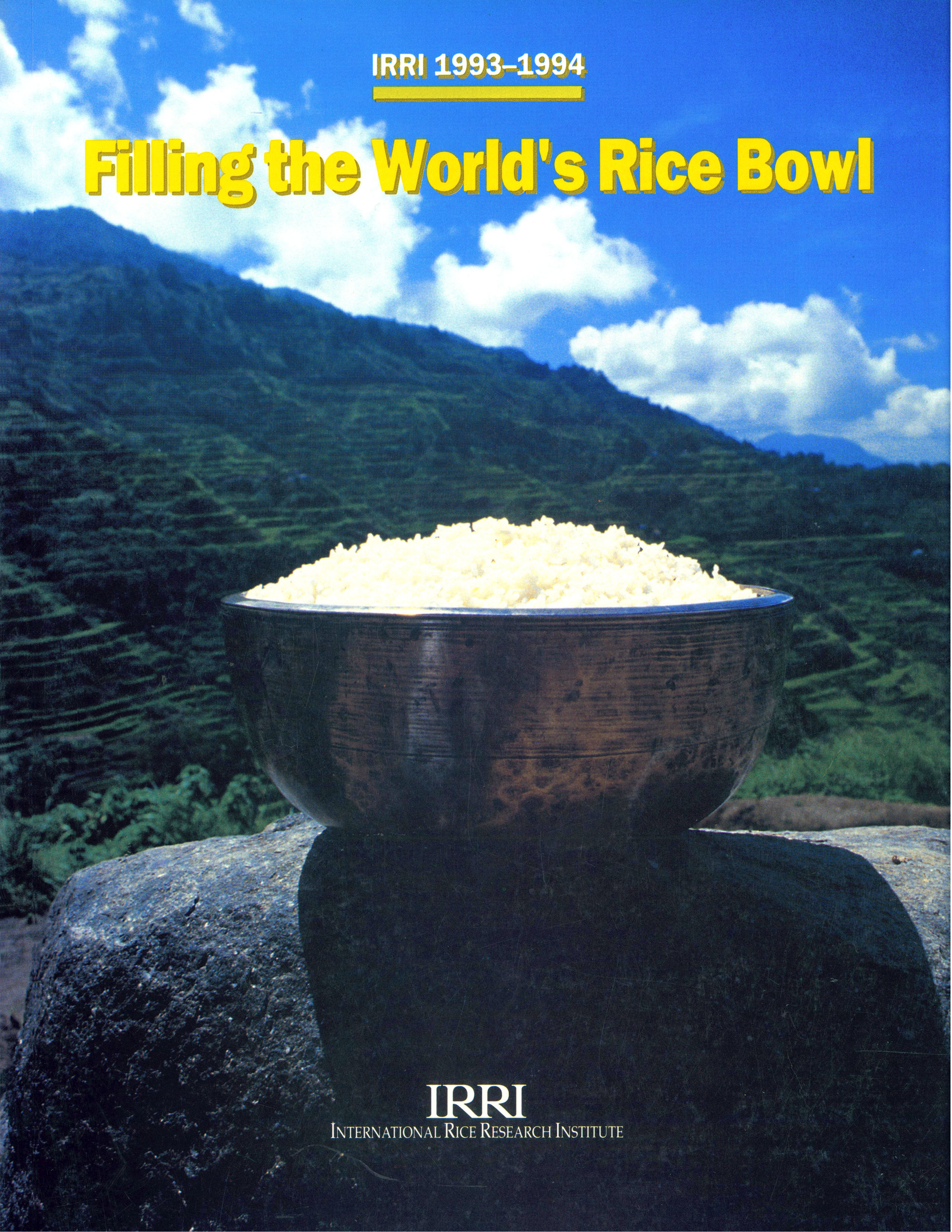
IRRI 1993–1994

Filling the World's Rice Bowl



IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

This illustration comes from a set of 15 drawings of unhulled rice grains donated to IRRI by eminent Japanese sculptor and artist Mitsuaki Tanabe in December 1993. He donated the drawings along with a stainless steel sculpture of a grain of wild rice-all from his “Momi” series. “Momi” is the Japanese word for an unhulled grain of rice. The artist feels a deep spiritual relationship with rice, and he has been commissioned to prepare another major sculpture in wood of a germinating rice seed for the new Learning and Visitors Center that IRRI is establishing.

Momi Series 1993

“In the “Momi” series I always wish to create something I can dedicate to the people of the many lands where rice is grown—something that may be considered an extension of their environment. My work aims to stimulate them with a sense of living.”

Mitsuaki Tanabe

IRRI's Mission Statement

Our Goal
To improve the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes.

Our Objectives
To generate and disseminate rice-related knowledge and technology of short- and long-term environmental, social, and economic benefit and to hdp enhance national rice research systems.

Our Strategy
We pursue our goal and objectives through:
- interdisciplinary ecosystem-based programs in major rice environments
- scientific strength from discipline-based divisions
- anticipatory research initiatives exploring new scientific opportunities
- conservation and responsible use of natural resources
- sharing of germplasm, technologies, and knowledge
- participation of women in research and development
- partnership with farming communities, research institutions, and other organizations that share our goal

Our Values
Our actions are guided by a commitment to:
- excellence
- scientific integrity- and accountability
- innovation and creativity
- diversity of opinion and approach
- teamwork and partnership
- service to clients
- cultural and gender diversity
- indigenous knowledge
- environment protection

Contents

Acronyms and abbreviations used in this report

ARFSN	Asian Rice Farming Systems Network
ASSP	Agricultural Support Services Project
BMZ	Der Bundesminister fur Wirthasliche (Germany)
BRRI	Bangladesh Rice Research Institute
CGIAR	Consultative Group of International Agricultural Research
CIDA	Canadian International Development Agency
CREMNET	Crop and Resource Management Network
CSIRO	Commonwealth Scientific Industrial Research Organisation
DOASL	Department of Agriculture, Sri Lanka
EC	European Community
ECSA	Eastern, Central, and Southern Africa
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FOFIFA	Foibe Fikarohana Ampiharina amin-ny Fampandrosoana ny Ambanivohitra (National Center for Applied Research on Rural Development—Madagascar)
GEF	Global Environmental Facility
GTZ	Gesellschaft fur Technische Zusammenarbeit (Germany)
ICAR	Indian Council for Agricultural Research
ICLARM	International Center for Living Aquatic Resources Management
ICRAF	International Center for Research in Agroforestry
IDEAL	Initiative for Development of Environmental Alliances through Leadership
IDRC	International Development Research Centre (Canada)
IFAD	International Fund for Agricultural Development (Rome)
IIMI	International Irrigation Management Institute
INGER	International Network for Genetic Evaluation of Rice
INSURF	International Network on Soil Fertility and Sustainable Rice Farming
IPM	Integrated Pest Management
JCIE	Japanese Center for International Exchange
NARS	National Agricultural Research Systems
NRI	Natural Resources Institute
ODA	Overseas Development Administration
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer (France)--*Now known as* Institut Francais de Recherche Scientifique pour le Developpement en Cooperation (French Institute of Scientific Research for Development)
Lao PDR	Lao People's Democratic Republic
PhilRice	Philippine Rice Research Institute
RDA	Rural Development Administration (Korea)
RF	Rockefeller Foundation
SARP	Systems Analysis and Simulation for Rice Production
UCL	Universite Catholique de Louvain
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
UV-B	Ultraviolet-B
WARDA	West Africa Rice Development Association
WAU	Wageningen Agricultural University

