genetics 2:815-822.

Khush GS. 2000. New plant type of rice for increasing the genetic yield potential. In: Nanda JS, editor. Rice breeding and genetics, research priorities and challenges. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd. p 99-108.

Khush GS. 2001. Challenges for meeting the global food and nutrient needs in the new millennium. Proc. Nutr. Soc. 60:15-26.

Khush GS. 2001. Rice improvement at IRRI: an example of international collaboration. Breed. Res. 3:281-286.

Khush GS. 2001. Super rice for increasing the genetic yield potential. In: Reeves ECR, editor. Encyclopedia of genetics. Chicago (USA): Fitzroy Dearborn Publishers. p 663-667.

Khush GS, Virk P. 2001. Rice improvement: past, present, and future. In: Kang MS, editor. Crop improvement: challenges in the 21st century. New York: Food Products Press, Inc. p 13-38.

Kihupi,AN, Angeles ER, Khush GS. 2001. Genetic analysis of resistance to bacterial blight, *Xanthomonas oryzae* pv. *oryzae* in rice, *Oryza sativa* L. Euphytica 117:39-46.

Kobayashi K, Osaki M, Morita S, Fukuta Y, Khush GS. 2001. QTL analysis for flag leaf in rice (*Oryza sativa* L.) Breed. Rese. 3 (suppl. 1): 234.

Kobayashi S, Ebron LA, Osaki M, Yagi T, Fukuta Y, Khush GS. 2001. Characterization of QTL affecting the number of spikelets per panicle in rice (*Oryza sativa* L.) grown under the tropical climate. Breed. Res. 3 (suppl. 2): 42.

Kobayashi S, Osaki M, Sato T, Fukuta Y. 2001. The genetic relationship of heading date with plant size clarified by QTL analysis in rice (*Oryza sativa* L.). Asian Agriculture Congress Abstract. p 69.

Li LK, Luo LJ, Mei HW, Wang DL, Shu QY, Tabien R, Zhong DB, Ying CS, Stansel JW, Khush GS, Paterson AH. 2001. Overdominant epistatic loci are the primary genetic basis of inbreeding depression and heterosis in rice. I. Biomass and grain yield. Genetics 158:1737-1753.

Li LK, Sanchez A, Angeles E, Singh S, Domingo J, Huang N, Khush GS. 2001. Are dominant and recessive plant disease resistance genes similar?: a case study of rice R genes and *Xanthomonas oryzae* pv. *oryzae* races. Genetics 159:757-765.

Luo LJ, Li ZK, Mei HW, Shu QY, Tabien R, Zong DB, Ying CS, Stansel JW, Khush GS, Paterson AH. 2001. Overdominant epistatic loci are the primary genetic basis of inbreeding depression and heterosis in rice II. Grain yield components. Genetics 158:1755-1771.

Mercado DM, Fukuta Y, Ebron LA, Khush GS. 2001. Identification of QTL for tolerance for iron toxicity in rice (*Oryza sativa* L.). Asian Agriculture Congress Abstract. p 282.

Ni J, Colowit PM, Oster JJ, Mackill DJ. 2001. Molecular markers linked to stem rot resistance in rice. Theor. Appl. Genet. 102:511-516.

Obara M, Kajiura M, Fukuta Y, Yano M, Hayashi M, Yamaya T, Sato T. 2001. Mapping of QTLs associated with cytosolic glutamine synthetase and NADH-glutamate synthase in rice (*Oryza sativa* L.). J. Exp. Bot. 52:1209-1217.

Quimio CA, Torrizo LB, Setter TL, Ellis M, Grover A, Abrigo EM, Oliva NP, Ella ES, Carpena AL, Ito O, Peacock WJ, Dennis E, and Datta SK. 2000. Enhancement of submergence tolerance in transgenic rice overproducing pyruvate decarboxylase. J. Plant Physiol. 156: 516-521.

Sato T, Fukuta Y. 2001. QTL analysis for seed longevity in rice. Breed. Res. 3 (suppl. 2): 39.

Sheehy J, Mitchell P, Dionora J, Tsukaguchi T, Peng SB, Khush GS. 2000. Unlocking the yield barrier in rice through a nitrogen-led improvement in the radiation conversion factor. Plant Prod. Sci. 3(4):372-374.

Shimizu H, Fukuta Y, Kobayashi A. 2001. QTL analysis for residual liquid amylose contents of cooking rice using Milyang 23/Akihikari recombinant inbred lines. Hokuriku Crop Sci. 36:18-20.

Singh S. Sidhu J, Huang N, Vikal Y, Li Z, Brar DS, Dhaliwal HS, Khush GS. 2001. Pyramiding three bacterial blight resistance genes (*xa5*, *xa13* and *Xa21*) using marker-assisted selection into indica rice cultivar PR106. Theor. Appl. Genet. 102:1011-1015.

Tsunematsu H, Yanoria MJT, Ebron LA, Hayashi N, Ando I, Kato H, Imbe T, Khush GS. 2000. Development of monogenic lines of rice for blast resistance. Breed. Sci. 50:229-234.

Tu J, Datta K, Khush GS, Zhang Q, Datta SK. 2000. Field performance of *Xa21* transgenic indica rice (*Oryza sativa* L.), IR72. Theor. Appl. Genet. 101:15-20.

Tu J, Zhang G, Datta K, Xu C, He Y, Zhang Q, Khush GS, Datta SK. 2000. Field performance of transgenic elite commercial hybrid rice expressing *Bacillus thuringiensis* d-endotoxin. Nat. Biotechnol. 18:1101-1104.

Uga Y, Dac L X, Fukuta Y, Fujimura T. 2001. QTL analysis for floral traits of rice using three RI populations. Breed. Res. 3 (suppl 1): 232.

Uga Y, Dac LX, Fukuta Y, Fujimura T. 2001. Comparative mapping of QTLs for flower organs of rice using three recombinant inbred lines. Asian Agriculture Congress Abstract. p 288.

Viraktamath BC, Virmani SS. 2001. Expression of thermosensitive genic male sterility in rice under varying temperature situations. Euphytica 122:137-143.

Virmani SS, Ilyas-Ahmed M. 2001. Environment-sensitive genic male sterility (EGMS) in crops. Adv. Agron. 72:139-195.

Virmani SS, Toledo RS. 2001. Development and use of tropical rice hybrids. In: Redona ED, Gaspar MG, editors. Hybrid rice in the Philippines: progress and new horizons. Munoz, Nueva Ecija (Philippines): Philippine Rice Research Institute. p 1-5.

Xu K, Xu X, Ronald PC, Mackill DJ. 2000. A high-resolution linkage map in the vicinity of the rice submergence tolerance locus *Sub1*. Mol. Gen. Genet. 263:681-689.

Xu K, Xu X, Zhang H, Deb R, Ronald PC, Mackill DJ. 2000. Fine-scale mapping of the rice submergence tolerance gene. Plant Anim. Genome VIII (San Diego, 9-12, 2000): p 4.

Yagi T, Nagata K, Fukuta Y, Tamura K, Ashikawa I, Terao T. 2001. QTL mapping of spikelet number in rice (*Oryza sativa* L.) Breed. Sci. 50:173-181.

Yamanaka S, Ishikawa R, Fukuta Y, Chitrakon S, Nakamura I, Sato T, Sato YI. 2001. Analyses and application of rice genetic resources. 2. Morphological traits and genetic features of upland rice cultivars in northern Thailand. Breed. Res. 3 (suppl. 1): 158.

Yamanaka S, Ishikawa R, Fukuta Y, Nakamura I, Sato T, Sato YI. 2001. Analyses and application of rice genetic resources. 3. Morphological traits and genetic features of upland rice in Laos. Breed. Res. 3 (suppl.2):266.

Yanoria MJT, Fukuta Y, Ebron LA, Mercado DM, Khush GS. 2001. QTL analysis for blast resistance using Philippine blast isolates in Rice (*Oryza sativa* L.). Asian Agriculture Congress Abstract. p 267.

Ye G, Tu J, Hu C, Datta K, Datta SK. 2001. Transgenic IR72 with fused *Bt* gene *cry1*AB/*cry1*Ac from *Bacillus thuringiensis* is resistant against four lepidopteran species under field conditions. Plant Biotechnol. 18(2):125-133.

Zhang J, Zheng HG, Aarti A, Pantuwan G, Tripathy JN, Sarial AK, Robin S, Babu RC, Nguyen Bay D, Sarkarung S, Blum A, Nguyen HT. 2001. Locating genomic regions associated with components of drought resistance in rice: gomparative mapping within and across species. Theor. Appl. Genet.103:19-29.

Social Sciences

Castella JC, Kam SP, Hoanh CT. 2001. New partnership mechanisms for integrated natural resource management: the Red River Basin (Vietnam) pilot region for operational ecoregional approach. Int. J. Sustainable Dev. 4(4):351-367.

Courtois B, Singh Bartolome B, Chaudhary D, McLaren G, Misra CG, Mandal NP, Pandey S, Paris T, Piggin C, Prasad K, Roy AT, Sahu RK, Sahu VN, Sarkarung S, Sharma SK, Singh A, Singh HN, Singh ON, Singh NK, Singh RK, Singh S, Sinha PK, Sisodia BV, Takur R. 2001. *See* **Plant Breeding, Genetics, and Biochemistry.**

Courtois B, Singh RK, Pandey S, Piggin C, Paris T, Sarkarung S, Singh VP, McLaren G, Baghes SS, Sahu RK, Sahu VN, Sharman SS, Singh S, Singh HN, Singh A, Singh ON, Sisodia BV, Mishra CH, Roy JK, Chaudhary D, Prasad K, Singh RK, Sinha PK, Mandal NP. 2001. *See* **Plant Breeding, Genetics, and Biochemistry**.

Dawe D. 2001. How far down the path to free trade? The importance of rice price stabilization in developing Asia. Food Policy 26:163-175.

Garcia YT, Garcia AG, Oo Marlar, Hossain M. 2001. Income distribution and poverty in irrigated and rainfed ecosystems: the Myanmar case. Econ. Polit. Weekly (52 & 53):4670-4676.

Hossain M, Bennett J, Datta S, Leung H, Khush G. 2000. Biotechnology research in rice for Asia: priorities, focus, and directions. In: Qaim M, Krattiger AF, von Braun J, editors. Agricultural biotechnology in developing countries: towards optimizing the benefits for the poor. The Netherlands: Kluwer Academic Publishers. p 99-120.

Hossain M, Bose ML. 2000. Growth and structural changes in Bangladesh agriculture: implications for strategies and policies for sustainable development. In: Sattar MA, editor. Changing rural economy of Bangladesh. Dhaka: Bangladesh Economic Association. p 1-20.

Hossain M, Sen B, Rahman HZ. 2000. Growth and distribution of rural income in Bangladesh: analysis based on panel survey data. Econ. Polit. Weekly 35(52&53):4630-4637.

Hossain M. 2001. Opening address: the challenge to feed the world's poor. In: Goodie J, Chadwick D, editors. Rice biotechnology: improving yield, stress tolerance and grain quality technologies for increasing food production. Novartis Foundation. New York: John Wiley and Sons, Ltd. p 1-10.

Hossain M. 2001. Rural economy and multi-functionality of agriculture. In: Proceedings of an APO Seminar on Role of Multifunctionality in Agricultural Policy Reforms, Tokyo, Japan, 26 January to 3 February 2000. Tokyo: Asian Productivity Organization. p 38-57.

Hossain M, Sen B, Rahman HZ. 2001. Growth and distribution of rural income in Bangladesh: analysis based on panel survey data. Econ. Polit. Weekly (52 & 53):4630-4637.

Husain AM, Hossain M, Janaiah A. 2001. Hybrid rice adoption in Bangladesh: a socioeconomic assessment of farmers' experiences. Research Monograph No. 18. Bangladesh Rural Advancement Committee and IRRI Social Sciences Division.

Isvilanonda S, Ahmad A, Hossain M. 2001. Recent changes in Thailand's rural economy: evidence from six villages. In: Econ. Polit. Weekly (52 & 53):4644-4656.

Khush GS, Sombilla MA, Hossain M. 2000. Livestock, ethics and quality of life in Asia: the food-feed dimension of grain demand. In: Hodges J, Han IK, editors. Livestock, ethics and quality of life. CAB International. p 175-198.

Morin S, Marcotte P, Bell M, Balasubramanian V, Palis F. 2001. Research for development: IRRI's strategy for enhancing research relevance and application. In: Cox P, Chhay R, editors. The impact of agricultural research for development in Southeast Asia. Proceedings of an international conference held at the Cambodian Agricultural Research and Development Institute, Phnom Penh, Cambodia, 24-26 October 2000.

Morin SR, Palis F, McAllister K, Papag A, Magsumbol M. 2001. Farmer learning and the international research centres: lessons from IRRI. Gatekeeper Series No. 96. London: International Institute for Environment and Development.

Pandey S. 2001. Adoption of soil conservation practices in developing countries: policy and institutional factors. In: Bridges M et al, editors. Land degradation: challenges and responses for the 21st century. New Delhi: Oxford & IBH Publishers.

Paris TR, Diaz C, Bautista E, Orge RF. 2001. Adding value in rice production: a case study of women's participatory evaluation of a rice flour mill in Central Luzon, Philippines. Phillip. Eng. J. 22(1):1-14.

Paris TR, Feldstein HS, Geron G. 2001. Technology in empowering women to achieve food security. In: Quisumbing A, Meinzen-Dick RS, editors. 2020 Vision Initiative Focus 6. A collection of 12 policy briefs. .Washington, D.C.: International Food Policy Research Institute.

Paris TR, Singh A, Luis J, Hossain M, Singh HN, Singh S, Singh ON. 2001. Incorporating gender concerns in participatory rice breeding and varietal selection: preliminary results from eastern India. In: Lilja N, Ashby A, Sperling L, editors. Assessing the impact of participatory research and gender analysis. Cali (Colombia): Centro Internacional de Agricultura Tropical.

Paris T, Singh A, Luis J, Singh HN, Singh ON, Singh S, Singh RK, Sarkarung S. 2001. Listening to farmers' perceptions through participatory varietal selection: a case study in villages in eastern India. In: CIAT: an exchange of experiences from South and Southeast Asia. Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement, Pokhara, Nepal, 1-5 May 2000. Cali (Colombia): Centro Internacional de Agricultura Tropical.

Paris TR, Singh A, Luis J. 2001. Listening to male and female farmers in rice varietal selection : a case in eastern India. In: CIAT: an exchange of experiences from South and Southeast Asia. Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement, Pokhara, Nepal, 1-5 May 2000. Cali (Colombia): Centro Internacional de Agricultura Tropical.

Sahu RK, Sahu VN, Paris T, Sharma ML, McAllister K, Singh RK, Sarkarung S. 2001. Understanding farmers' selection criteria for rice varieties: a case in Madhya Pradesh, eastern India. In: CIAT: an exchange of experience from South and Southeast Asia. Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement, Pokhara, Nepal, 1-5 May 2000. Cali, Colombia: Centro Internacional de Agricultura Tropical.

Sombilla M, Hossain M. 2000. Rice and food security in Asia: a long-term outlook. In: Chern WS, Carter CA, Yi-Shei S, editors. Food security in Asia: economics and policies. Edward Elgar Publishing Ltd. p 35-59.

Thakur J, Bose ML, Hossain M, Janaiah A. 2001. Rural income distribution and poverty in Bihar: insights from village studies. Econ. Polit. Weekly (52&53):4657-4663.

Ut Tran Thi, Hossain M, Janaiah A. 2001. Modern farm technology and infrastructure in Vietnam: impact on income distribution and poverty. Econ. Polit. Weekly(52&53):4638-4643.

Rice research seminars

Greenhouse gases, climatic change and rice. Dr. W.H. Patrick, Jr., Boyd professor, Wetland Biogeochemistry Institute, Louisiana State University, USA.

The problems of QTL mapping in segregating populations. Dr. M.J. Kearsey, professor of biometrical genetics, The University of Birmingham, United Kingdom.

Training/delivery for impact: the new millennium. Dr. P. Marcotte.

The rice for life project. Dr. M.B. Jackson, head, Integrated Plant Physiology Group, IACR-Long Ashton Research Station, University of Bristol, United Kingdom.

Gene discovery at Syngenta. Dr. A. Greenland, Syngenta, United Kingdom.

Soil and fertilizer information system of China. Dr. Wei-Li Zhang, director, Division of Information Agriculture, Soil and Fertilizer Institute, Chinese Academy of Agricultural Sciences (CAAS), Beijing, and Ms. Ming-Zao Liang, Soil and Fertilizer Institute, CAAS, Beijing.

Understanding yield variations among farmers' fields in irrigated rice systems. Dr. C. Loyce.

Appropriating life...from biology to the social debate. Dr. B. Chevassus-au-louis, director for research, Institut de la recherche agronomique (INRA); president of the board, Agence Francaise pour la securite, sanitaire des alimentaire (AFSSA), France.

Plant database potpourri. Dr. K. Sakata, chief bioinformatician for the INtegrated rice genome Explorer (INE) database, RGP, Japan; Dr. P. Jaiswal, curator for the Gramene database, USDA-ARS, Cornell; Dr. Y. Yamazaki, curator for OryzaBase, National Institute of Genomics, Japan; and Dr. M. Polacco, curator for MaizeDb, USDA-ARS, University of Missouri.

Bioinformatics@IRRI.
Dr. R. Bruskiewich.

Tackling rice issues beyond rice fields through integrated natural resource management.
Dr. J.-C. Castella.

The soil chemist, the mother, and the mother-in-law.
Dr. G. Kirk.

The biodiversity decade.
Dr. M.T. Jackson.

Rice farming, research extension, and sportscars. Mr. I. Mason, rice farmer, Jerilderie, New South Wales Riverina; Mr. R. Ford, manager, Rice Research Australia Pty Ltd., Jerilderie, New South Wales Riverina; and Ms. B. Clarke, science liaison manager, Norwich Research Park, United Kingdom.

Intellectual property rights. Dr. V. Henson-Apollonio, senior research officer for the Intellectual Property Advisory Central Committee, International Service for National Agricultural Research, The Hague, The Netherlands.

That other stuff: in search of ecological blueprints for sustainable rice soil management. Dr. W. Reichardt.

IRRI research programs: direction, process, content, and impact. Dr. R. Wang.

How would you like your rice today? Rice quality in the Philippines and implications for postharvest management. Dr. R. Bakker.

IRRI's long-term experiments: the treasure revisited. Dr. R.J. Buresh.

Growth, inequality, and poverty in the Philippines: going beyond cross-country averages. Dr. N. Fuwa, assistant professor of agricultural economics, Agricultural Economics Department, Faculty of Horticulture, Chiba University, Japan.

IRRI Agricultural Engineeringæputting science into practice. Mr. J.F. Rickman.

Rice, a water crisis, and Jane Fonda. Dr. B. Bouman.

Moral certainty in agriculture. Dr. R. Zimdahl.

Rodents in rice: problems and future needs in Asia. Dr. G. Singleton.

GM crops: issues and concerns. Dr. E.M.T. Mendoza, research professor, Institute of Plant Breeding, College of Agriculture, University of the Philippines Los Banos, College Laguna.

Division seminars

Crop, Soil, and Water Sciences

Introduction to the chemistry of soils. Dr. W.H. Patrick, Jr., consultant, Louisiana State University, USA.

Advances in research on the role of redox chemistry in soil processes and plant growth: a historical perspective. Dr. W.H. Patrick, Jr., consultant, Louisiana State University, USA.

Developing an approach for improving crop cultivar competitiveness. Dr. B. Caton.

Flooding and submergence: response and adaptation. Dr. M.B. Jackson, University of Bristol, UK.

Escape strategies in flooding and submergence tolerance. Dr. M.B. Jackson, University of Bristol, UK.

Dynamics of N uptake and N distribution in crops: diagnostic tools for N fertilization management. Dr. G. Lemaire, National Agronomic Research Institute, France.

Management of clay soils in lowland rice-based cropping systems. Dr. G. Kirchhof, canditate for soil scientist/agronomist position.

Helping Cambodian farmers to manage soils and fertilizer. Dr. P.F. White, candidate for soil scientist/agronomist position.

Entomology and Plant Pathology

ARBN: building NARS capacity on rice biotechnology. Ms. M. Bernardo.

Crop protection compendium, latest development and opportunities. Mr. P.R. Scott, director, Programme Development, CAB International, Wallingford, UK.

Marker-aided pyramiding of bacterial blight resistance genes in maintainer lines of rice (*Oryza sativa*) hybrids. Ms. L. Borines.

Using candidate defense genes to predict quantitative blast resistance: a method to improve disease resistance in advanced breeding populations. Dr. Bin Liu.

Diversity of life inside a rice stem. Dr. A. Barrion.

The effect of rice variety and nitrogen on oviposition and egg parasitism of green leafhoppers. Ms. C. Granados and Ms. M. Nieto, student trainees.

Rodent management in Southeast Asia: ecological and biological perspectives. Dr. G. Singleton, rodent management consultant.

Crop responses to stem borer attacks: implications on evaluation of resistance. Dr. E. Sanchez and Dr. Zeng Rong Zhu.

Applications of disease resistance candidate genes in Asian Rice Biotechnology Network (ARBN). Dr. Jianli Wu.

Plant Breeding, Genetics, and Biochemistry

Utilization of perenniality for fixing heterosis in rice breeding. Prof. Li Qinxiu, Institute of Crop research, Sichuan Academy of Agricultural Sciences, China.

Fishing for alleles: new ways to integrate QTL detection with cultivar development in rice. Dr G. Atlin.

Rices that defy salts: development of rice varieties for the coastal wetlands of Bangladesh. Dr. G. B. Gregorio.

Field performance of transgenic rice with *Xa21* and *Bt* genes. Dr. Jumin Tu.

Chromosome substitution lines in plants: construction and application for QTL analyses. Dr. M.J. Kearsey, professor of biometrical genetics, The University of Birmingham, UK.

Social Sciences

Changes in agriculture and economy in the flood-prone environment in Bangladesh: implications for rice research strategy. Dr. M. Hossain.

Community and IPM: the geography of learning. Dr. S. Morin.

The rice seed delivery system in Bangladesh: institutional and policy issues. Dr. A. Janaiah.

Trends in total factor productivity for the rice-wheat system in Indian Punjab. Dr. J. Singh.

Genotype by environment biogeography: a new approach to understanding biogeographical phenomena. Dr. D. Falvo.

Training Center

IRRI's computer-based information delivery system in training agricultural researchers. Ms. R. Bakker-Dhaliwal.

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

Staff changes in 2001

January

Dr. Barney P. Caton joined as affiliate scientist, Crop, Soil, and Water Sciences Division.

Dr. Thelma R. Paris, formerly an affiliate scientist, appointed as gender specialist, Social Sciences Division.

Dr. Peter G. Cox, agricultural economist, Cambodia-IRRI-Australia Project, left after completing his assignment.

Dr. Pompe Sta. Cruz joined as project scientist, Training Center.

Mr. Bawonpon Chonipat joined as consultant, IRRI-Bangkok Office.

Dr. William Patrick, Jr. joined as consultant, Crop, Soil, and Water Sciences Division, and left after completing his assignment on the same month.

Dr. Paul Shapiro joined as consultant, Office of the Deputy Director General for Research.

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

February

Dr. Joginder Singh joined as visiting scientist, Social Sciences Division.

Dr. David Shires joined as consultant, Training Center.

Dr. Michael B. Jackson joined as consultant, Crop, Soil, and Water Sciences Division.

Mr. Jay Leslie MacLean joined as consultant, Communication and Publications Services.

Dr. Choon-Kwan Kang joined as collaborative research fellow, Social Sciences Division, and left after completing his assignment.

Dr. Yeon-Kyu Hong joined as collaborative research fellow, Entomology and Plant Pathology Division.

Ms. Hyun-Soon Kim joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, and left after completing her assignment.

Mr. Chang-Jae Ki joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

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

Dr. Paul Shapiro, consultant, Office of the Deputy Director General for Research, left after completing his assignment.

March

Mr. Peter J. Fredenburg joined as editor/writer, Visitors and Information Services.

Dr. Guan Dongming joined as project scientist, Crop, Soil, and Water Sciences Division.

Mr. Jeom-Ho Lee joined as visiting scientist, Plant Breeding, Genetics, and Biochemistry Division, and left on the same month after completing his assignment.

Mr. Nguyen van Ngoc joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Santiago Obien joined as consultant, International Programs Management Office.

Mr. Guo Longbiao joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Michael B. Jackson, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

April

Dr. Thanda Wai joined as intellectual property rights specialist, Office of the Deputy Director General for Partnerships.

Dr. David J. Mackill joined as head, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Rogelio V. Cuyno joined as visiting scientist, Training Center.

Dr. Tae-Soon Kwak joined as visiting research fellow, Crop, Soil, and Water Sciences Division.

Dr. S. Srinivasa Rao joined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Luciana Villanueva joined as consultant, Entomology and Plant Pathology Division.
Dr. Gilles Lemaire joined as consultant, Crop, Soil and Water Sciences Division, and left after completing his assignment.
Dr. Santiago Obien, consultant, International Programs Management Office, left after completing his assignment.
Mr. Nguyen van Ngoc, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Mr. Walter Rockwood, consultant, Communication and Publications Services, left after completing his assignment.
Dr. Yeon-Kyu Hong, collaborative research fellow, Entomology and Plant Pathology Division, left after completing his assignment.
Mr. Chang-Jae Ki, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Mr. Woon-Ho Yang, collaborative research fellow, Crop, Soil, and Water Sciences Division, left after completing his assignment.

May
Dr. Michael T. Jackson appointed as director for program planning and coordination.
Dr. Cailin Lei joined as project scientist, Entomology and Plant Pathology Division.
Dr. Gloria S. Cabuslay joined as project scientist, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Lijun Luo joined as visiting scientist, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Nguyen Thi Lang joined as visiting scientist, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Bhanudeb Bagchi joined as visiting scientist, Social Sciences Division.
Dr. Bazlul A.A. Mustafi joined as visiting scientist, Social Sciences Division.
Prof. Scott Pearson joined as consultant, Social Sciences Division, and left after completing his assignment on the same month.
Prof. Richard Barichello joined as consultant, Social Sciences Division, and left after completing his assignment on the same month.
Ms. Jing Tan joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Grant R. Singleton joined as consultant, Entomology and Plant Pathology Division.
Dr. Kim-Ki Young joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Jumin Tu, project scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Santiago Obien joined as consultant, International Programs Management Office, and left after completing his assignment on the same month.
Mr. Kuk-Hyun Jung, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his appointment.
Mr. Kyung-Ho Kang, collaborative research fellow, Biometrics and Bioinformatics Unit, left after completing his assignment.
Dr. Woon-Go Ha, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Ms. Kimberly Marie Webb, collaborative research fellow, Entomology and Plant Pathology Division, left after completing her assignment.

June
Dr. Guy Kirk, soil chemist and deputy head, Crop, Soil, and Water Sciences Division, resigned.
Dr. Sadiqul I. Bhuiyan, water scientist and IRRI representative for Bangladesh, left after completing his assignment.
Dr. John M. Schiller, agronomist and team leader, Lao-IRRI Project, left after completing his assignment.
Dr. Bijay Singh joined as consultant, Crop, Soil, and Water Sciences Division.
Mr. Robert Hill joined as consultant, Public Awareness.
Dr. Robert L. Zimdahl joined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Roger Rowe joined as consultant, Director General's Office, and left after completing his assignment on the same month.
Ms. Renate Braun joined as collaborative research scientist, Lao-IRRI Office.
Dr. Lijun Luo, visiting scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Mr. Guo Longbiao, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his appointment.
Ms. Kuk-Hyun Jung, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing her appointment.
Mr. Min-Gu Kang joined as collaborative research fellow, International Programs Management Office, and left after completing his assignment on the same month.
Mr. Jung-Whoy Song joined as collaborative research fellow, International Programs Management Office, and left after completing his assignment on the same month.