IRRI in Brief—1993-1994

- IRRI replanned, restructured, reframed and reorganized to meet future needs
- *Rice Research in a Time of Change*—IRRI's Medium-Term Plan for 1994-1998 published
- Sixteen IRRI breeding lines from the irrigated rice breeding program named as varieties in nine countries, bringing the total number of IRRI breeding lines named as varieties throughout the world to 252
- Two IRRI-derived salt-tolerant cultivars identified by the Philippine Seed Board for prerelease
- IRRI's Genetic Resources Center became responsible for the international rice genealogy data base; 2,900 records on crosses in Korea and 18,000 hybrid records from latin America now added to data base
- Genebank collections increased to 74,700 Oryza sativa samples, 1,330 O. glaberrima and 2,216 wild species; accessions of Oryza sativa distributed to institutions in 29 countries
- Use of biotechnology allowed successful transfer of valuable genetically controlled features (such as resistance to diseases) into existing high-yielding rice lines
- Sheath blight, and matching the nitrogen supply to crop demand focused on as major factors in sustaining yields in intensively cropped ricefields
- Emphasis continued on using computer modeling to design new plant types with higher yield potential: results from manipulating configurations of rice plants supports predictions
- Scientists of the Rainfed Lowland Rice Research Consortium evaluated 880 breeding lines for the variable environments of the rainfed lowland ecosystem
- Rainfed Lowland Rice Research Consortium research revealed important chemical processes that improve the tolerance of rice to excess water
- Upland Rice Research Consortium research indicated opportunities for using indigenous fungal pathogens for biological weed control
- Improved upland rice varieties showed considerable promise, particularly in Indonesia and Vietnam
- Elite lines developed for use in flood-prone areas, and provided to Cambodia, Myanmar, and Vietnam, performed well
- integrated pest management approach had considerable impact in Vietnam and other countries
- A combined biological, medical, sociological study produced significant new information about the effects of pesticides on people
- Scholars from 29 countries participated in IRRI degree or postdegree training programs; trainees from 19 countries participated in 10 group courses
- International symposium on Climate Change and Rice hosted by *IRRI;* 41 conferences, workshops and meetings also hosted or cosponsored
- Twelve scientific books published, some as dual imprints with commercial scientific publishers; approximately 56,000 copies of major IRRI publications distributed worldwide
- IRRI's library renovated and upgraded; its monograph collection now numbers 105,500

Preparing the World's Rice

Fifty years ago, the second world war was coming to an end—good reason to celebrate. Fifty years from now, we will be in the middle of the next century. Then the world will have to feed 10 billion people or more, half of them in Asia, and half of them rice eaters. This does not look like a reason to celebrate-not from today's viewpoint.

Right now, the world is not prepared for such a challenge. Not only must people be fed, more than another two billion must have employment opportunities, gainful employment that ensures a life of dignity. Even now one billion people, or about 20 percent of the global population, can only dream of such. a life.

Can the world just wait for a solution to turn up? It definitely cannot—especially when it comes to a staple food like rice, upon which the daily existence of more than two billion people depends.

Even if most of us do not yet feel the effects in our own daily lives, our generation will be held responsible for the most reckless, devastating, life-endangering attitude that people have ever adopted towards the natural resources on which life on our globe depends. The wealth and

Philippines E. Masferre

Bowl for the Next Century

lifestyle of those on the upper deck, the one fifth of the world's population living comfortably, is being funded in most cases not by newly generated income and resources, but by literally eating up what, only too often, Nature has created and developed over millions of years.

For example, at today's rate of consumption our known resources of phosphates, an irreplaceable and valuable natural fertilizer, will be completely depleted in about 150 years. Given the history of man, what is 150 years?

Our generation's irresponsible attitude toward its world, especially during the second part of this century, has led to the erosion and depletion of soil and water resources, the loss of forest cover and riceland and the disappearance of endangered species, as reported by the United Nations Conference on Environment and Development (UNCED) in 1992 in Rio.

Rice, that crucial grain, is an integral part of human history, tied to us in countless traditions, interwoven in the oldest religious rites. We rightly say rice "culture" since this life-giving grain is part of human cultural evolution. Rice is the wood's only crop planted by emperors and kings, offered to the Gods and eaten

U.S.A., R. Kendrick

by both the wealthiest and the poorest. Rice is more than simply a food composed of carbohydrate, protein, fat, and. micro-nutrients. It has been a companion of humankind for more than 7000 years, back beyond our knowledge, beyond our imagination.

Rice is but one of between 5,000 and 10,000 edible plant species on our globe. To maintain our awareness of how this one crop has influenced the lives of people up to today, IRRI is establishing a rice learning center in Los Baños. In this center the different rice-growing ecosystems, their history, their potential for the future, the research needed to make them productive and sustainable, and IRRI's contribution, will be described. By doing this, we want not only to inform the more than 35,000 visitors who come to our Institute annually, we want also to contribute to the preservation of the most important cultures related to rice.

From the beginning of this year, IRRI has started to implement its new work plan. This was carefully prepared over the past year based upon a strategy developed in 1988 and 1989 that gave the long-term perspective for our role as an international institution serving national rice research together with the needs of the rice-eating world.

Optimism is not an abundant commodity on our globe these days, but we at IRRI are optimistic for several reasons:

- We transformed most of our previous 5-year Work Plan for 1990-1994 into successful reality and, by doing so, retained and regained donor and partner confidence in our ability to solve problems.
- We are convinced that our research agenda will serve our goal—the well-being of farmers and consumers, specifically the resource poor.
- Not only did our new work plan for the next 5 years pass all external review processes, it also received the highest marks from the most rigorous and respected scientists and donors.

Indonesia, R. Kendrick

Philippines, R. Guevarra

'Rice, that crucial grain, is an integral part of human history, tied to us in countless traditions, interwoven in the oldest religious rites. Rice is the world's only crop planted by emperors and kings, offered to the Gods, and eaten by both the wealthiest and the poorest."


Japan, R. Kendrick


India, R. Kendrick

- We replanned, restructured, reframed, and reorganized our Institute to meet future needs and constraints, long before it became a painfully felt necessity in other sectors, including international agricultural research in general.
- We developed working relationships and collaborative mechanisms with national research systems worldwide—the consortia, the networks, shuttle research—in which IRRI is playing, and. will continue to play, an important role in strategic and applied research.

We were thus able, even before the beginning of 1994, to start with confidence some of the new and very exciting programs that will help keep supply and demand for rice in 2025 in balance, while sustaining the world's natural resource base.

To make that happen, 870 million tons of unmilled rice will be needed each year—70 percent more than today. And that must be grown with less water, less labor, less losses, less pollution, and on much less land than today. Many may say it is impossible. Their fathers—50 years ago—might have said that flying to the moon is impossible. We believe that we can increase yields enormously; that the efficiency with which nutrients are used by the plant can be vastly improved. We have already begun a "new frontier" project to develop rice plants that fix their own nitrogen directly from the air. And we already know that the drudgery of rice production can to a large extent be removed.

Through use of rice plants of a new design at present under development at IRRI, the high-potential irrigated systems serving predominantly urban consumers can become much more efficient. These rices, with a yield potential 20-30 percent better than today's best, will most probably be growing in farmers' fields within the next 5 years.

Integrated pest management research has demonstrated the possibility of drastically reducing insecticide use, thus serving the needs of farmers in cutting production costs, improving their health, and those of the public in reducing environmental concerns.

Research on intensively managed rice systems has shown that timing fertilizer application better with the aid of up-to-date electronic tools that will shortly become available at very low cost, can increase the efficiency with which rice crops can take up nutrients—and by so doing, reduce costs and pollution simultaneously.

Some of our latest "man-on-the-moon" projects, such as developing perennial rice and creating rice plants that can fix nitrogen, have already stimulated enough donor interest for us to begin expeditions into these new areas of rice research toward a better balance between the protection of natural resources and people's needs for food.

These adventures are not driven by a desire for scientific extravaganza, but by our deep conviction that through science, we will be able to reverse the trend of rural erosion, and that we can contribute to increasing sustainable yields while keeping the different environments where rice is grown in balance.

Providing the scientific answers for filling the world's rice bowl in the 21st century', for preparing the living base for 5 billion rice eaters: that's what makes agricultural and rice research so different; that's what determines our research agenda; and that's the stimulus, the driving force of our enthusiasm and commitment.

KLAUS LAMPE
Director General

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Philippines, E. Masferre


Thailand, R. Kendrick

Madagascar, R. Kendrick

Madagascar, R. Kendrick

The worlds rice production must rise by 70 percent, yet it must come from the same or a smaller total land area. Research must be conducted to increase the productivity of existing ricelands while simultaneously sustaining soil fertility, protecting the environment, and providing equitable returns to farmers.

IRRI Revamps its Work Plan

If the rice-eating world is to be fed in the 21st century, IRRI will have to meet important new challenges. By the year 2025 some 8.3 billion people will inhabit the earth, and about 4.3 billion will be rice consumers. The world's rice production must rise by 70 percent, yet it must come from the same or a smaller total land area. Research must be conducted to increase the productivity of existing ricelands while simultaneously sustaining soil fertility, protecting the environment, and providing equitable returns to farmers.

During 1993 IRRI developed a new work plan. Entitled *Rice Research in a Time of Change: IRRI's Medium-Term Plan for 1994-1998,* this replaced the previous work plan. Both the new work plan and its predecessor have been based on IRRI's long-term strategy. *2bward 2000 and Beyond,* that was developed over 2 years in 1988 and 1989, and reviewed, in 1993.

This strategy divided IRRI's activities into five interdisciplinary research programs and five international support programs. The approach remains the same for the new Medium-Term Plan, which commenced on 1 January- 1994.

This corporate report covers the transition period for the end of the previous work plan and the commencement of the new Medium-Term Plan. Reports cover the activities of each of the 10 programs in the research and international, programs, and each. is presented with the objectives and projects laid down in the new Medium-Term Plan.

RESEARCH PROGRAMS

The five research programs concentrate on the four major environments in which rice is grown. A fifth, termed the cross-ecosystems research program, focuses on research that will generate knowledge applicable to all, or several, ecosystems.

The programs are designed to focus on the many interlocking facets that make up each ecosystem and affect rice production. They bring an integrated approach to each ecosystem by maximizing close collaboration between the appropriate scientific disciplines. They are forward-looking, using IRRI's disciplinary strengths to address issues of strategic importance.

IRRI ecosystem-based research program

- Irrigated rice
- Rainfed lowland rice
- Upland rice
- Flood-prone rice (formerly called deeperwater and tidal wetlands)
- Croos-ecosystems

INTERNATIONAL PROGRAMS

The five international support programs aim to strengthen the research capabilities of rice research institutions and scientists within the global family of nations. They aim squarely at supporting a well-functioning-international rice research system based on national and international partnerships, with links to a wide range of specialized, institutions and backed up by documentation and information exchange. Close interaction occurs with the ecosystem-focused research programs.

IRRI international programs
- Germplasm conservation, dissemination, and evaluation
- Crop and resource management networks
- Information and knowledge exchange
- Training
- National research services

IRRI'S RESEARCH THEMES

The 1990-94 work plan identified four key challenges:
- increasing rice productivity
- achieving sustainability
- protecting the environment
- addressing social equity.

IRRI's Medium-Term Plan for 1994-1998 focuses on meeting these same challenges, along with some newly emerging concerns, and the linkages and interactions between the challenges. The central issue is how to balance the need for ever greater food production at prices that are profitable to farmers and affordable to consumers, against very real concerns about protecting natural resources and the environment for future generations. The new plan stresses more and new forms of collaboration and greater collaboration with national research programs, other research institutions, and nongovernment organizations.

It is also designed to make progress with five themes, covering IRRI's responsibilities towards people, permanency, productivity, protection, and partnership. Work within the Institute's 10 programs is grouped, carried out, and monitored against these themes.

Better understanding of the way households, communities, and nations manage their resources can help in setting research priorities and in formulating public policy.


China, R. Kendrick

People: helping improve living and working conditions

People are the ultimate focus for rice research. Better understanding of the way households, communities, and nations manage their resources, and of the factors that determine the trade-offs people make between maximizing their incomes in the short term and sustaining their resource base in the long term, can help in setting research priorities and in formulating public policy, Evaluating the impacts of policy and technological change also provides information to guide modification of and to set new directions for public policy and research.

Projects on improving living and working conditions
- Raising the yield plateau
- Apomixis-ensuring equity in use of hybrid rice
- Germplasm improvement for rainfed lowlands
- Improved crop and resource management for flood-prone areas
- Agroecological characterization, technology impact, gender, and policy analyses
- Evaluation and exchange of sustainable production systems and technologies

Permanency: sustaining the natural resource base

The permanency of the food production base on which the world relies, now and in the future, depends on our care and use of the genetic diversity of rice and on our husbandry of agriculture's natural resource base—soil, water, and biological activity, Preserving genetic resources in perpetuity, evaluating the long-term effects of intensively cropping ricefields, mitigating farmers' risks through characterizing resource use, and arresting degradation are crucial activities.

IRRI, R. Kendrick


Philippines, A. Javellana

Projects on sustaining the natural resource base

- Reversing trends of declining productivity in intensive irrigated rice
- Sustaining the lowland resource base
- Improving rice-wheat systems
- Characterizing and analyzing environments
- Rehabilitation and sustainability of upland rice-based farming systems
- A sustainable system for the uplands: developing a perennial rice plant
- Assessing the potential of rice germplasm
- Conservation of rice genetic resources
- International Network for Genetic Evaluation of Rice (IN GER)

Productivity: increasing resource use efficiency

Nearly three quarters of the growth in rice production since 1966 has come from increases of productivity from the land made possible by widespread adoption of modern high-yielding varieties and associated/and management practices. Quick-maturing varieties like IR36 produced similar yields in much less time, allowing more intensive cropping.

The breakthroughs needed to achieve greater rice production to meet growth in demand in the near future will require that

Preserving genetic resources in perpetuity, evaluating the long-term effects of intensively cropping ricefields, mitigating farmers' risks through characterizing resource use, and arresting degradation are crucial activities.

the productivity of other resources must also increase. A major increase in production is needed, but we cannot hope to achieve this without much higher efficiency in the use of nutrients, especiaIy nitrogen, water, and labor. This means matching improved cultivars to improved resource management.

This increased productivity will have an additional benefit: higher productivity derived from changes in plant efficiency adds very little to costs for farmers. Gains can be shared by both producers and consumers.