Mr. Do-Ha Kwon joined as collaborative research fellow, International Programs Management Office, and left after completing his assignment on the same month.

July

Dr. Moon-Hee Lee, internationally recruited staff seconded from Rural Development Administration, Korea, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.

Dr. Ho-Yeong Kim joined as internationally recruited staff seconded from Rural Development Administration, Korea, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Il-Ryong Choi joined as plant virologist, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Kenneth McNally, formerly affiliate scientist, Plant Breeding, Genetics and Biochemistry Division, appointed as molecular geneticist/ molecular taxonomist, Genetic Resources Center.

Dr. Pierre Siband, internationally recruited staff seconded from CIRAD, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Tina Botwright joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Fida M. Abbasi 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. Ruifa Hu joined as visiting scientist, Social Sciences Division.

Dr. Pham van Du joined as consultant, Crop, Soil, and Water Sciences Division.

Dr. Maria Ana E. Odejar joined as consultant, Social Sciences Division.

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

Dr. Elsa Rubia-Sanchez, consultant, Entomology and Plant Pathology Division, left after completing her assignment.

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

Dr. Luciana Villanueva, consultant, Entomology and Plant Pathology Division, left after completing her assignment.

August

Dr. Zhao Ming, affiliate scientist, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Albert D. Atkinson joined as training and courseware specialist, Training Center.

Dr. Gurdev S. Khush, principal plant breeder and head, Plant Breeding, Genetics, and Biochemistry Division, retired.

Dr. Etsuko Araki joined as postdoctoral fellow, Crop, Soil, and Water Sciences Division.

Dr. Zahirul Islam joined as project scientist, Training Center.

Dr. Qui-Woung Kim joined as visiting research fellow, Agricultural Engineering Unit.

Dr. Li Xiaofang joined as visiting scientist, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Ram C. Sharma joined as visiting scientist, Entomology and Plant Pathology Division.

Dr. Guy Kirk joined as consultant, Crop, Soil, and Water Sciences Division.

Ms. Joyce Gorsuch joined as consultant, Training Center.

Dr. Euan K. James joined as consultant, Crop, Soil, and Water Sciences Division, and left after completing his assignment on the same month.

Dr. Gim Gyung-Mee joined as collaborative research fellow, Social Sciences Division.

Mr. Ke-Yup Lee joined as collaborative research fellow, Biometrics and Bioinformatics Unit.

Mr. Sang-Yong Lee joined as collaborative research fellow, Biometrics and Bioinformatics Unit.

Dr. Moon-Tae Son, joined as collaborative research fellow, Biometrics and Bioinformatics Unit.

Dr. Joginder Singh, visiting scientist, Social Sciences Division, left after completing his assignment.

Dr. Bhanudeb Bagchi, visiting scientist, Social Sciences Division, left after completing his assignment.

Dr. Peter Mitchell, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Maria Ana E. Odejar, consultant, Social Sciences Division, left after completing her assignment.

Dr. Kenneth S. Fischer, consultant, Office of the Deputy Director General for Research, left after completing his assignment.

Dr. Pham van Du, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Ms. Karen McAllister, collaborative research fellow, Social Sciences Division, left after completing her assignment.

September

Dr. Conrad Stevens joined as molecular biologist/ molecular pathologist, PETRRA, IRRI-Bangladesh office.

Mr. Karl Goeppert joined as project team leader and IRRI representative for Lao PDR, IRRI-Lao Project.

Dr. Parminder Virk, formerly affiliate scientist, appointed as irrigated rice breeder, Plant Breeding, Genetics, and Biochemistry Division.

Dr. Wolfgang Reichardt, microbiologist, Crop, Soil and Water Sciences Division, left after completing his assignment.
Dr. Xu Weijun, project scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Yong-Hwan Cho, joined as visiting scientist, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Gurdev S. Khush was appointed consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Julie Reynolds joined as consultant, Training Center.
Mr. Himanshu Pathak joined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Pabitra Banik joined as consultant, Social Sciences Division.
Dr. Ken-ichi Kakuda joined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Yong-Hwan Choi, visiting scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Nguyen Thi Lang, visiting scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing her assignment.
Dr. Moon-Tae Song, collaborative research fellow, Biometrics and Bioinformatics Unit, left after completing his assignment.
Mr. Sang-Yong Lee, collaborative research fellow, Biometrics and Bioinformatics Unit, left after completing his assignment.
Dr. Gim Gyung-Mee, collaborative research fellow, Social Sciences Division, left after completing her assignment.
Mr. Ke-Yup Lee, collaborative research fellow, Biometrics and Bioinformatics Unit, left after completing his assignment.

October
Dr. Arumugam Kathiresan, project scientist, Plant Breeding, Genetics, and Biochemistry Division, resigned and then appointed as international research fellow in the same division.
Dr. M. Miah, joined as IRRI liaison scientist for Bangladesh, IRRI-Bangladesh Office.
Dr. Erik Sacks, affiliate scientist, Plant Breeding, Genetics, and Biochemistry Division, resigned.
Dr. Hak-Soo Suh joined as visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. V. Manoharan joined as consultant, Crop, Soil, and Water Sciences Division.
Dr. Zeng-Rong Zhu, project scientist, Entomology and Plant Pathology Division, left after completing his assignment.
Dr. Fida M. Abbasi, visiting research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Li Xiaofang, visiting scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing her assignment.
Dr. Julie Reynolds, consultant, Training Center, left after completingher assignment.
Mr. Robert Hill, consultant, Public Awareness, left after completing his assignment.
Mr. Jay Leslie MacLean, consultant, Communication and Publications Services, left after completing his assignment.
Dr. Pabitra Banik, consultant, Social Sciences Division, left after completing his assignment.

November
Dr. Kshirod K. Jena joined as temperate rice breeder and country representative for Korea, IRRI-Korea Office.
Dr. Shi Yan joined as postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division.
Mr. Do-Yeong Kwak joined as visiting research fellow, Entomology and Plant Pathology Division.
Dr. Tran Thi Ut joined as visiting research fellow, Social Sciences Division.
Mr. Nguyen van Ngoc joined as consultant, Crop, Soil, and Water Sciences Division.
Mr. Chen Ren-Tian joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Guo-Hui Ma joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Edilberto Redoña joined as consultant, Plant Breeding, Genetics, and Biochemistry Division, and left after completing his assignment on the same month.
Dr. Sadiqul I. Bhuiyan joined as consultant, International Programs Management Office, and left after completing his assignment on the same month.
Ms. Hendrika van Laar joined as consultant, Crop, Soil, and Water Sciences Division.
Mr. Un-Sang Yeo joined as collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Abubakr Abdelaziz Mohamed, project scientist, Crop, Soil, and Water Sciences Division, resigned.
Dr. Ram C. Sharma, visiting scientist, Entomology and Plant Pathology Division, left after completing his assignment.
Dr. Bazlul A.A. Mustafi, visiting scientist, Social Sciences Division, left after completing his assignment.
Dr. Grant R. Singleton, consultant, Entomology and Plant Pathology Division, left after completing his assignment.
Dr. V. Manoharan, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.

Dr. Tahlim Sudaryant, joined as consultant, Social Sciences Division, and left after completing his assignment on the same month.
Dr. Somporn Isvilanonda joined as consultant, Social Sciences Division, and left after completing his assignment on the same month.
Dr. Jikun Huang joined as consultant, Social Sciences Division, and left after completing his assignment on the same month.
Dr. Kim-Ki Young, collaborative research fellow, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Mr. Chang-Kug Kim joined as collaborative research fellow, Biometics and Bioinformatics Unit, and left after completing his assignment on the same month.

December
Dr. Matthias Wissuwa joined as international research fellow, Crop, Soil, and Water Sciences Division.
Dr. P. M. Reddy, affiliate scientist, Crop, Soil and Water Sciences Division, left after completing his assignment.
Dr. Harold J. Nesbitt, agronomist and team leader, Cambodia-IRRI-Australia Project, left after completing his assignment.
Dr. Yongming Gao joined as postdoctoral fellow, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Shailaja Hittalmani joined as visiting scientist, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Raj. K. Shrestha joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Dr. Andrzel Kilian joined as consultant, Entomology and Plant Pathology Division, and left after completing his assignment on the same month.
Dr. Shoshi Kikuchi joined as consultant, Entomology and Plant Pathology Division, and left after completing his assignment on the same month.
Dr. Noel Mamicpic joined as consultant, Plant Breeding, Genetics, and Biochemistry Division.
Prof. P.G. Chengappa joined as consultant, Social Sciences Division.
Dr. Emerlito Borromeo, project scientist, Entomology and Plant Pathology Division, left after completing his assignment.
Dr. Guan Dongming, project scientist, Crop, Soil, and Water Sciences Division, left after completing her assignment.
Dr. Bi Xuezhi, project scientist, Plant Breeding, Genetics, and Biochemistry Division, left after completing her assignment.
Dr. Nguyen Tri Khiem, visiting research fellow, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Dr. Tran Thi Ut, visiting research fellow, Social Sciences Division, left after completing her assignment.
Mr. Himanshu Pathak, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Dr. S. Srinivasa Rao, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Dr. Robert L. Zimdahl, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Mr. Nguyen van Ngoc, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Dr. Noel Mamicpic, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Mr. Chen Ren-Tian, consultant, Plant Breeding, Genetics, and Biochemistry Division, left after completing his assignment.
Dr. Ken-ichi Kakuda, consultant, Crop, Soil, and Water Sciences Division, left after completing his assignment.
Mr. Bawonpon Chonipat, consultant, IRRI-Bangkok Office, left after completing his assignment.
Dr. Guo-Hui Ma, consultant, 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.

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Research support services

ANALYTICAL SERVICE LABORATORIES

The Analytical Service Laboratories (ASL) continued to provide both analytical and analysis-related services to IRRI research projects. The unit completed 48,358 analyses for routine plant, soil, solution, and fertilizer samples, elemental C/N, and stable isotope ratio analyses of ^{13}C and ^{15}N. A total of 7,315 samples were run for N by near-infrared reflectance analysis, 620 of these analyzed for simultaneous N, starch, and soluble sugars.

A new digestion method for plant samples was validated. The procedure was a modified version of the protocol being used by the United States Department of Agriculture Laboratory at Cornell University. It involved the slow digestion of plant samples at increasing temperature regimes (60, 130, 150, and 180 ºC) in very high-purity nitric acid and finishing off with the addition of nitric:perchloric (1:1) acid at 240 ºC. The resulting digest can be analyzed for 10 elements in the inductively coupled argon plasma spectrometer (ICP). Sample weight has been reduced from 1.00 g to 0.500 g as the ICP is very sensitive. This reduced the total amount of salt introduced into the plasma and helped maintain calibration. Recoveries for iron and aluminum from plants with low concentrations of these elements were improved considerably. Sodium, however, cannot be determined in this digest. The only disadvantage of this procedure is that digestion takes 3 d to complete.

Training

ASL was able to coordinate two training sessions for users. The Philippine Nuclear Research Institute (PNRI) trained staff (10 from PBGB Division and the Purchasing Unit) on proper handling of radioisotopes. The training is a prerequisite for getting a license to use radioactive materials in the Philippines. The lectures focused on the principles of radioactivity, handling procedures during normal and emergency conditions, radioactivity and dose measurements, radiation protection, radiation monitoring in relation to contamination and decontamination, safe transport, radiowaste management, applications in agricultural research, and licensing rules and regulations. Practical aspects centered on monitoring, decontamination, and waste management. An examination and a visit to the PNRI research facilities capped the 5-d training.

Another 3-d training workshop for current and prospective users of high-performance liquid chromatography (HPLC) was also organized. Lectures and practical sessions on different modes of separation, instrument operation, method development and validation, quantitation, and troubleshooting were conducted by an applications chemist from Dakila Trading Corporation. The application of the Jasco Borwin chromatography software for acquiring and handling data was also demonstrated. A total of eight researchers, scholars, and scientists participated in this training.

Radioisotope Laboratory

Projects assisted through the use of radioisotope laboratory facilities and liaison services of the PNRI were

- Molecular characterization of introgression in rice
- Assessing seed purity of F_1 hybrids
- Tagging salinity tolerance in rice
- Evaluation of transgenic rice
- Cloning genes for apomixis
- Sulfur nutrition
- DNA isolation and fragmentation
- Tagging gall midge resistance genes
- Physiological basis of the trade-off between perenniality and productivity in perennial upland rice
- Source-sink relationship in super yielding rice for maximum yield potential
- Microbial productivity measurements

- Carbon mineralization experiments
- GPI (glycosyl-phosphatidylinositol)-anchored proteins

Organic Analysis Laboratory

ASL provided consulting services, method development, and run-ready facilities to the following projects.

Analysis of volatile compounds emitted by some rice plant varieties

Previous field studies showed that new plant type (NPT) prototype entries had significantly higher density of striped stem borer (SSB) egg masses during the rice-growing season and higher density of SSB larvae and pupae during harvest than the improved indica dwarf varieties IR64 and IR72. It was inferred that there might be some particular volatiles in the NPT entries that served as attractants for SSB oviposition. Hence, preliminary analyses were done to investigate the profile of volatile compounds released by the NPT rice entries and the two indica varieties during the vegetative and reproductive stages.

Solid phase micro-extraction (SPME) is a method found suitable for the extraction of volatile compounds in plants. It is a fast and solventless alternative to conventional extraction techniques. The volatile compounds emitted by plants are adsorbed directly onto a fused-silica fiber that is coated with a suitable stationary phase, 100 um of nonbonded polydimethylsiloxane (Supelco, Sigma-Aldrich Co., USA) and immediately analyzed by gas chromatography (GC).

Prior to use, the new fiber is preconditioned or heated at 250 °C for 2 h with continuous flushing with helium. It is then exposed to the headspace above the incubated plant sample wherein the volatiles partition from the gaseous phase into the stationary phase of the fiber until equilibrium is reached. The adsorbed volatiles are analyzed by inserting the fiber into the injector port of a GC where the analytes are desorbed at 250 °C and carried by helium into a capillary column (SPB-5, 30 m × 0.25 mm, 25 μm film thickness).

In the experiment, we initially used a GC (Hewlett-Packard 5890 Series II plus) equipped with a flame ionization detector (SPME-GC)) to obtain a profile of the number and intensity of the volatile compounds present in the different rice cultivars. Subsequently, we used a GC coupled to a mass spectrometer (GC-MS, HP 5890 GC attached to an HP 5970 MSD, Hewlett-Packard, Palo Alto, CA, USA) to identify individual volatile components by comparison of their mass spectra with those in the Wiley and NIST libraries. Data were collected and processed using the HP ChemStation (G1034C version C.02.00).

- SPME-GC showed that the NPT prototype rice lines tested (IR65564-, IR68011-) had significantly higher number of volatile compounds with higher peak intensities than the improved indica cultivars (IR64 and IR72). Subsequent analyses by SPME-GC-MS allowed identification of the major volatile constituents of the rice varieties tested.
- Zingiberene, a sesquiterpene, was found to be the most abundant volatile compound in the NPT prototype lines, which showed 11-31% peak area in the total ion chromatogram (TIC).
- Other compounds emitted by NPT lines were sesquiterpenes, bisabolene (3.1-6.4% peak area), sesquiphellandrene (5-12% peak area), curcumene (4.7-11% peak area), and farnesene (0.7-4.6% peak area). Hydrocarbons, heptadecane (1.4-17.0% peak area), pentadecane (1.4-11.6% peak area), and a ketone, 2-tridecanone (0.9-3.1% peak area), were also detected. The sesquiterpenes and heptadecane were consistently present in all three replicate samples of the NPT lines analyzed at vegetative and reproductive growth stages. Pentadecane was mostly present at the vegetative stage of both NPT lines and at the reproductive stage of IR68011-. The ketone, 2-tridecanone, was found in trace amounts at the reproductive stage of NPT line IR65564-.
- SPME-GC-MS confirmed fewer volatile compounds in the improved indica dwarf varieties than in the NPT lines. Further, scarcity of peaks in TIC of indica varieties was significantly shown at reproductive than at vegetative stage.
- Major components emitted by IR64 and IR72 were the hydrocarbons, heptadecane (16-36% peak area), pentadecane (6.5-31% peak area), and hexadecane (1.3-2.3% peak area). Heptadecane was dominant in IR64, while pentadecane was dominant in IR72, both at vegetative stages. Some isomers of bicyclic sesquiterpenes—e.g., cadinene (7.2-12% peak area) and muurolene (6.3-7.7% peak area)—were also found at the vegetative stage of both indica varieties, but most significantly in the IR72 variety.

Seasonal dynamics of root toxins

ASL continued to provide facilities and supervision to the project on HPLC analysis of phenolic acids in soil solutions. This was part of the study on seasonal dynamics of root toxins in rice soils as affected by long-term water and straw management. Related studies on the effect of pH, exposure to light, and presence of Fe ions on analysis of phenolic acids were also done.

- Recovery of sinapic acid and *p*-hydroxybenzoic acid decreased drastically when soil solutions spiked with the phenolic acid standards were acidified with 1 to 6 drops of 6 M HCl (from pH 7.1 to 2.0) prior to HPLC analysis. Acidification was previously done to avoid oxidation of ferrous to ferric ions and formation of the reddish brown precipitate (ferric oxide), which interferes with the analysis of phenolic acids. To avoid both acidification and oxidation of ferrous ions, the sampling procedure was modified by using the resin membrane technique for extracting iron from the soil solution. This rendered the soil solutions suitable for analysis by HPLC.

- Peak intensities of some phenolic acid standards decreased with time. This was most likely due to prolonged exposure of the standard solution to light, which caused isomerization of some phenolic acids. The change in ratio of trans-cis isomers caused a shift in uv maxima (ultraviolet wavelength of maximum absorbance) of the analyte, and hence, a decrease in response at the selected wavelength of the uv absorbance detector. Isomerization was avoided by storing the standard and sample solutions in the dark and by avoiding long exposures to light during sample preparation for HPLC analysis.
- Vanillic acid and *p*-hydroxybenzoic acid were the only phenolic acids detected in soil solutions collected from the LTE rice fields during the season. The amount of *p*-hydroxybenzoic acid was generally larger than vanillic acid. Traces of vanillic acid were detected in varying amounts (up to 0.7 umolar) after transplanting and during the growing season. Up to 4.0 umolar *p*-hydroxybenzoic acid was measured much earlier, before transplanting, and amounts varied, depending on straw and water treatments.

Extraction of abscisic acid from leaves of wild rices

The phytohormone abscisic acid (ABA) is known to be a key factor regulating stress responses of plants, particularly in relation to water availability. It apparently acts as a signal of reduced water availability and hence is used as an indicator of plant tolerance for drought.

ASL provided consultation and training on HPLC and use of organic extraction facilities to Plant Physiology unit staff to assist them in their study of endogenous ABA in wild rices.

BIOMETRICS AND BIOINFORMATICS UNIT

Consulting

The biometrics group regularly assists with the design and analysis of trials and surveys for IRRI programs and collaborative partners. We have assisted with the analysis of multisite trials and in the design and randomization of multienvironment evaluation trials for northeast Thailand. Collaborators from India, Bangladesh, Thailand and Indonesia have visited the Unit for assistance with analysis and interpretation of research results. This consultation has resulted in coauthorship of several papers.

The following are some of the projects the Biometrics staff had been involved in:

1. Genetics of RTBV resistance in Balimau Putih and TN1 (EPPD)
2. First annual NRS survey (DAHR)
3. "Tubig at Palay" (CSWS)

Statistical research

- Comparison of methods of handling missing data in pattern analysis completed with Ms. Criselda Ramos who worked on her masteral thesis on this topic.
- Paper prepared on "A Modified Nonlinear Regression for Estimating the Linear and Quadratic Response Plateau Parameters" with Jonathan Quiton, Thomas George, and Russel Yost.
- Thesis topics on "The use of pedigree information in breeding programs" developed in collaboration with Ms. A. Raman, PhD scholar in BBU.

Biometrics training

Nine training courses were conducted for IRRI staff, trainees, and visiting scientists:

Course	Date	Participants (no.)
IRIS Training Course	5–9 Feb	17
EDDA-Online Course	19 Feb–16 Mar	21
Introduction to SAS	7–11 May	23
Categorical Data Analysis	4–8 May	14
Introduction to IRRISTAT	2–6 July	14
G x E Analysis of Data	6–17 Aug	11
Joint UP-IRRI Bioinformatics In-service Workshop	5–7 Nov	11
Internal Perl Computer Language Training Workshop	17–19 Oct	10
ARBN Workshop on DNA Microarrays & Bioinformatics	3–7 Dec	50+

Database development and deployment

- Design and status of the International Crop Information System (ICIS) reviewed in collaboration with ICIS partners.
- A network established for developing controlled vocabularies and common data exchange protocols for linking plant bioinformatics resources.
- An international workshop for ICIS developers hosted at IRRI.

- Tools developed for analysis of genetic relationships with linkage to characterization, evaluation,, and genetic data.
- Full Internet access to the Unternational Rice Information System (IRIS) established, while capacity for off-line partnerships maintained.
- Updated CD edition of IRIS published.
- Historical data for ecosystem-oriented INGER nurseries loaded to the data management system.
- Members of the South and Southeast Asia shuttle breeding networks trained on the use of IRIS applications to manage breeding programs.
- Historical data from shuttle breeding networks incorporated into IRIS.

Bioinformatics

- Mutant database established within IRIS with a WWW interface hosting trait directed queries.
- Prototype link between ICIS and NCGR ISYS established to transfer mapping information and allow use of the NCGR comparative mapping tool.
- International network of collaborative ties set up with bioinformatics ARIs in Canada, Europe, Japan, and the USA.
- Canada-CGIAR Linkage Fund grant awarded for "Functional Annotation of Rice Genome Sequences;" project exchange initiated.
- Intraweb-linked bioinformatics UNIX computation server commissioned.
- Work initiated on design and implementation of laboratory information management systems for functional genomics, including bar coding system.

COMMUNICATION AND PUBLICATIONS SERVICES

IRRI on the Web

IRRI's four Web sites—The IRRI Home site (www.irri.org), Riceweb, Riceworld, and the IRRI Library site—continue to grow in popularity. During 2001, about 224,000 visitors to the Web sites made nearly 1 million "hits," or movements within the sites. Clients downloaded nearly a quarter of a million files (usually pdf) of popular information products, such as installments of the discussion paper series, stories from the 2000-2001 annual report, sections of the *International Rice Research Notes* (*IRRN*) and annual program reports, and IRRI-developed software.

During the year, the Web sites were enhanced by the addition of

- electronic versions of the two 2001 issues of the *IRRN* (www.irri.org/irrn.htm), the 2000 Program Report (www.irri.org/00ProgramReport/00programreport.htm), and recent IRRI conference and workshop proceedings (www.irri.org/absidx.htm).
- new sections devoted to the International Rice Information System or IRIS (www.iris.irri.org), the Medium-Term Plan for 2002-2004 (www.irri.org/MTP2002-2004.html), a more user-friendly online publications catalog (www.irri.org/pubcat2000/pubcontents.htm), and an improved site for the Training Center (http://www.training.irri.org).

On the Intranet, the IRRI Photo Bank of nearly 5,000 images made its online debut for internal use by staff—for now. Availability of this media asset to external users is being considered. We are also looking into expanding the concept to the level of a shared system for either all Future Harvest Centers or a selected subset. Such a proposal was made to other Centers late in the year.

Traditional publications

CPS produced and distributed 19 titles, including 10 scientific books, four limited proceedings, two technical bulletins, one discussion paper, and two special publications. One scientific book, *Rice: nutrient disorders and nutrient management,* copublished with the Potash and Phosphate Institute (PPI), included an accompanying CD—our first such combination. Another title, *RiceIPM*, copublished with the Centre for Pest Information Technology and Transfer (CPITT)/University of Queensland, was our first release made solely as a CD. Due to budgetary constraints, two issues each (instead of three) of the *International Rice Research Notes* and *Rice Literature Update* were printed and distributed.

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 2001, the unit printed 1,375,503 pages of text, not including IRRI books, which were contracted out. About 6,384 original slides were produced and 699 black-and-white photographs were printed. IRRI graphic artists produced 84 illustrations, laid out 1,470 pages for publications, and prepared 112 posters. In addition to the work reported here, IRRI editors worked on 120 journal articles and miscellaneous papers (conference papers, proposals, and others) totaling about 2,476 pages of text, tables, and figures.

EXPERIMENT STATION

The Experiment Station (ES) served 199 requests for land and facilities. The planted field area totaled 233 ha. The Plant Breeding, Genetics, and Biochemistry Division remained as the biggest user of the farm.

Division	Dry season (ha)	Wet season (ha)
PBGB	76.92	78.48
GRC	16.24	3.11
CSWS	12.64	12.94
ES/AE	6.80	7.81
EPPD	5.75	6.17
CIAT	3.00	2.00
TC	1.50	–
Total	122.85	110.51

The ES provided support and maintenance services for the nurseries—9.70 ha (5.3 ha dry bed and 4.4 ha wet bed). Drybed nurseries were constructed with the use of a modified tractor-powered rototiller equipped with fluted rollers that mark the rows and furrows. Ammonium sulfate, complete fertilizers, muriate of potash, solophos, urea, zinc oxide, and zinc sulfate were used in the 2001 plantings. Total fertilizers used amounted to almost 70 t.

ES planted and harvested 14.44 ha of lowland fields for breeder seed increase and seed production materials. Where possible, crop establishment in seed production plots was mechanized using either the mechanical transplanter, the back-pack seed, or blower/spreader. Direct seeding was also done in some production plots. The Thai combine harvester was used in harvesting and threshing seed production plots and borders of experimental plots. Integrated pest management (IPM) was practiced on fields, resulting in no insecticide applications in some of the seed increase and seed production plots.

A total of 121 t of different rice materials were processed (threshing, drying, cleaning, and storing) during the year from harvests of seed increase, seed production, and border rows of experimental plots.

Compared with 2000, insecticide use was lower by 8%, while molluscicide use was reduced by 75%. While these reductions may be attributed to lesser incidence of snails and insect pests during the year, the associated benefits of maintaining fallow fields through dry tillage, water management, and weed control cannot be discounted. Herbicide use, on the other hand, increased by 12% as a result of increased application in fallow fields, perimeter areas, and levees. Application of sublethal doses of nonselective herbicide was done to reduce cost of mowing and brush cutting in maintaining fallow areas, levees, and perimeter fences.

Pre-plant and post-plant application of molluscicide was largely mechanized by the use of the Mudmaster, while preemergence application of herbicides was done using tractor boom and hand tractor sprayers.

ES also provided rat control services consisting of 1,714 baiting stations installed with 1,200 kg of rat baits for field and outreach areas. Likewise, 2.06 ha of bird nets and 83.16 ha of active barrier system (rat fences) with 1,351 live traps were installed. Some 11,413 rats were caught during the year.

Irrigation water was supplied in 70 ha of irrigated lowland areas, whereas 15 ha of uplands were irrigated using the overhead sprinkler system. Improvement in the irrigation system continued with the installation of 1,800 pieces of polyvinyl chloride irrigation pipes in Blocks G6-12, UD1-4, UF1-2, UM2-3, UN2-3, UP4, and UX1 and the installation of 1,950 cement pipes at the 100, 600-700, and 2,000 series and at UC1, UD1-4, and UV2. There were 654 manhole covers installed at the old and new lowland and upland areas. Five hundred and ninety eight units of drainage outlets were developed and constructed in both the new lowland and upland areas. A total of 19 gate valves were also replaced during the year.