Projects on increasing productivity

- Improving nutrient management
- Identifying tillage and water interactions
- Managing resources for enhanced productivity
- Improving germplasm for the uplands
- Improving germplasm for flood-prone areas
- Improving crop and resource management for flood-prone areas
- Assessing opportunities for nitrogen fixation in rice
- Quantifying the performance of rice ecosystems through systems approaches
- International Network for Genetic Evaluation of Rice (ING ER)

China, R. Kendrick

Philippines, H. Conklin

We cannot hope to achieve the major increase needed to meet future demand without much higher efficiency in the use of nutrients, (especially nitrogen), water, and labor.

Protection: caring for the environment

Growing enough rice to feed rapidly growing populations is already pressurizing fragile environments. IRRI shares international concerns about land degradation, soil erosion, water shortage, and pollution. This translates into research on ways to protect the environment and human health, while helping poor farmers improve the profitability of their rice-based systems.

Projects caring for the environment

- Improving pest management
- Examining global climate change
- Controlling human disease vectors
- Integrated Pest Management Network
- Managing weeds using chemicals: the role of allelopathy and biological control
- Mobilizing biotechnology tools for rice breeding
- Exploiting biodiversity for sustainable pest management
- Quantifying the performance of rice ecosystems through systems approaches
- Asian Rice Biotechnology Research Network

Partnerships: supporting and working with partners

Virtually all IRRI's work involves some form of collaboration, or partnership. This has many synergistic benefits—shortening the time needed to solve problems, speeding the transfer of information and advanced research methodologies, enabling scientific collaboration across political borders and economic barriers, and stretching scarce research resources. Important partnerships include bilateral agreements, shuttle research, joint ventures, consortia and networks.

Projects with a primary focus on partnership

- Improving rice-wheat systems
- Integrated Pest Management Network
- International task force on hybrid rice
- Rainfed Lowland Research Consortium
- Upland Rice Research Consortium
- Asian Rice Biotechnology Research Network
- International Network for the Genetic Evaluation of Rice
- Evaluation and exchange of sustainable production systems and technologies
- Conferences and workshops
- Collaborative in-country training
- National research services

Important partnerships include bilateral agreements, shuttle research, joint ventures, consortia and networks.

Cambodia, H. Nesbitt

IRRI's modes of partnership

IRRI scientists work with colleagues all over the world—in national agricultural research systems, in other advanced institutions and laboratories, in sister international agricultural research centers, in order regional and international organizations, in voluntary and nongovernment organizations, and in the private sector.

- **National research services**
  Direct consultation and training enable strengthening of a national program's capabilities for undertaking its own research and for participating in partnerships with other programs.
- **Technology evaluation networks**
  Voluntary, open, informal associations of scientists and research organizations with common interests allow members to exchange and evaluate technology, and share experiences and information.
- **Research networks**
  Individual scientists from IRRI and other institutions organize and conduct research driven by a predetermined theme or set of research tools,
- **Research consortia**
  A group of selected institutions, including IRRI, mutually agree to accept different responsibilities to contribute to achieving a common objective.
- **Bilateral national program-IRRI collaboration**
  Scientists of IRRI and a collaborating institution/country meet bienni-ally to review research progress and agree on a joint work plan for specific activities of mutual benefit.
- **Shuttle research**
  IRRI and a national program or another institution carry out different phases of a project, with an exchange of scientists temporarily posted to each other's institution.
- **Joint venture**
  IRRI and a collaborating institution together carry out a specific research project, with cost sharing.

NEW APPROACHES

The medium-term plan confronts the long-term challenges for feeding the world in 2025 and beyond with three new mechanisms by selecting "mega projects" and "new frontier projects", and developing "research consortia."

Mega projects

These projects focus on emerging and evolving issues of major concern to growth and sustainability of rice production. Research to explain and resolve these issues should have an exceptionally large impact. The expectation of success from research directed at resolving the issues is high. The nominated mega projects are major projects within the research and international services programs, and while IRRI is guaranteeing them core funding, additional funding from outside the Institute would enable it to expand and accelerate the extensive research needed to increase their impact. IRRI is therefore seeking additional support for the projects from donors.

Mega projects 1994

- **Raising the irrigated rice plateau**
- **Reversing trends of declining productivity in intensive irrigated rice**
- **Improving rice-wheat systems**
- **Conservation of genetic resources**
- **Exploiting biodiversity for sustainable pest management**

New frontier projects

These projects aim to explore exciting opportunities to stretch the horizons of rice research, unconstrained by concerns of failure. The chances of success may be difficult to predict, but the returns from success will be high. IRRI can only provide limited funding from its core budget for these exploratory projects, and is therefore seeking support for individual projects from donors. With additional support, IRRI will be able to develop collaborative linkages with other advanced laboratories already working in related areas, and thus exploit the potential for achieving important advances in rice research.

New frontier projects 1994

- Apomixis-ensuring equity in use of hybrid rice
- Assessing opportunities for nitrogen fixation in rice.
- Managing weeds using less chemicals: the role of allelopathy and biological control
- Developing a perennial rice plant: a sustainable agricultural system for the uplands

Research consortia

These are groups of research institutions, including IRRI, from rice-growing countries who agree to accept different responsibilities to contribute to achieving a common aim. They can harness the growing capacity of national research systems and institutes to conduct research of strategic importance. Two research consortia were established in 1991 with special funding support, one for the rainfed lowlands and one for the uplands. After more than two years of experience with these consortia, it is clear that such consortia can successfully address the broad issues vital to improving the productivity and sustainability of the vastly variable rice ecosystems. They can also be a mechanism for addressing agroecological concerns.

IRRI is seeking extra core funding to support the two existing consortia, and for two more—the intensive irrigated, and the flood-prone ecosystems.

Research consortia can successfully address the broad issues vital to improving the productivity and sustainability of the vastly variable rice ecosystems. IRRI is seeking extra core funding to support the two existing consortia and for two more — the intensive irrigated, and the flood-prone ecosystems.

Philippines, M. Cairns

Cambodia, G. Trebuil

Research Program Highlights

Philippines, E. Masferre

IRRIGATED RICE ECOSYSTEM

Expenditure 1993 — $3,572,000
Approved budget 1994 — $3,780,000
Budget planned 1995 — $4,700,000
Internationally recruited staff — 11
Nationally recruited staff — 88

Program goal

To improve the welfare of farm households and urban rice consumers through increased, environmentally sound, sustainable production from irrigated rice systems.

Projects

- Raising the yield plateau
- Reversing trends of declining productivity in intensive irrigated rice
- Improving nutrient management
- Identifying tillage and water interactions
- Enhancing postharvest technology
- Improving pest management
- Sustaining the lowland rice base
- Examining global climate change
- Improving rice-wheat systems
- Apomixis — ensuring equity in use of hybrid rice

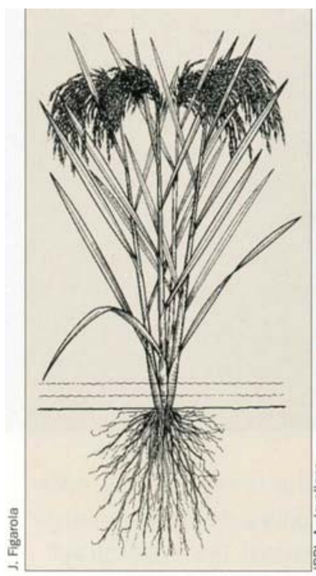
Rationale

Fifty five percent of the world's ricefields, or 80 million hectares, are irrigated, and they produce more than 75 percent of the wood's rice. Seventy four million of these irrigated hectares are located in East Asia. Irrigated ricefields supply 90 percent of the rice needed by urban and rural landless consumers, and the stability of urban rice supplies and prices in recent years has stemmed largely from growth in rice production from irrigated farms. Production from such farms will need to rise considerably further if this situation is to continue until the year 2025.

Almost all of IRRI's irrigated rice research projects involve strong collaboration with leading Asian universities and research institutions that study irrigated rice, and this collaboration has the twin benefits of broadening the research that can be done, and of strengthening the capacities of the collaborating institutions. Close collaboration also occurs with leading laboratories throughout the world.

Irrigated rice research objectives

- To increase the potential of irrigated rice in tropical and subtropical environments by 50 percent
- To determine the causes of long-term productivity decline in intensively cropped systems
- To increase the profitability and sustainability of intensive, irrigated rice production through developing crop and resource management techniques for increasing input-use efficiency
- To develop environmentally sustainable and economically viable pest management technology that uses minimal amounts of pesticides
- To characterize the water supply and water-induced degradation of irrigated lowlands, and assess the impact of upper watershed activities on lowland productivity
- To quantify the impact of global climate change on irrigated rice productivity and the impact of irrigated rice production on global climate change



Highlights

Increasing the yield potential

The target for intensively cropped irrigation systems is to raise possible yields by up to 50 percent. This is being pursued by redesigning the rice plant to improve its potential yield, by developing hybrid rices for the tropics, and by improving crop management.

- Sixteen IRRI breeding lines from the irrigated ,ice breeding program were named as varieties in nine countries in 1993, which brings the number of IRRI breeding lines named as varieties by the countries of the world up to 252.
- Eleven IRRI-derived breeding lines were released as new varieties in Cambodia, India, Indonesia, Madagascar, and Vietnam. Three rice hybrids (two semiarid and one tropical) were released by Andhra Pradesh and Tamil Nadu states in India, and they have yielded about 1 ton per hectare more than local checks,
- Research continues on developing rice plants that will have a much higher yield potential than today's best varieties. Comparisons of tillering patterns of new plant types (improved tropical japonicas) during the 1993 wet season showed they produced fewer tillers than the high-yielding IR72, but the number of grains per panicle was much higher. It was still too early to estimate the yield potential of the new plant types.

Research continues on developing new rice plant types that will have a much higher yield potential than today's best varieties.

- The tropical japonica rices of Asia, commonly known as bulus, that are still grown in some low temperature-affected parts of Asia, although fairly good yielders, have the drawbacks of being tail and take more than 7 months to mature. Nevertheless, they possess traits that match the cultural and management practices of farmers who grow them. Five years of research into breeding improved bulus appears to have paid off. Shorter statured bulus that mature in 122-135 days have been produced. These significantly outyield local checks, and possess acceptable levels of cold tolerance and blast resistance.

Maintaining high yields

The intensively-managed irrigated rice systems of Asia are only about 30 years old. Yet there are signs that in the long term, their productivity may decline. The decline has appeared in IRRI's long-term continuous cropping experiment, commenced in 1963, in several experiments in India and the Philippines, and in the fields of innovative farmers who adopted intensive cropping very early. More inputs of nitrogen and other resources are now needed to reap the same crops. A new IRRI 'mega project' is investigating the processes at work, and how they can be mitigated by improved management.

- A field experiment evaluating the interactive effects of the nitrogen supply, root nematodes, and sheath blight on the yield potential of IR72 indicated that sheath blight limits the yields that can be achieved by adding nitrogen fertilizer, Only 7.7 tons per hectare were achieved with an application of 200 kg of nitrogen per hectare without control, compared with 9.1 tons per hectare with control. Nematode infection appeared not to have any effect. These initial results indicate that the nitrogen supply and sheath blight pressure are dominant influences on yield potential at IRRI on soils requiring fertilizer nitrogen to achieve maximum yield potential.
- Long-term experiments at IRRI and the Philippine Rice Research Institute (PhilRice) indicate that while soil organic matter levels have not decreased in the long term as rice yields have declined, the soil nitrogen supply has decreased. Thus, in contrast with many other agricultural systems, in intensively cropped irrigated ricefields the soil organic matter content does not indicate the soil nitrogen supply. In these fields, the chemical structure of soil organic matter may change in such a way that the nitrogen in the soil organic matter becomes less available.

IRRI, A. Javellana

Reduction of the ozone layer, probably caused by chlorofluorocarbons people have released, is increasing the amount of biologically harmful ultraviolet radiation reaching the earth.

Effects of climate change

For the first time in history, the world's climate appears to be changing as a direct result of human activity. Increasing levels of carbon dioxide (CO2) and methane (CHO in the atmosphere are causing global warming reduction of the ozone layer, probably caused by for example chloroflourocarbons people have released, is increasing the amount of biologically harmful ultraviolet radiation reaching the earth. Crops themselves emit both methane and nitrous oxide (N_2O), which is another greenhouse gas from which other oxides of nitrogen that reduce the ozone layer may also be derived. These changes affect plant growth, and therefore could have both positive and negative effects on crop production. IRRI is investigating the implications of climatic change for rice growing. Research highlights include:

- Studies modeling the effects on rice production of a doubled level of CO2 in the atmosphere and consequent effects on temperatures indicate reduced production from China, Thailand, and Bangladesh. However, countries such as Indonesia, Malaysia, Taiwan, as well as parts of India and China, should benefit. These results should not be viewed with much alarm since, given the time scale involved for the changes to occur, new varieties more closely adapted to the gradually changing conditions should have been bred, thus mitigating the effects of climatic change.
- Modeling studies also indicate that global warming affects egg predators of the brown planthopper, the major rice pest. Among two mirid bug egg predators, *Tytthus chinensis* is more common than *Cyrtorhinus lividipennis* in northeast Thailand where temperatures am high. At temperatures 5 °C higher than normal, T. *chinensis* appeared at least 10 times more tolerant of heat than *C. lividipennis*. Thus, egg predator populations should be able to adjust to warmer temperatures.
- Field research made possible by IRRI-US Environmental Protection Agency collaboration has confirmed that rice fields are a major global source of CH4 and that they emit significant amounts of N_2O. Emission of N_2O is high during the rainfed fallow season but not during the flooded ,rice season. Conversely methane is emitted during the flooded periods. Midseason drainage mitigated CH_4 emissions without significantly increasing N_2O emissions. Different plant types also affect the amount of methane emitted. For example, field measurements indicated the traditional Dular variety emitted about 30 percent more CH_4 than the new plant variety IR65597.

Surveys showed farmers in the Philippines and Vietnam applied the most pesti-cides during the early crop stages, and most applica-tions in both areas were insecticides.

Managing pests

Most organisms occurring in rice crops are not harmful, and are frequently beneficial. Some 500 species of arthropods 0nsects and spiders), for example, may appear in a ricefield during any one season, but only a few are a potential threat. Further, improved rice cultivars can tolerate or are resistant to some pests. Pest management seeks to use tolerance and resistance to prevent crop losses, and to minimize the undesirable effects of pesticides on the beneficial organisms, and also on farmers.