Land development work consisted of conversion of upland to lowland fields in the 200, 900, and 2,000 series and in Blocks UD and UC (6.5 ha) and resizing of plots. This was done to meet the increasing demand of scientists for additional crop-growing areas. Land contours were also improved in the 10-ha upland areas in Blocks UM, UO, and UW to improve water use efficiency in the area. Excavation work for irrigation lines in UD, UF, UM, UR, and UX (900 m) and drainage excavation in UD, UF, and the 700 and 1000 series (1,300 m) were also done. Major road rehabilitation and repair work was carried out on 1,900 m of the main road of the old, lowland and upland area. Reshaping and backfilling of about 825 m of roadside, reservoir, parking lot, and retaining walls along creeks were done. Civil works included the construction of the 10-m Maitim bridge, the re-propping of 125 m of eroded river banks, and the installation of 1,700 m of fencing in the 300, 500, and 2000 series and Block UK reservoirs to improve aesthetics, efficiency, safety, and security in these areas.

Institutewide expenditure on contract work was 2% higher this year due to the salary increase implemented during the year. The bird boy expense was 2% lower than the previous year. On the other hand, total man-hour utilization of the institute was 5% and 2% lower than the previous year, respectively, for contract work and bird boy services.

Four hundred and fifty-eight requests for repair and maintenance of light and heavy equipment and implements were served. Extraction, repair, and installation of submersible pumps in the 100 series and Block UK were successfully done during the year. Fabrication works included frames for a 4-m furrower, 12-m boom sprayer for Mudmaster, and two units of irrigation pipe trailers. Installation and painting of the side railings of the newly constructed bridge were also carried out. Year-round repair and maintenance work for small farm equipment and machinery was provided.

To maintain a harmonious relationship with nearby communities, organizations, and institutions, the ES also served external requests for equipment and services. The various groups included the different departments of the University of the Philippines Los Baños, the UP Open University, and the municipalities of Los Baños and Bay.

To improve aesthetic appeal and extend the useful life of the ES buildings, renovation was done on the roof and support structures of the main service building. Refurbishment of the ES administration offices was also undertaken to modernize and improve efficiency and productivity in these areas.

Controlled growth facilites and grounds

The Controlled Growth Facilities and Grounds (CGFG) unit of the ES supported 30 experiments in the Phytotron, 113 experiments in the greenhouses/ screenhouses, and 17 experiments in the containment level-4 (CL-4) transgenic greenhouses. Six hundred and 300 maintenance service requests were served in the East Greenhouses and West Greenhouse, respectively. Eight thousand assorted pots were provided during the year.

A total of 890 t of soil was provided to meet various research requirements during the year. Improvement in the efficiency of soil grinding and hauling operations and in the reliability of soil supply even during the rainy season was achieved with the help of the newly acquired mini-dump truck, a new 10-hp soil-grinding machine, a new soil sterilizer, and the construction of a new soil-grinding shed in the upland farm.

The 2001 facility improvement program undertaken for the greenhouses included general repainting operations and glassroof replacements in at least three glasshouses and screen replacements for two screenhouses. A new UV-resistant polycarbonate roofing material was used and adopted as standard replacement material for the aging glassroofs in the greenhouses. Better light transmission, durability, lower costs in the long run, safe use, and ease in handling and installation were some of the advantages noted with the use of this material.

The annual shutdown for preventive maintenance operations in the Phytotron was shifted to November of each year. This new standard procedure 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.

The old and worn-out insulation of hot and cold water lines of the air-handling units (AHU) were replaced. Repair and replacement of rusted and worn-out I-beam supports of the glasshouse bays were also done during the shutdown period. The old inefficient condensers of chiller #1 as well as the old and defective compressor units were also replaced. Reverse osmosis (RO) grade water utilization at the Phytotron was 54,000 L for the whole year, while 1,006 requests for the use of the sample drying oven were served.

Routine ground maintenance and development operations were done year-round. Mass plantings and plant rejuvenation techniques were done to meet increasing demands for indoor ornamental plants. Concrete ponds were constructed for the maintenance and rearing of Japanese Koi fish populations being raised in the IRRI ornamental ponds. Isolated breeding tanks were also maintained to facilitate low-cost multiplication and hence eventually reduce or recover maintenance costs in the long run. Low-cost re-landscaping of some high-profile areas in the staff housing and research center was done to improve the aesthetic appeal of these locations. Grounds equipment were also upgraded to increase efficiency and reduce maintenance costs. Replacement acquisitions included a Kubota tractor, gang mower implements, push mowers, riding mowers, brush cutters, blowers, shredder machine, hand gadgets, and tool kits.

LIBRARY AND DOCUMENTATION SERVICE

To better serve the information needs of rice scientists all over the world, the Library provided improved access to electronic resources through its home page and online catalog. More than 200 links to vital internet resources were created. In the past year, 732 requests for literature and literature searches from 52 countries were provided either in electronic format via e-mail or through photocopies sent by snail mail. About 222 information requests from CGIAR centers were answered.

With the addition of 7,397 rice literature citations, the rice bibliography database now contains 195,719 records. Bibliographic records totaling 6,939 were added to the online catalog, which now has 67,654 entries. The rice dissertation collection grew by 267, with increased acquisitions from China, Korea, and Japan. The present library collection has a total of 123,594 titles. In addition, there were 1,346 active journal titles, most of which acquired as gifts and through exchange.

Worldwide distribution of the rice bibliography on CD-ROM was initiated.

As a result of the CGIAR-wide knowledge-sharing initiative, the Library is now an active member of the CGIAR Library and Information Services (LIS) Consortium, which is developing programs aimed at reducing costs of acquisitions and services. Active participation in the CGIAR-FAO Information Finder Project was also pursued.

In addition, the training of librarians from the Philippines and other developing countries continued.

VISITORS AND INFORMATION SERVICES

- IRRI strengthened its partnership with regional and national media, such as the Confederation of ASEAN Journalists in Singapore, and supported the activities of the Asia Rice Foundation, Asian Rice Media Advocacy Network, Rice Media Advocacy Network, Asia-Pacific Forum of Environmental Journalists, Environmental Broadcast Circle, Philippine Agricultural Journalists, Inc., and Philippine Foundation for Rural Broadcasters.
- Developed programs and organized interviews for more than 20 visiting local and foreign journalists including those from the *New Jersey Star Ledger*, *Mainichi Daily News*, and *Far Eastern Economic Review*, as well as for producers of science documentaries such as NHK of Japan.
- Thirty-five press releases and 13 photo releases were issued. Six major press releases and eight major photo releases were also placed in the Institute's Media Hotline Internet site. Two letters to the editor were issued in response to golden rice and biotechnology issues.
- A complete package of video on the arrival of golden rice at IRRI was produced and distributed to television stations in the Philippines, Japan, and to the "*60 Minutes*" TV show in the United States. The Institute also provided *TIME Magazine* with photographs on the handover of the first golden rice seeds to IRRI by co-inventors Dr. Ingo Potrykus and Dr. Peter Beyer.
- International press clippings with reference to IRRI or rice research totaled 69 including those from *TIME Magazine*, *The Weekend Australian Magazine*, *The Australian*, *Financial Times*, and *AGRIASIA*. National press clippings totaled 208 and website clippings, 89.
- Four *IRRI Hotline* issues were produced and distributed electronically via IRRI web sites. Seven issues of the in-house publication *Sandiwa* were distributed to IRRI staff.
- Produced/broadcast until first quarter of the year the science and information radio program *The IRRI Hour* in cooperation with the University of the Philippines Los Baños, College of Development Communication.
- Provided support to IRRI participation in various activities of the Los Baños Science Community and the municipal government of Los Baños.
- Handled 61, 325 visitors during the year, up by 22% from 49,759 in 2000, that included Her Excellency President Gloria Macapagal-Arroyo of the Republic of the Philippines and His Excellency Tran Duc Long, President of the Socialist Republic of Vietnam, six ambassadors, members of the diplomatic community, and 20 representatives of donor countries and international organizations, academic, and nongovernment organizations.
- Mounted two national and two international traveling exhibitions.
- Hosted and cohosted 24 regional and international conferences, workshops and symposia apart from the regular and special in-house seminars, workshops, and meeting reviews (see table on page 94). More than 700 representative delegates from at least 34 countries participated in regional and international conferences and workshops.
- Seven IRRI-funded community projects on solid waste management, bio-intensive gardening, monthly medical consultations, farmers' seminar on biotechnology, donation of books and computers, and neighborhood emergency services training implemented in barangays (villages) in IRRI's host province benefited hundreds of families and their dependents.

International and regional conferences, workshops, symposia, and meetings hosted or cosponsored by IRRI in 2001.

Date	Event	Venue	Number of	
			Participants	Countries represented
12-14 Jan	**Program Review on Validation and Delivery of New Technologies for Increasing the Productivity of Flood-prone Ricelands of South and Southeast Asia**	**Bangladesh**	**29**	**6**
14-20 Jan	Problem-based Research Planning for ICM Project	Indonesia	54	1
22-23 Feb	**ARBN Steering Committee Meeting**	**IRRI**	**13**	
26-27 Feb	Strategic Marketing Workshop	IRRI	23	1
26-28 Mar	**Initial Workshop on Development of a Diagnostic Key for Problems in Tropical Rice Crops**	**IRRI**	**11**	**3**
26-28 Mar	Development of a Diagnostic Key for Problems in Tropical Rice Crop Workshop	IRRI	11	3
26-31 Mar	**National Training on Needs and Opportunity Analysis for Planning ICM in selected sites in Indonesia**	**Indonesia**	**54**	**1**
2-3 Apr	IRRI-Country Representatives' Meeting	IRRI	13	7
29-30 Apr	**Farmer's Participatory Appraisal and Workplan Meeting**	**Bangladesh**	**62**	
3-4 May	Nepal-IRRI Research Dialogue	Nepal	72	2
10-11 May	**CIO-IRRI Strategic Alliance Meeting**	**France**		**2**
14-16 May	CIMMYT-IRRI Meeting on Functional Genomics of Drought Tolerance	IRRI	7	1
14-18 May	**ICIS Workshop**	**IRRI**	**42**	**14**
5 Jun	Interinstitutional Communication Workshop (ICW) 2001	IRRI	120	1
21-22 Jun	**Thailand-IRRI Workplan Meeting**	**Thailand**		**2**
27-28 Jun	East and Southeast Asia Regional Priority-setting Exercise	IRRI	37	16
17-18 Jul	**INGER Training-Workshop on Intellectual Property Rights**	**Thailand**	**38**	**19**
13-17 Aug	Finance and Administrative Staff Meeting	IRRI	16	10
23-28 Sep	**Review and Planning Meeting of Rodent Ecology Work Group**	**Vietnam**	**20**	**9**
5-12 Nov	Center-commissioned External Review (CCER) of the Consortia for Less Favorable Environment	IRRI	17	7
10-11 Nov	**5th Annual CORRA Meeting**	**Thailand**	**29**	**18**
12-15 Nov	Workshop on Data Analysis and Synthesis: Relationship Between Multiple Pests and Yields	China	11	7
3-7 Dec	**Microarray and Bioinformatics Training Workshop**	**IRRI**	**55**	**10**
10-11 Dec	Rainfed and Upland Rice Research Consortia Steering Committee Meeting	India	10	8

INFORMATION TECHNOLOGY SERVICES

Work in 2001 covered the following:

- Broadband Internet connection
- Firewall
- Storage area network with gigabit Ethernet backbone
- Outsourcing asset management, generation of an IT inventory
- Replacement of old servers
- Consolidation of PC procurement
- Introduction of online training materials

In July, IRRI dropped its leased line to the United States and substituted a higher bandwidth local Internet connection instead. The result was a dramatic improvement in Internet accessibility. The change was accompanied by the introduction of a firewall for IRRI's network to protect it from external hacking. This entailed reconfiguring every PC on the network, with the exact number unknown initially. A new IT inventory was prepared with the work outsourced to the IRRI user community. An IT plantilla was constructed from this (both to be audited in early 2002 and to be used for planning purposes thereafter). Both PC and server purchasing activities were consolidated and tendered for IRRI as a whole, as were storage systems and asset management services. The result was reduced cost and improved service for IRRI (Dell, our PC vendor, arranged to have on-site contract staff and service units for hardware at no added to cost to IRRI). The year also marked the first introduction of at-your-desk e-learning courseware on Microsoft Office 2000 applications.

Infrastructure

- Installation of additional fiber on campus, including redundant links between major buildings and replacement of last of old coaxial cable (at PBGB Headhouse)

- Replacement of leased line between ISH and IRRI with DSL circuit with 4-month payback time (pending installation of fiber optic link); redeployment of Cisco 2600 router as a backup router for IRRI's new Internet connection Addition of appliances to IRRINET (security cameras, swipe card readers, etc.)
- Tendering for fiber optic link to ISH
- Procurement of DSL equipment to extend network to Pleasant Village Apartments
- Deployment of new Cisco 3640 routers at IRRI and at PHNET (enabling connection of multiple Internet links)
- Installation of additional optical switches and activation of 2nd ports at ISH; completion of MDF facility at IRRI guesthouse
- IVDN leased line discontinued and replaced with 1 Mb local circuit (with Eastern Telecom)
- Deployment of IRRI firewall (Netscreen Technologies)
- Establishment of DMZ for publicly accessible systems at IRRI using a separate physical network
- Installation of rack servers (12) to replace jumble of different systems (list); racks deployed in CPS, Umali, and Finance Systems office
- Installation of large UPS system in CPS
- Construction of a separate high-performance (Gigabit) Ethernet network for storage traffic and deployment of a storage area network (SAN) based on a Network Appliance Filer F820 with ability to take timed snapshots and make online backup of mission-critical data
- Installation of new KVM (keyboard, video, mouse) technology in CPS to manage servers
- Establishment of dedicated IRRI mirror site in DMZ for data replication using APAN to mirror sites in Japan and China (uses Linux)
- Deployment of first wireless Ethernet technology at IRRI; to be extended to conference and meeting rooms in future
- India office now connected to Internet full time (reviewed proposals, negotiated solution)
- Deployment of network storage at ISH
- Directors migrated to laptops running Windows 2000, using offline folders for data synchronization
- Directors assisted in adopting Palm Pilot technology

Software development
- Creation of self-reporting IT asset inventory system
- Development of IRRI Internet address management system
- Deployment and assistance in evaluation of CIAT Project Manager software
- Development of telephone directory database used to generate both Intranet web pages and output for printed directory; now includes nicknames

Software applications
- Licensing SAS version 8 from institutional capital budget and deploying on a dedicated server on the network; it is now accessible (with client software) from anywhere on the campus, including homes of staff
- Licensing the Oxford English Dictionary Online Edition for IRRI and for the entire CGIAR (first ever CGIAR-wide software license; negotiated a very favorable price: $875 a year for about 5,000 desks)
- Licensing Promodag: a tool for helping analyze Microsoft Exchange mail traffic
- Development of a program for generating unique admin passwords capable of running on both PC and Palm Pilot

Services
- Registration of IRRI.CN, CGIAR.CN, IRRI.ORG.JP and CGIAR.ORG.JP
- Establishment of new incoming fax service with OCR translation for DPPC
- Outsourcing asset management services
- Collaboration on tender for CGIAR IT and communications services: generation and issuance of request for information (RFI) and (RFP)
- Introduction of T drive for temporary storage or transfer of electronic information
- Introduction of e-learning tools for Microsoft Office 2000 software; concessionary license obtained for 6 months, later converted on a concessionary basis to a CGIAR-wide license and a copy of the system installed at IRRI was set up on the IVDN at CGNET Services

Policy
- Development, with ITAC, of IRRI Network Users' Code of Conduct
- Assisted in introduction of new policies for support of IT skills training
- Implementation of tendering for major purchases at an institutional level instead of at organizational unit level
- Agreement of policy on consolidation of IT capital budget and procedures for deciding on charging for optional items
- Outsourcing of part of PC system setup and warranty repairs
- Outsourcing of desktop asset management services

- Server passwords of other units requested by ITS for the first time and held for emergency use (dealing with security threats)
- Switch to "organizational unit" and concomitant changes in systems as organizational structure is used in managing information
- Making presentations off the network (and burning CDs afterwards)
- Supplies: buffer stock of common items held by ITS and charged back
- Introduction of lease PCs for IRRI IRS and project scientists
- No procurement of stand-alone laser printers and few of other types
- Outposting of an ITTS staff to Finance to help with implementation of new financial system and related tasks
- Agreement to outsource classroom training reached; quotations obtained
- Removal of CD drives from minimum specification machine and replacement with external CD writers

Asset management/administration
- Office 2000 software coverage now exceeds 4xx computers
- PC hardware and software inventory automated with deployment of asset management software (Computer Associates AimIT)
- Software deployment automation initiated with deployment of asset management software (Computer Associated ShipIT)

Knowledge management(KM)/information sharing
- Participation in the 2nd CGIAR Knowledge Management Meeting, establishment of internal discussion group and sharing of KM-related information
- Production of "commercial" for the Organizational Change Program on use of KM at IRRI in creation of new phone book
- Addition of nicknames to IRRI telephone directory; greater consistency between telephone and email directories
- Regular submission of items to the *IRRI electronic bulletin* on use of IT facilities at IRRI
- Periodic bulletins to ISH residents
- Improvement of clearance form for departing staff
- Provision of detailed HR software specifications to Administration/Human Resources

Process innovations
- IRRI put its "seats" for anti-virus software up for bid by other centers. The result was competition within the CGIAR for IRRI's pariticipation in a deal and an eventual saving on price of about $10/seat/year on a recurring basis (for legal software).
- PC procurement was changed and simplified by issuance of "standard issue" equipment with each organizational unit free to upgrade or supplement at its own expense.

External activities
- First IRRI mirror web sites set up and creation of IRRI CD set (for presentation in Japan by DG)
- Participation in events in China (strategic planning for a proposed national agricultural information system and later national workshop on agriculture and IT) and Japan (APAN meeting)
- Participation in KM workshop and (zero output) CG IT Strategy Meeting

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Finances

Summary of financial support to the IRRI research agenda, 2001 (US$'000).

Asian Development Bank	655
Australia	1,537
Bangladesh	94
Belgium	150
Brazil	10
Canada	
Canadian International Development Agency	661
International Development Research Centre	49
China	130
Denmark	1,022
European Commission	1,862
France	512
Germany	
Federal Ministry for Economic Cooperation	181
Federal Ministry for Economic Cooperation/ German Agency for Technical Cooperation	677
India	150
International Fund for Agricultural Development	183
Iran	280
Japan	6,881
Korea	359
Netherlands	309
Norway	110
Philippines	122
Portugal	3
Rockefeller Foundation	788
Spain	25
Sweden	349
Switzerland	1,398
Thailand	26
United Kingdom	3,449
United States of America	
United States Agency for International Development	3,730
United States Department of Agriculture	194
World Bank	3,819
Others	233
TOTAL	**29,948**

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Weather summary

The climate in the year 2001 was relatively wet in the early part and unexpectedly dry in the later part. February was a rainy month during a dry season, with 11 rainy days, a value twice the number of rainy days during normal years in that period. September and October, months with normally high incidence of tropical disturbances, received 50% less rainfall than expected (Fig. 1a).

Annual rainfall for year 2001 was 2,034 mm for the IRRI dryland (upland) site and 1,895 mm for the wetland (lowland) site. These values were 228 mm higher than the long-term average rainfall for the upland site and 17.5 mm higher for the lowland site. Los Baños experienced twice as much rainfall in October this year, compared with the long-term amount. The wettest day at IRRI occurred 26 Jun with more than 103 mm rainfall per day. The longest recorded continuous wet spell was 10 d at the upland site (26 Jun-5 Jul) and 8 d at the lowland site (18-25 Oct). The longest continuous dry spell was 12 d at the upland site (12–23 Apr) and 16 d in the lowland site (7–22 Jan).

Mean monthly solar radiation reached a peak in April (more than 23 MJ m^{-2} d^{-1}) and gradually declined to 13 MJ m^{-2} d^{-1} in December (Fig. 1b). Solar radiation was relatively low during the first decade of July. The highest recorded cumulated solar radiation (28.8 MJ m^{-2} d^{-1}) occurred 2 May. The average duration of bright sunshine was about 9 h d^{-1} in April and declined to low values of 4 h d^{-1} in July. The longest record of sunshine at Los Baños was on 1 May with 12.0 h of bright sunshine.

Maximum temperature reached its highest monthly mean value in May (34.3 ºC at the upland site and 33.1 ºC at the lowland site), then gradually dropped to a lower monthly mean value in December (about 29 ºC in both sites). Throughout the year, the recorded averages of maximum temperature were very similar to the long-term average. The hottest day in Los Baños was on 6 May with 37 ºC of recorded maximum temperature at the upland site.

The distribution of minimum temperatures was more stable than that of maximum temperatures. Minimum air temperatures were generally higher than the long-term monthly averages from January until May. The coldest day for 2001 was 28 Dec in the upland site and 25 Nov in the lowland site, with both sites having a recorded temperature of 20 ºC.

Mean early morning relative humidity ranged from 81 to 89%. Midday vapor pressure deficit (Fig. 1d) was consistent with the long-term trend at the lowland site and stayed minimal at the upland site.

Daily mean windspeed, measured at 2-m height was 1.5 m s^{-1} for the upland site and 1.4 m s^{-1} for the lowland site. Windspeed was generally low (<2.0 m s^{-1}), except during tropical disturbances. Maximum 24-h average windspeed was 5.7 m s^{-1} at the upland site on 24 Sep.

Because of a slightly higher air temperature, lower amount of rainfall, and higher vapor pressure deficit at midday, free water evaporation at the upland site was slightly higher than at the lowland site. Open-pan evaporation totals were 1,651 mm at the upland site and 1,606 mm at the lowland site. These values were 327 mm lower than the long-term evaporation total at the upland site and 174 mm lower than the long-term evaporation at the lowland site.

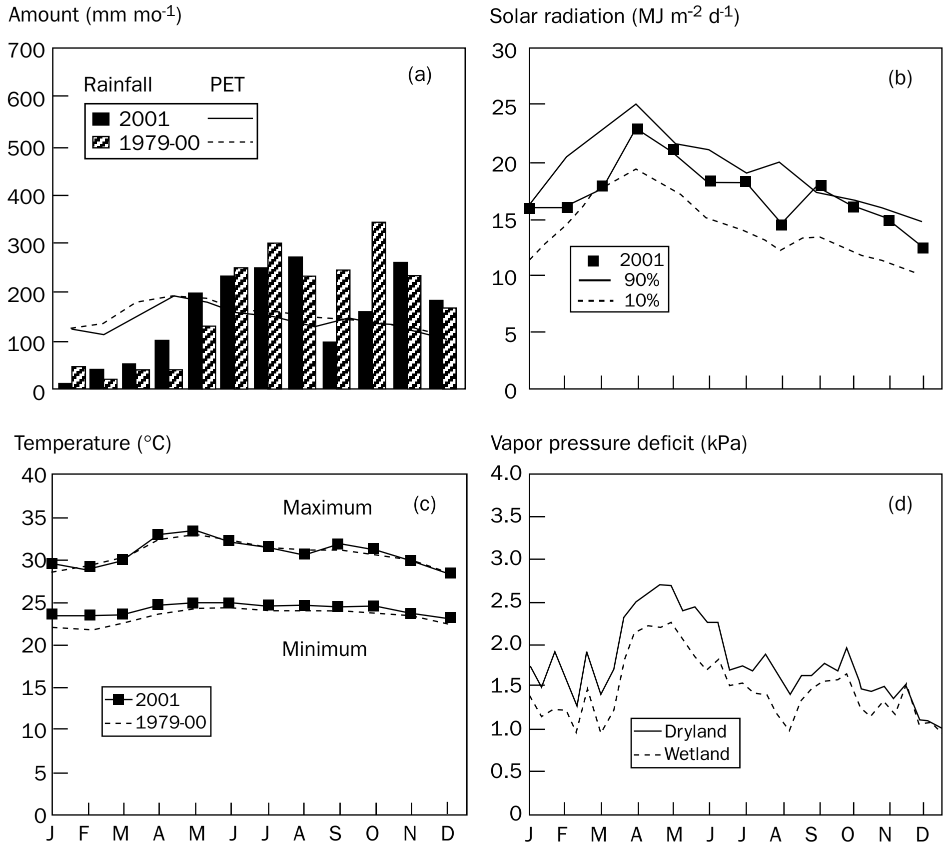

Fig. 1. Agroclimatic trends at IRRI for a) rainfall and potential evapotransporation, b) radiation, c) maximum and minimum temperatures, and d) vapor pressure deficit during 2001.

Table 1. Monthly weather data for IRRI stations in the Philippines, 2001.

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)		15	153	51	38	223	308	200	324	111	177	260	175	2034
IRRI, wetland site	(14°11' N, 121°15' E)		6	125	48	91	194	227	251	264	100	163	252	174	1895
								Solar radiation (MJ m⁻² day⁻¹)							
IRRI, dryland site			16.2	15.6	18.1	23.2	21.0	18.3	18.1	14.4	18.1	16.6	15.7	13.0	17.4
IRRI, wetland site			15.8	15.4	17.7	22.8	20.9	18.2	18.2	14.4	18.1	16.2	15.2	12.5	17.1
								Relative humidity (%)							
IRRI, dryland site			83	87	*82*	82	83	84	86	89	86	86	82	86	85
IRRI, wetland site			84	88	*83*	81	82	83	84	88	83	86	81	86	84
								Temperature (°C)							
IRRI, dryland site		Max	30.5	29.9	31.4	34.0	34.3	33.2	32.0	31.4	32.5	31.6	30.2	28.9	31.7
		Min	23.2	23.4	23.8	24.4	24.4	24.3	23.5	24.1	23.8	24.3	23.7	22.9	23.8
IRRI, wetland site		Max	29.2	28.7	29.9	32.9	33.1	32.1	31.4	30.8	31.7	31.0	29.6	28.2	30.7
		Min	23.5	23.5	23.8	24.7	25.0	24.9	24.3	24.7	24.4	24.5	23.7	23.1	24.2
								Windspeed (m s⁻¹)							
IRRI, dryland site			1.6	1.9	1.7	1.3	1.4	1.3	1.4	1.5	1.5	1.4	1.8	1.6	1.5
IRRI, wetland site			1.8	1.6	1.5	1.4	1.2	1.2	1.3	1.2	1.0	1.2	1.8	2.0	1.4
								Evaporation (mm mo⁻¹)							
IRRI, dryland site			130	114	154	193	182	138	144	120	139	126	120	91	1651
IRRI, wetland site			127	108	144	194	181	143	148	110	131	114	117	90	1606

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Jing Tan, *PhD, consultant*[4]
Enrique R. Angeles, *PhD, consultant*
Ma Guo-Hui, *PhD, consultant*[3]
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Ellen Tumimbang, *MS, consultant; assistant scientist I*[4]
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Jae-Ki Chang, *PhD, collaborative research fellow*[1]
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Alvaro M. Pamplona, *BS, assistant scientist II*
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Dante Adorada, *BS, assistant scientist I*[4]
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Modesto M. Amante, *MS, assistant scientist I*
Mark Dondi Arboleda, *MS, assistant scientist I*
Carlos L. Casal, Jr., *BS, assistant scientist I*
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Ruth E. McNally, *MS, assistant scientist I*[5]
Rhulyx O. Mendoza, *BS, assistant scientist I*
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Robert C. Ona, *BS, assistant scientist I*
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Jessica D. Rey, *MS*, *assistant scientist I*
Benito U. Romena, *BS*, *assistant scientist I*
Jose P. Roxas, *MS, assistant scientist I*
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Lina B. Torrizo, *MS*, *assistant scientist I*
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Elmer V. Aquino, *BS, researcher*[5]
Justina M. de Palma, *BS, researcher*[5]
Reycel M. Maghirang, *MS, researcher*[5]
Doris M. Mercado, *BS, researcher*[5]
Joie M. Ramos, *BS*, *researcher*[5]
Apollo Neil R. Monroy, *BS*, *researcher*[5]
Mark Tamerlane S. Nas, *BS*, *researcher*[5]
Eric L. Paragas, *BS, researcher*[5]
Ma. Ruby Sallan, *BS, researcher*[4]