- The 1992 market value for pesticides used in ,ice was estimated at over US$3 billion. Surveys of farmers in Leyte, Philippines, and the Mekong Delta, Vietnam indicated that farmers applied the most pesticides during the early crop stages, and that most applications in both areas were insecticides. Substantial proportions of the sprays used were in the World Health Organization's extremely hazardous (Ia) and highly hazardous (Ib) categories. The main target pests were leaf-feeding insects. However, *laboratory* and field studies have shown that rice crops can recover from early damage by leaf-feeding insects without suffering yield loss. Less than 20 percent of the sprays applied by farmers in Leyte could be considered appropriate, which indicates that the farmers' perceptions of pest management are highly influenced by the sight of insects eating their young crops, and the desire not to risk any damage.
- Analysis of a random sample of 152 rice-farming households in the Philip-

Indonesia, R. Kendrick

The sheath blight quandary

Sheath blight is caused by a fungus, *Rhizoctonia solani*. It is a disease that causes yield losses in intensively managed irrigated rice crops where nitrogen fertilizer is applied to achieve high yields. It has caused losses in intensively cropped areas of Vietnam, Southeast Asia, China, and Japan. The higher the nitrogen fertilizer application, the more susceptible the crop becomes to infection and the greater the yield loss from the pathogen. With applications above about 180 kg of nitrogen per hectare, losses are around 1.5 tons per hectare without disease control. However, with application rates of 100 kg per hectare or less, sheath blight has little effect on yield and infection levels are relatively low.

Research has shown that sheath blight is not a new disease. Indeed, the *Rhizoctonia* has always been there. It lives not only on rice, but also on many other plants. It has only become an important rice disease when the crop became intensively cultivated.

There are several reasons for this. Modern high-yielding rice cultivars are much shorter in stature than traditional ones. They also tiller prolifically, and are planted much closer together. So the density of the stems and leaves in the crop is much greater and conditions inside the crop have become more humid, airless, and hot—ideal conditions for fungal growth. The more nitrogen that is added, the more luxuriant growth and the better the conditions for the Rhizoctonia.

This situation presents a quandary to researchers who are trying to raise yields ever higher. The greater the potential yields, the greater the potential for fungi such as *Rhizoctonia* to cause disease and loss.

Trying to eradicate the disease from the ricefields offers little hope. The *Rhizoctonia* is there all the time on weeds and on the rice straw from previous crops. Consequently, the problem has become worse as more crops have been grown each year from the same piece of land.

A number of lines of attack are being tried—such as knowledge-based nitrogen fertilizer management strategies that match the seasonal pattern of crop demand for nitrogen with the available supply from the soil and applied fertilizer. The goal is to provide nitrogen without excess or deficiency, to avoid disease-favoring luxuriant growth resulting from an oversupply, or yield loss because of a lack of, sufficient nitrogen. This objective is also important for minimizing fertilizer nitrogen losses and potential environmental concerns.

Researchers also have been looking for sources of genetic resistance. They have screened large numbers of samples and have found lines that suffer less damage from Rhizoctonia, but none of these has yet provided a reliable source. However, using biotechnology to move genes that control production of the enzyme chitinase into the high-yielding rice plants may help. This enzyme helps protect rice plants from *Rhizoctonia* and other fungi. Some varieties produce it naturally, but not in amounts large enough to protect them, or they produce it too late. Adding in genes to produce more enzyme earlier may protect the plants.

If new rice varieties that can potentially yield 15 tons per hectare are to reach their potential, it will be essential that ways be found to control *Rhizoctonia*—and other organisms. Depending on the environment, other diseases such as rice blast or bacterial blight, or even insect pests like yellow stem borer, can also limit yields as nitrogen applications rise and cropping intensifies. The greater the intensity, the greater the problems, and hence the greater the need to apply nitrogen as efficiently as possible throughout the season to gain the optimum effect and avoid undesirable side effects, like obtaining too luxuriant growth.

pines taken between 1989 and 1991 to assess the medical and economic impact of pesticides on their health has produced valuable results that include the following:

— The incidence of eye abnormalities increases significantly with age and with exposure to insecticides, but less so with herbicides; an increase in the application of insecticides from the mean level of one application to two per season will increase the probability of eye problems by 22 percent, and farmers applying three recommended doses of insecticides per season have a 53 percent (1 in 2) probability of having chronic eye problems.

— Skin problems are positively related to the use of insecticides and herbicides, although only herbicide use is significant. With one herbicide application, the probability of skin problems rises to 30 percent (1 in 3), and with two to 50 percent (1 in 2).

— Respiratory abnormalities are related to age, smoking, and exposure to insecticides. Herbicide use apparently also increased the chances of respiratory abnormality, but not significantly. Farmers applying one recommended, dose of insecticide and herbicide per crop had a 50 percent higher probability of respiratory, abnormalities if they smoked.

— Regular alcohol, consumption and use of pesticides, especially herbicides, were significantly associated with polyneuropathy, a degenerative disease of the nerves usually caused by toxins. While the sample mean had a 2 percent (1 in 50) chance of contracting the disease, this probability rose by 550 percent for farmers who regularly consumed alcohol.

— Contrary to the commonly held view among farmers, using a cloth to cover the mouth and nose while spraying does not provide protection. Indeed it actually causes more problems because the cloth absorbs chemicals and the farmers then inhale through this concentrated film of chemicals.

- In experiments in pest management involving farmer participation, groups of farmers in the Philippines and Vietnam were persuaded to experiment with abstaining from using early season insecticide sprays. Most farmers (90 percent) stopped early spraying and did not experience any yield loss due to insect damage after one season. It appears that spraying during the first 40 days is not only unnecessary, it seems counterproductive. By participating in the testing of simple concepts, farmers can acquire knowledge and change their pest management practices.

Water and tillage

Wet seeding—the practice of sowing pregerminated rice seed onto wet soil—is attractive to farmers because it is less labor-intensive than transplanting rice seedlings. However there are problems with water management, weed control, and stand establishment.

Direct seeding — wet and dry

Farmers planting their crops in irrigated, flood-prone, and rainfed lowland areas have two choices. They can plant their seeds in nurseries, and then transplant the seedlings, or they can plant the seeds directly into their ricefields. Direct seeding comes in two forms: wet and dry direct seeding. The choice of which to use depends on the circumstances.

In wet direct-seeded rice, pregerminated seed is broadcast onto wet soil, that may or may not have been puddled. The technique is used for irrigated rice, especially in Malaysia and the Mekong Delta of Vietnam, and in very favorable rainfed lowland rice areas. Compared with transplanting, wet direct seeding reduces substantially the amount of labor needed for growing a rice crop, Wet direct-seeded rice also consumes less water, mainly because less is used in preparing the land, which is done in a much shorter time. Wet seeding allows rice to survive drying out of the soil in rainfed crops better.

The major disadvantage of using wet direct seeding is that weeds become a problem, and many farmers who are short of labor therefore must use herbicides. Also, the farmer's land must be very level, and he or she must manage the irrigation water efficiently to avoid waterlogging as the crop becomes established.

With dry direct-seeding, the rice is seeded into moist ground by various methods. In rainfed areas, early planting of dry-seeded quick-maturing varieties allows time for farmers to plant a second crop that uses late season rainfall. Dry direct seeding is used in flood-prone, rainfed lowland, and irrigated rice areas, and is, of course, the only means of planting upland rice. It has the general advantages of using less water, since soil preparation occurs in dry ground, and of a much lower need for labor than either direct wet seeding or transplanting. Again, the major disadvantage is that farmers must invest more on controlling weeds — using either labor, herbicides, or a combination of both.