Darlene L. Sanchez, *BS, researcher*[5]
Jason D. Talag, *BS, researcher*[5]
Ma. Theresa G. Sta. Cruz, *BS, researcher*[5]
Rosalie E. Lanceras, *BS, researcher*
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Leila H. Herbano, *BS, administrative coordinator*[8]
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Yolanda C. Aranguren, *BS, secretary II*[5]
Minerva B. Bandian, *BS, secretary II*
Nelie M. delos Reyes, *BS, secretary II*
Florie Hernandez, *BS, secretary II*
Emily P. Alcantara, *BS*, *secretary I*[5]
Lorelie S. Olivo, *BS*, *secretary I*[5]
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Virgilio M. Angeles, *research technician II*
Gener P. Aquino, *research technician II*
Renel C. Aventurado, *research technician II*[5]
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Orlando T. Lucero, *research technician II*
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Marina C. Manzanilla, *BS, research technician II*[5]
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Joselito Panting, *research technician II*
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Gil T. Tamisin, *research technician II*
Irma R. Tamisin, *research technician II*[5]
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Social Sciences

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Sushil Pandey, *PhD, deputy head and agricultural economist*
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Kam Suan Pheng, *PhD, GIS specialist*
Mercedita A. Sombilla, *PhD, policy economist*[13]
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Chu Tai Hoanh, *PhD, affiliate scientist*
Guy Trebuil, *IRS seconded from CIRAD*[4] *(based in Bangkok, Thailand)*
Francois Bousquet, *IRS seconded from CIRAD*[4] *(based in Bangkok, Thailand)*
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Joginder Singh, *PhD, visiting scientist*[3]
Bhanudeb Bagchi, *PhD, visiting scientist*[3]
B.A.A. Mustafi, *PhD, visiting scientist*[3]
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Ma. Isabel Ferino, *MS, assistant scientist*[7]
Fe B. Gascon, *MS, assistant scientist*
Alice Laborte, *MS, assistant scientist*
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Ma. Shiela Valencia, *BS, researcher*
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Angelina Malabrigo, *BS, senior secretary*[12]
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Ramil Gutierrez, *BS, secretary*
Shirley Raymundo, *BS, secretary*[1]
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Lauro R. Malihan, *AB, ES supervisor I*
Mario A. Mandilag, Sr., *ES supervisor I*
Apolinario B. Resurreccion, *ES supervisor I*
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Erlinda A. Oracion, *BS, administrative coordinator*
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Enrico A. Lucero, *secretary II*
Cecilio L. Villamayor, *secretary I*
Candido S. Solivas, *BS, lead research technician*
Isaias C. Abuyo, *lead research technician*
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Jose H. Sacdalan, *lead research technician*
Rolando D. Llorico, *lead research technician*
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Valentin C. Burgos, *lead research technician*
Nazario B. Timbol, *lead research technician*
Jesse C. Banasihan, *lead research technician*
Manuel B. Demontano, *equipment operator II*
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Nicasio V. Malabanan, *equipment operator II*
Leopoldo J. Mercado, *equipment operator II*
Marcial E. Pabalate, *equipment operator II*
Democrito A. Puma, *equipment operator II*
Francisco G. Calibo, *equipment operator I*
Edgardo B. Pamulaklakin, *equipment operator I*
Marcelo P. Torres, *equipment operator I*
Rolando G. Guevarra, *mechanic II*
Rogelio R. Pamulaklakin, *mechanic II*
Juanito M. Rosario, *mechanic II*
Efren E. Viquiera, *mechanic II*
Luzvimindo L. Mapiscay, *electrician I*
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Rolando R. Pacion, *stock assistant*
Romeo T. Llamas, *welder*
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Pedro C. Aala, *research technician II*
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Pedro C. Mendoza, *research technician II*
Ramiro C. Panting, *research technician II*
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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*
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*
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Danilo O. Amoloza, *research technician II*
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Melecio J. Arcillas, *research technician II*
Oscar L. Caspillo, *research technician II*
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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*
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Edgardo T. Diaz, *research technician II*
Quirino L. Atienza, *research technician I*
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Pedro E. Aquino, *BS, research technician III*
Gertrudo R. Arcillas, *research technician III*
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

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Joselito T. Guyo, *BS, instrumentation specialist*
Lilia R. Molina, *BS, researcher*
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Jose G. Rosales, *research technician III*
Edgar O. Amoloza, *research technician III*
Jesus S. Belen, *research technician II*

Biometrics and Bioinformatics Unit

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Violeta Bartolome, *MOS, statistical specialist*
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Arllet Portugal, *MS, database administrator II*
Luralyn Ramos, *BS, database administrator II*
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Genetic Resources Center

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Ma. Concepcion U. Toledo, *BS, assistant scientist II*
Ma. Socorro R. Almazan, *BS, assistant scientist I*
Amita B. Juliano, *BS, assistant scientist I*
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Minerva I. Macatangay, *lead research technician*
Bernardo P. Mercado, *lead research technician*
Bernardino T. Almazan, *research technician III*
Virgilio T. Ancheta, *research technician III*
Vicente M. Arcillas, *research technician III*
Emerlinda E. Hernandez, *research technician III*
Felix R. Llanes, *research technician III*
Virgilio P. Magat, *research technician III*
Gregorio M. Mercado, *research technician III*
Mario A. Rodriguez, *research technician III*
Ernesto C. Sumague, *research technician III*
Nelia A. Resurreccion, *BS, research technician III*
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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*
Arnold B. Gonzales, *research technician II*
Nestor P. Leron, *research technician II*
Jose M. Marasigan, *research technician II*
Honorio M. Oboza, *research technician II*
Renato T. Pizon, *research technician II*
Romulo R. Quilantang, *research technician II*
Florencio F. Villegas, *research technician II*
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Isabelita P. de Mesa, *BS, research technician I*[5]

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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]
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Marilyn G. Belen, *AB, data encoder*[4,5]
Leo G. Simpao, *data encoder*[5]

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Sylvia Katherine S. Lopez, *MS, CPS assistant manager II*
Teresita V. Rola, *BS, CPS assistant manager I*
Ginalyn H. Santos, *BS, web developer and multimedia designer*
Victor Alarcon, *BS, multimedia developer*
Ma. Guadalupe Y. Cardenas, *BS, technical writer/editor for multimedia*[4]
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Eva B. Ramin, *BS, CPS supervisor I*
Rogelio M. Alfonso, *CPS supervisor I*
Jose M. Ibabao*, video production supervisor*
Erlie E. Putungan, *BS, graphics designer*
Juan V. Lazaro IV, *graphics designer*
Grant L. Leceta, *graphics designer*
Emmanuel A. Panisales, *BS, graphics designer*
Lingkod C. Sayo, *BS, photographer*
Ariel Javellana, *BS, photography assistant*[4]
Rodolfo L. Carpio, *video specialist*
Lorenzo C. Santos, *BS, marketing assistant*
Reynaldo L. Stevens, *printer*
Romeo R. Dimapilis, *BS, sales assistant*
Rogelio R. Quintos, *BS, secretary II*
Susan A. Robles, *BS, secretary I*[1]
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George R. Reyes, *BS, secretary I*
Reynaldo G. Patulot, *office clerk*
Arleen A. Rivera, *office clerk*

Library and Documentation Service

Mila M. Ramos, *MLS*, *librarian*
Carmelita S. Austria, *MLS*, *assistant librarian*
Rene Manlangit, *BLS*, *assistant librarian*
Iris Marigold P. Operario, *BLS*, *acquisitions librarian*
Allan Crispulo R. Vallarta, *BLS*, *catalog librarian*[4]
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Maria Consuelo M. Salinas, *BS*, *library assistant II*
Kazuko Morooka, *BA, librarian (Japan Library Office)*[1]
Guido Talabis, *library assistant I*
Charlene R. Ramos, *BS*, *library assistant I*
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Mauro Malabrigo, Jr., *library assistant I*
Emmanuel Mendoza, *BS*, *Library assistant I*
Isagani P. Garcia, *library assistant I*
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Maria Aisa Atienza, *BS, library assistant I*[4]
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Information Technology Services

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Alexander B. Cosico, *BS*, *systems analyst/programmer*
Ma. Christina A. Visperas, *BS*, *systems analyst/ programmer*
Marlene M. Chang, *telecom administrator*
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Arturo L. Gonzales, *BS*, *computer technician*[1]
Analiza Q. de Roxas, *BS*, *secretary II*[4]
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Robert Hill, *consultant*[3]
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Joselito A. Platon, *BS, community project officer*
Estrella Castro, *BS, administrative coordinator*
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Pompe Sta. Cruz, *PhD, project scientist*[8]
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Lorenzo D. Ocampo, Jr., *BS, secretary I*
Priscilla P. Comia, *BS, secretary I*
Jennifer D. Hernandez, *BS, secretary I*[4]

International Programs Management Office

Headquarters-based

Mark A. Bell, *PhD, head*
Vethaiya Balasubramanian, *PhD, agronomist/CREMNET coordinator*
Abdul Karim Makarim, *PhD, project scientist*
Julian A. Lapitan, *MS, senior associate scientist and manager*
Antonio C. Morales, *MS, assistant scientist II*
Ma. Angeles Quilloy, *MS, assistant scientist II*
Margaret Ann S. Jingco, *BS, administrative coordinator*
Cecilia V. Lopez, *BS, administrative coordinator*[4]
Felicidad S. Danglay, *BS, secretary II*
Edna R. Reyes, *secretary II*
Ruperto D. Torres, *BS, research technician III*

Country-based

Bangladesh
Sadiqul I. Bhuiyan, *PhD, IRRI representative and water scientist*[1]
Noel P. Magor, *PhD, PETRRA project manager and IRRI representative*
Conrad Stevens, *PhD, consultant, Seed Health Improvement Project*[4]
M. A. Hamid Miah, *PhD, liaison scientist*[4]
Manik Lal Bose, *MS, consultant, Flood-prone Project*
Ahmad Salahuddin, *MS, PETRRA project officer*
M. A. Ghani, *PhD, PETRRA project research management officer*[4]
Tapash Kumar Biswas, *MS, PETRRA project monitoring and evaluation officer*
AKM Azad Chowdhury, *BS, technical/research officer*
Shaila Arifa Nabi, *MS, PETRRA project technical assistant*
Roucksana Begum, *MS, PETRRA project facilitator*[4]
Salim Ahmed, *BA, office manager*
Jamila Khandekar, *MBA, finance officer*
Tahmina Banu, *MCom, accounts assistant*
Alphonse Prodip Bashu, *MCom, accounts assistant*
Atiquzzaman, *accounts assistant*[4]
Shahjadi Parvin, *BA, administrative assistant*
Shamima Sultana, *MA, administrative assistant*
Fouzia Sultana, *MA, receptionist-cum-inventory assistant*
Mohammad Samad, *office assistant*
S.M. Sujat, *office attendant*
Jopinath Bazi, *driver*
Mohammad Jamal, *driver*
Mohammad Naseem, *driver*
M. Alim Ullah, *guard*
Fazlu Miah, *guard/gardener*
Mohammad Ahsan Ullah, *driver*
M. A. Mazid, *guard*

Cambodia
Harry J. Nesbitt, *PhD, agronomist and team leader*
Peter G. Cox, *PhD, agricultural economist*[1]
Lorelei Domingo, *BS, administrative coordinator/cashier*
Huy Lisa, *driver*
Ek Sokhim, *guard*
Hul Choeun, *guard*
Im Thay, *guard*
Ou Bora, *guard*
Yong Savoeun, *guard*

CONSULTANTS
Brad Collis, *journalist/photographer*[3]
Judie Coultas, *BS, business entrepreneur consultant*[3]
Michael Coultas, *business consultant*[3]
Kun Thyda, *PhD, HRD policy consultant*[3]
Roger Mauldon, *PhD, socioeconomic consultant*[3]
Joanne Moller, *socioeconomic consultant*[3]
Wendy Morgan, *PhD, integrated pest management consultant*[3]
Simon Moore, *BS, scientific writer*[3]
Courtney Norris, *impact study assessment on NGO*[3]
Santiago Obien, *PhD, corporate planning and HRD policy consultant*[3]
Don Puckridge, *PhD, history of CARDI writer*[3]
Edward Smith, *BS, fisheries advisor*[3]
Neil Urwin, *environmental consultant*[3]
Ken White, *website design consultant*[3]
Peter White, *PhD, soil consultant*[3]
Tim Wrigley, *environmental consultant*[3]

SECONDED FROM THE MINISTRY OF AGRICULTURE, FORESTRY, AND FISHERIES
Chan Phaloeun, *MS, farming systems agronomist*
Chea Sareth, *BS, farming systems assistant*[2]
Chet Kim Ngoy, *BS, plant breeding assistant*
Chhorn Nel, *BS, crop protection assistant*[2]
Hin Sarith, *MS, soil research assistant*[3]
Hun Yadana, *BS, plant breeding assistant*
Kearn Meth, *MS, administrative deputy chief*[4]
Kep Poch, *BS, farming systems assistant*
Khay Sathya, *BS, training assistant*
Khiev Bunnarith, *BS, research assistant*

Khun Leanghak, *BS, co-chief of station operations*[2]
Lang Mondul, *BS, training assistant*[2]
Lor Bunna, *BS, glasshouse supervisor*[2]
Mak Solieng, *PhD, social scientist*[2]
Meas Pyseth, *MS, agricultural engineer*
Men Sarom, *PhD, plant breeder*
Mot Sana, *BS, social science assistant*[2]
Ny Vuthy, *PhD, crop protection*[4]
Ouk Makara, *MS, plant breeder*[2]
Pao Sinath, *BS, agricultural engineer*
Pheav Sovuthy, *MS, soil scientist*[2]
Pheng Sophea, *MS, crop protection*[2]
Pith Khon Hel, *BS, plant breeder*
Pol Chanthy, *MS, crop protection assistant*
Preap Visarto, *MS, crop protection*[2]
Ros Chhay, *PhD, soil scientist*
Sakhan Sophany, *MS, research assistant*
Say Puthea, *Dipl., director of station operations*
Sek Kim Sem, *agricultural engineer assistant*
Seng Vang, *PhD, soil scientist*
Sum Bunna, *MS, agricultural engineer*[2]
Suon Vanny, *MS, research assistant*[2]
Theng Vuthy, *BS, farming systems assistant*[2]
Ty Channa, *MS, head of training*
Ung Sopheap, *BS, co-chief of station operations*
Kim Rany, *administrative assistant*[2]
Ly Somonea, *BS, administrative assistant*[2]
Sim Theavy, *administrative assistant/accountant*[2]
Sok Songly, *administrative assistant*
Prou Nhet, *driver*
Sam Simeth, *driver*
Teng Touch, *driver*[1]
Thap Sokhun, *driver*
Van Sarom, *driver*
Sam Simeth, *driver*
Kong Hun, *guard*
Ouk Samphors, *guard*
Oum Phirun, *guard*[1]
Sok Sovannarith, *guard*

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

India
R.K. Singh, *PhD, IRRI representative*
Jamal Pervez Noor, *BCom, finance and administrative officer*
Tara Chand Dhoundiyal, *BS, travel assistant*[1]
Nikhil Juneja, *BA, office clerk (travel)*[4]
Chander Mohan, *BCom, office clerk*
Savita Sharma, *BA, steno typist*
Soban Singh Topwal, *driver*[1]
Raj Kumar, *driver*[1]
Vinod Kumar Singh, *driver/utility man*[4]
Ayodhya, *driver/utility man*[4]

Indonesia/Malaysia/Brunei Darussalam
Mahyuddin Syam, *MPS, communication specialist and liaison scientist*
Francisca Herjati, *Dipl, executive secretary*
Bambang Soewilanto, *BS, administrative assistant*
Iwan Adidharmawan, *BS, accounting supervisor*
Diah Wurjandari Soegondo, *BS, researcher*
Darman, *driver*
Endang Suhendi, *driver*

Japan
Hiroyuki Hibino, *PhD, liaison scientist*
Kazuko Morooka, *BA, librarian*[1]

Lao PDR
John Schiller, *PhD, team leader/research programmer*[1]
Karl Goeppert, *MS, project team leader and IRRI representative*[4]*)*
Bruce Linquist, *PhD, upland agronomist*
Kouang Duangsila, *IRRI coordinator*
Sone Mosky, *training officer*
Bouachanh Keopha, *administrator*
Ounheunane Phouthachit, *administrator/accountant*
Sansai Samountry, *accountant*
Bounmy Sengthong, *JPO project assistant*
Kham Souk Mosky, *driver-general services*
Khamphay Onesanga, *driver*
Samien Luanglath, *guard/cleaner*
Chanh Sommaniphone, *guard*
Done Srithinath, *guard*

Myanmar
Tin Hla, *PhD, IRRI coordinator*
R.P. Kaushik, *PhD, project scientist*[1]
Ohnmar Tun, *BS, administrative coordinator*
Myint Soe, *driver*

Thailand
Boriboon Somrith, *PhD, IRRI representative*
Dome Harnpichitvitaya, *MS, researcher*
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*
Phikul Kitprasong Leelagud, *BS, office clerk*
Amporn Sookyong, *utility person*
Pipat Buntham, *BS, field technician*
Chusak Kartipatee, *field technician*
Charoenchai Morakotkheaw, *field technician*
Sompong Pachanapool, *field technician*
Chaiporn Soising, *field technician*
Gaisorn Tanupant, *field technician*[4]
Pramote Tanupant, *BS, field technician*
Surat Taweesin, *driver/mechanic*[1]
Thavil Sukrak, *driver*

Vietnam
Nguyen Thanh Huyen, *BS, administrative officer*
Nguyen Hoai An, *BS, accountant*[4]
Nguyen Huu Hai, *driver/office assistant*

Director General's Office

Sylvia R. Arellano, *BS, DG assistant*
Maura K. Lago, *BS, secretary II*
Anna Christine A. Doctolero, *BS, secretary I*

Office of the Deputy Director General for Research

Adonna M. Robles, *MS, program coordinator*
Lucia V. Gamel, *AB, executive secretary*
Ana Lyn Genil, *BS, secretary I*[4]

Office of the Deputy Director General for Partnerships

Ramon A. Oliveros, *MS, assistant manager II*
Alma Bernardo, *BS, administrative coordinator*
Carolyn N. Wangdi, *secretary I*

Office of the Director for Program Planning and Coordination

Corinta Q. Guerta, *MS*, *senior associate scientist*[8]
Monina S. La'O, *BA, assistant manager I*[4]
Eric B. Clutario, *BS, database administrator*[4]
Alberto Aguilar, *BS, administrative coordinator*[1]
Marisol Camasin, *BS, office clerk*

Partnerships Development Office

David M. Ingles, *MM, partnerships development officer*

Intellectual Property Management Unit

Thanda Wai, *PhD, intellectual property specialist*[4]

Finance

Mario F. Ocampo, *MBA, senior manager*
Elisa S. Panes, *BS, senior manager*
Melba M. Aquino, *BS,senior manager*
Loriza E. Dagdag, *BS, senior manager*[4]
Leonisa M. Almendrala, *BS, assistant manager II*
Nestor C. Lapitan, *BS, assistant manager II*
Cedric C. Joson, *BS, assistant manager II*[1]
Leny M. Medenilla, *BS, budget supervisor II*
Eleah R. Lucas, *BS, budget supervisor I*
Rolando T. Ramos, *BS, cash supervisor II*
Julie C. Carreon, *BS, cash supervisor II*
Baby Ruth A. Rillo, *BS, accounting supervisor II*
Imelda S. Silang, *BS, accounting supervisor II*
Miriam M. Telosa, *BS, accounting supervisor II*
Cristina Sta. Romana, *BS, accounting supervisor II*
Ma. Judy M. Anicete, *BS, accountant II*
Helen R. Aquino, *BS, accountant II*
Gemma N. Corcega, *BS, accountant II*
Tony C. Deza, *BS, accountant II*
Rodelita Dollano, *BS, accountant II*
Ailene R. Garcia, *BS, accountant II*
Lily R. Go, *BS, accountant II*
Jonalyn R. Gumafelix, *BS, accountant II*[4]
Leonor Herradura, *BS, accountant II*
Reymunda C. Labuguen, *BS, accountant II*
Alvin C. Leal, *BS, accountant II*
Nestor Marcelo, Jr., *BS, accountant II*
Clarissa B. Mateo, *BS, accountant II*
Juancho N. Pangilinan, *BS, accountant II*
Arsenio L. Valeriano, Jr., *BS, accountant II*[1]
Maria Zenaida V. Borra, *BS, accountant I*
Christina D. Casanova, *BS, accountant II*
Charlene F. Dalmacio, *BS, accountant*[4]
Paulito J. Oleta, *BS, accountant I*
Grace P. Pascual, *BS, accountant I*
Mary Grace P. Rayco, *BS, accountant I*
Marilyn Ignacio, *data encoder*
Flordeliza Lopez, *BS, data encoder*
Malaya Salas, *BS, data encoder*
Vilma T. Ramos, *BS, executive secretary*
Ma. Theresa M. Sevilla, *BS, secretary II*
Noel T. Lantican, *BS, secretary I*
Vilma C. Maligalig, *BS, secretary I*
Roderick B. Maligalig, *BS, secretary I*

Office of the Director for Administration and Human Resources

Charito G. Medalla, *BS, executive secretary*
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, HR-national staff manager*
Manuel H. Zaragosa, *BS, employee relations manager*[3]
Lilian M. Mendoza, *MS, employee relations manager*[4]
Eloisa V. Revilla, *BS, psychometrician*
Sylvia P. Avance, *BS, HR specialist*[18]
Gladys Faith Tan, *BS, HR specialist*[4]
Alma C. Cedillo, *BS, orientation assistant*[3]
Joan L. Belsonda, *AB, gender and diversity assistant*
Alfredo R. Reyes, *BS, HR benefits assistant*
Aida A. dela Rea, *BS, medical technologist*
Remedios J. Bondad, *BS, HR assistant*
Ma. Francisca R. Gallivo, *HR assistant*
Larry Montermoso, *HR assistant*[4]
Iluminada B. Oleta, *BS, secretary II*

Materials Management Services
Ramon Guevara, *MBA, manager*[1]
Frisco L. Guce, *MS, manager*[4]
Generoso San Felipe, *BS, MM assistant manager II*
Felicisimo Kalaw, *BS, MM supervisor II*
Zenaida Belarmino, *BS, purchaser*
Lourdes Belison, *BS, purchaser*
Nerisa Gutierrez, *BS, purchaser*
Luzviminda Oleta, *BS, purchaser*
Conception Elybeth Alcantara, *MBA, MM assistant*
Anatolio Magampon *BS, property disposal assistant*
Irineo Esguerra, *warehouseman*
William Estrellado, *warehouseman*
Ernesto Nimedez, Jr., *BS, warehouseman*
Jose Sibal, *warehouseman*
Priscilla Cabral, *BS, shipping assistant*
Macario Beato, *documentation and cargo handling clerk*
Francisco Quilloy, *materials expediter*
Dionisio Dumlao, *MM, attendant*
Delfin Lacandula, Jr., *MM attendant*
Edison Samonte, *MM attendant*
Fred Angeles, *fuel attendant*
Maureen Cabarrubias, *data encoder*
Jane Carlos, *data encoder*
Anicia Malabanan, *data encoder*

Legal Services
Walfrido E. Gloria, *MBA, manager*
Cherryl M. Cruz, *BS, secretary II*

Central Registry Services
Remedios E. Ballesfin, *BS, administrative coordinator*
Angelica P. Valintos, *BS, administrative coordinator*
Wilmer B. Jacob, *office clerk*
Roberto T. Paz, *office clerk*
Louell R. Tanzo, *BS, central files assistant*
Felix C. Estipona, *Makati office assistant*

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*
Erenita Gabriel, *MEd, FHS supervisor I*[4]
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*
Rogelio P. Granzore, *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*
Crisanto P. Dawinan, *BS, nurse*
Rowena L. Natividad, *BS, secretary*
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, manager*
John Arturo M. Aquino, *BS, vehicle repair shop supervisor*
Ariel B. Nuque, *BS, MVRS coordinator*
Nelson C. Tagle, *dispatching section supervisor*
Reynaldo G. Elmido, *MPDS dispatcher*
Sesinando B. Guerta, *MPDS dispatcher*
Bonifacio M. Palis, *MPDS dispatcher*
Carlito C. Cabral, *MPDS assistant*
Perlita E. Malabayabas, *BS, secretary II*
Jaime D. Atienza, *mechanic II*
Romeo L. Jarmin, *mechanic II*
Armando E. Malveda, *mechanic II*
Roduardo S. Quintos, *mechanic II*
Edwin S. Cabarrubias, *mechanic I*
Roger M. Cuevas, *mechanic I*
Mabini M. Linatoc, *mechanic I*
Ronilo M. Villanueva, BS, mechanic I
Danilo G. Abrenilla, *driver*
Crisencio L. Balneg, *driver*
Rolando A. Cabrera, *driver*
Amador L. de Jesus, *driver*
Roberto C. Delgado, *driver*
Rodrigo M. Fule, *driver*
Diosdado D. Mamaril, *driver*
Reynaldo P. Martinez, *driver*
Hernani M. Moreno, *driver*
Eduardo L. Pua, *driver*
Angelito C. Quijano, *driver*
Danilo C. Sanchez, *driver*
Oscar A. Templanza, *driver*
Renato C. Vivas, *driver*
Emilio R. Gonzales, Jr., *AC mechanic*

Physical Plant Services
Douglas Avila, *BS, manager*
Alfredo Mazaredo, *MS, manager*
Enrique delos Reyes, *BS, manager*
Alberto Adviento, *BS, PP supervisor II*
Emmanuel Eusebio, *BS, PP supervisor II*
Jaime Fojas, *BS, PP supervisor II*
Fernando Madriaga, *BS, PP supervisor II*
Nestor Malabuyoc, *BS, PP supervisor II*
Nilo Barraquia, *BS, PP supervisor I*
Domingo Escasura, *PP supervisor I*
Jaime Angeles, *BS, PP supervisor I*
Teodoro Carreon, *PP supervisor I*
Crisencio Custodio, *PP supervisor I*
Tiburcio Halili, *PP supervisor I*
Rodolfo Calibo, *lead PP technician*
Fidel Alvarez, *carpenter*
Rodrigo Castillo, *BS, carpenter*
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*
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*
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*
Cesar Padonan, *electrician II*
Rolando Simon, *electrician II*
Marissa Templanza, *BS, administrative coordinator*
Benita M. Pangan, *BS, office clerk*
Larry Salgado, *BS, drafting technician*
Manuel Alforja, *welder/tinsmith*
Apolinario Armia, *welder/tinsmith*
Anito Mabalhin, *welder/tinsmith*
Percival Leon, *physical plant assistant*
Francisco Ador, *mason*
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 Agricultural Engineering Unit.
[7]Transferred from Biometrics Unit.
[8]Transferred from Crop, Soil, and Water Sciences Division.
[9]Died during the year.
[10]Appointed Director for Program Planning and Coordination.
[11]Transferred from Genetic Resources Center.
[12]Transferred from the Office of the Deputy Director General for Research.
[13]Transferred from Donor Relations Office.
[14]Transferred from Plant Breeding, Genetics, and Biochemistry Division.
[15]Transferred from Finance.
[16]Continues to serve as special adviser (ad hoc basis).
[17]Transferred from Human Resources.
[18]Transferred from Training Center.
[19]Transferred from Information Technology Services.

Rice Science for a Better World

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