IRRI is concentrating its studies of direct seeding on use of wet direct seeding in the irrigated rice ecosystem, and on use of dry direct seeding in the rainfed lowland and irrigated systems.

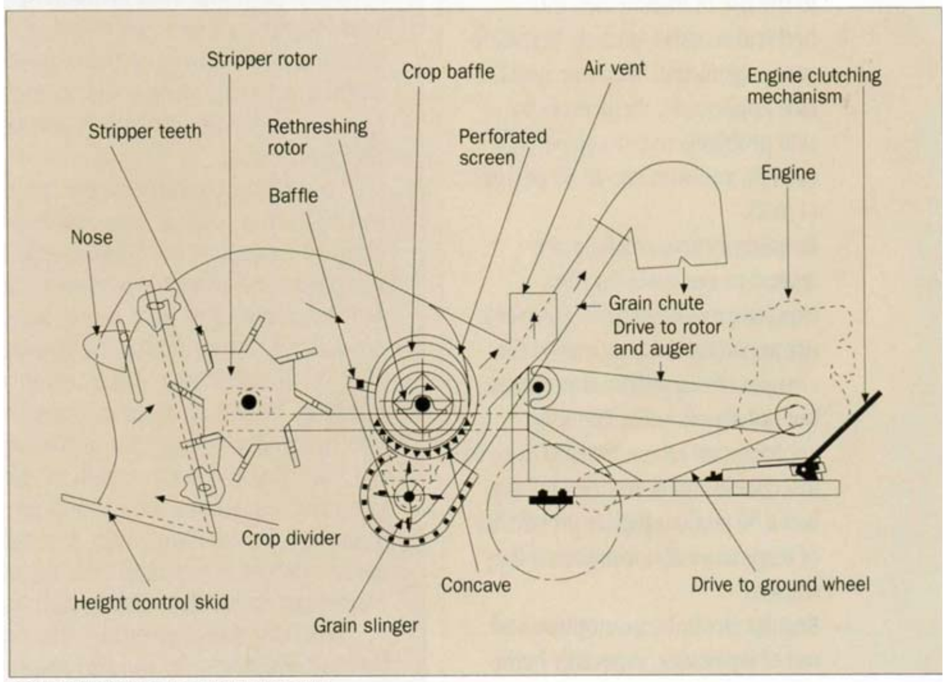
- Studies of wet seeding show that it is both more efficient than transplanting and can give similar yields. As competition for water increases, the technique is becoming more popular, not only because it saves the back-breaking toil of transplanting, but also because it is more water-efficient. Farmers use 20 percent less water because wet seeding takes only between 7 and 10 days of water-intensive land preparation, compared with between 25 and 30 days for transplanted rice—factors that mean higher profits for farmers.
- Farmers who grow wet-seeded rice consistently use higher than recommended seeding rates to suppress weeds and apply herbicides at rates lower than recommended because, they say, higher rates do not result in better weed control. Trials over two seasons have confirmed that seeding at rates higher than the recommended. doses indeed helps suppress weeds and results in higher yields in some cases. Herbicide rates can be reduced to half the recommended levels without lowering their effectiveness.

Equipment for small farmers

Engineering studies to help in production and storage of rice have concentrated on small-scale machinery that is inexpensive to make, is portable, and. can be operated by one farmer. The aim is to help farmers and their households.

- The design of a portable stripper-gatherer harvester has now been expanded to include variants that include a thresher, and another that also includes a bolt-on cleaner to form a stripper-combine harvester, A stripper-gatherer has now been built by a collaborating manufacturer in Sri Lank. The stripper-thresher combination has also been built at the Chinese Academy for Agricultural Mechanization Sciences. The Thai Department of Agriculture and the Philippine Rice Research Institute (PhilRice) have also commenced stripper-harvester production projects, and work has commenced in Vietnam on manufacturing a stripper-gatherer system.

IRRI, A. Javellana



IRRI-Silsoe prototype design—ODA funding support

The design of a portable stripper-gatherer harvester has now been expanded to include variants that include a thresher, and another that also includes a bolt-on cleaner to form a stripper combine harvester,

RAINFED LOWLAND RICE ECOSYSTEM

Expenditure 1993 — $1,832,000

Approved budget 1994 — $2,150,000

Budget planned 1995 — $2,730,000

Internationally recruited staff—7

Nationally recruited staff — 48

Program goal

To improve the economic well-being of resource-poor farmers of the rainfed lowlands through sustainable increased productivity- in ,rice and rice-based production systems.

Projects

- Characterizing and analyzing agricultural environments
- Managing resources for enhanced productivity
- Germplasm improvement
- Rainfed Lowland Rice Consortium

Cambodia, H. Nesbitt

Rationale

About 18 percent of the world's rice production comes from the 40 million hectares of rainfed lowlands planted to rice—27 percent of the wood's rice area. This rainfed lowland rice is mostly grown in South and Southeast Asia. These areas are among the world's most densely populated rural regions and home to some of the world's poorest rural and urban people. The potential impact of rainfed lowland rice research is thus enormous. Drought flooding, pests, and adverse soil types limit the majority of rainfed lowland rice farmers from adopting high-yielding cultivars and using fertilizers and other inputs. Significant productivity gains will translate immediately into greatly increased rice production.

Achieving significant productivity gains requires an understanding of the processes that determine how the rice plants adapt to stresses such as disease and drought, and of how these, the plants, and farmers' practices interact. Because of the breadth of these research questions and of the great variety and wide geographic dispersal of rainfed low-land rice environments, five countries—Bangladesh, India, Indonesia, Philippines, Thailand — and IRRI have formed the Rainfed Lowland Rice Consortium to conduct targeted strategic research on the major constraints to rice production.

Achieving significant Productivity gains requires an understanding of the processes that determine how the rice plants adapt to stresses such as disease and drought, and of how these, the plants, and farmers' practices Interact,

Rainfed lowland rice research objectives

- To understand and record the variety of circumstances facing rice farmers in the rainfed lowland system, assess the risks and benefits of agriculture in the different circumstances, and develop a clear picture of which new technologies can be developed for these different circumstances.
- To develop appropriate methodologies for analyzing and manipulating plant traits, water availability, soil-plant nutrient processes, and cropping systems technologies.
- To understand and exploit the genetic and physiological mechanisms for adaptation to prevalent characteristics of different rainfed lowland environments
- To develop new rice plant types adapted to different rainfed lowland rice systems and low- to moderate-input production
- To develop sustainable intensified production systems for increased productivity and greater yield stability by integrating improved germplasm potential with agroecosystem potential

Highlights

Towards better crop management

Dry direct seeding of rice into dry ground saves labor and water compared with traditional transplanting of seedlings. However, it brings its own problems, particularly weeds. These two closely related issues will become increasingly important as rainfed lowland cropping systems become more intensive, and as labor shifts to more attractive enterprises and becomes scarce.

- Studies of farms in Luzon, Philippines, show that farmers could save as much as US$44 per hectare per season on labor by adopting dry direct seeding; on average dry seeding proved more profitable than transplanting seedlings, even though land preparation costs were slightly higher because the majority of farmers used hired tractors for dry plowing. Crops grown with dry land preparation also needed between 20 and 40 percent less water. Direct seeding had the advantages of lower labor requirements, earlier crop establishment that allowed more effective use of the premonsoon rains, and earlier maturing of crops that allowed growing of a follow-up crop.
- Tests of the competitive ability of dry-seeded rice cultivars against weeds showed that the number of weeds in a crop (as indicated by their total weight) did not necessarily indicate the rice yield, The cultivar growing with the greatest weight of weeds yielded more than 5 tons per hectare — better than many cultivars growing with significantly lower weed weights.
- Experiments conducted at IRRI during 1.993 also showed how the levels of soil moisture and soil drying affect the emergence of rice and three weed species. Drying the soil within 5 days of seeding did not affect the emergence of rice seeds. However, it reduced weed emergence by between 28 and 54 percent and caused some germinating weed seeds to die. This explains why weed numbers are low in dry-seeded ricefields where the topsoil layer dries after seeding.

Breeding better rice cultivars

These studies focus on breeding improved rice cultivars adapted to the two major stresses of lowland rainfed rice growing — excess water and water shortage. A combination of plant traits rather than a change of any single trait is needed, and such traits as intermediate height, photoperiod sensitivity, and drought and submergence tolerance would greatly increase the reliability of yields from improved plants. A large proportion of the activities have moved to two areas that represent major subecosystems—eastern India for work on submergence-tolerant population development, with the Central Rice Research Institute at Cuttack serving as the main center, and. northern Thailand for studies on drought and tolerance of nutrient-poor soils, with the Ubon Ratchathani Rice Research Center serving as lead center.

- At the Rainfed Lowland Rice Consortium key site at Cuttack, India, evaluation of some 880 breeding lines for adaptation to moderately deep (30-50 cm) flooding has resulted in selection of about 15 percent as suitable for further testing.
- The process of alcoholic fermentation enables organisms to produce energy without oxygen (anoxia). This can be particularly important for rice seedlings that grow in waterlogged soils that often lack oxygen. Studies of the importance of the ability of rice roots to use alcoholic fermentation to produce energy showed that the growth rates of the coleoptiles in young seedlings are related to the rates of ethanol synthesis. Aldehyde, a toxic intermediate of alcoholic fermentation, can rise to high concentrations in some intolerant varieties when oxygen is in short supply in flooded soils, Measuring high rates of alcoholic fermentation and low aldehyde concentrations in rice exposed to oxygen-deficient conditions could be useful indicators in breeding programs aimed at increasing submergence tolerance, Biotechnology is now being used to manipulate the genes controlling these processes with the aim of increasing the tolerance of rice for oxygen deficiency.

Drought, flooding pests, and adverse soil types limit the majority of rainfed lowland rice farmers from adopting high-yielding cultivars and using fertilizers and other inputs. Significant productivity gains will translate immediately into greatly increased rice production.

UPLAND RICE ECOSYSTEM

Expenditure 1993—$888,000
Approved budget 1994—$1,130,000
Budget planned 1995—$1,540,000
Internationally recruited staff—4
Nationally recruited staff—14

Program goal

To rehabilitate and. sustain upland farming systems and secure rice production for local communities.

Projects
- Germplasm improvement
- Rehabilitation and sustainability of upland rice-based farming systems
- Developing a perennial rice plant: a sustainable system for the uplands
- Upland Rice Research Consortium
- Managing weeds using less chemicals - the role of allelopathy and biological control


Philippines, M. Cairns

Rationale

The 21 million tons of rice produced each year from the 19 million hectares under rice in the uplands of Asia, Africa, Latin America, and the Caribbean support millions of people, mostly at subsistence level, Upland rice farmers are among the world's poorest. Slash-and-burn agriculture opens the way for serious soil erosion and soil degradation. The farmed upland areas are diverse, usually have poor or degraded soils, and have topographies that range from slopes to well-drained fiat ands. Rice yields average 1 ton per hectare or less.

India, Indonesia, Philippines, Thailand, and IRRI have formed the Upland Rice Research Consortium, which has targeted five key sites. Each represents a subecosystem and a major production constraint. Research is under way on the impact of drought, problem soils, weeds, land degradation, the effects of blast disease on productivity, environmental security, and the needs of upland farm families. Improving rice productivity is seen as the starting point for alleviating the

Upland rice farmers are among the world's poorest. Slash-and-burn agriculture opens the way for serious soil erosion and soil degradation.

interrelated problems that contribute to degradation of the uplands and damage to the watersheds for the lowlands,

Highlights

Improving upland rices

Until relatively recently, much less effort has been expended on breeding improved rice plants for upland areas than on the potentially more productive irrigated and rainfed lowland regions. The research is therefore at a much earlier stage. In one line of study, traits for yield stabilization and increased yield are being combined, and the improved cultivars are being tested for their adaptation for different upland environments. Some advances include:

- Studies at many sites indicate improved rice varieties are now available to upland rice farmers that produce stable yields, that have good resistance to pests, diseases, physical and chemical constraints, and that yield between 50 and 100 percent more rice than local checks. Two accessions are now widely grown by farmers in Vietnam and Sumatra, Indonesia; one has been released nationwide in Vietnam. Several other varieties are being used by national breeding programs in hybridization studies.
- In Sumatra, the upland improved cultivar IR47686 has shown promise.

Contour hedgerow systems assessed

Removal of primary forest cover and continuous cropping of sloping lands are the principal causes of massive soil erosion that leads to declines in soil fertility- and crop yields. Contour hedgerows offer one possible technology to address this problem.

- Surveys and studies in Luzon and Mindanao, Philippines, of farmers who had adopted hedgerows and alley cropping revealed that while these were clearly reducing erosion and increasing long-term stability- of sloping lands, they were not well regarded since they did not provide short-term economic returns. Therefore ways need to be found to ensure that these systems generate income for the poorest farmers, and thus provide an economic incentive to adopt them.
- Studies have begun on developing a perennial rice plant. Such plants could be grown along contours to provide ground cover that acts as a soil barrier, while at the same time yielding a desired and economic product--namely rice.

Upland rice research objectives

To develop improved techniques and technology for increasing and stabilizing upland rice yields

To develop a range of upland rice production practices that will help rehabilitate degraded uplands and transform them into sustainable agroecosystems

To explore the feasibility of developing a perennial upland rice plant

To search for germplasm that is allelopathic to weeds

Better pest management

Research has concentrated on managing weeds, rice blast, and nematodes—major limiting factors in upland rice production —and on developing rice cultivars that can outcompete weeds.

- Studies in Leyte, Philippines, of how weed communities change with time on overused and followed land showed that, for the most part, farmers growing rice and maize accurately assess their weed problems, and fallow their fields when yields decline. They also accurately assess which weeds are indicating that their fields have recovered after fallowing.
- Tests in the uplands of Leyte, Philippines, of how well 18 rice cultivars competed against weeds showed that weeds caused yield reductions that varied between 77 and 27 percent, depending on the cultivar. The most competitive cultivars formed many tillers, had a large leaf area (which shaded out the weeds), and grew rapidly. IR55419-04, which was identified as a competitive cultivar in 1992, continued to perform well.
- Applying an indigenous fungal pathogen of the noxious weed grass *Eleusine indica* has significantly reduced this weed, and the pathogen could become a useful control agent for this weed.
- In the Lao *PDR,* and in Sumatra, Indonesia, root-knot and root-lesion nematodes frequently occur together, and their impact increases with crop intensification. Comparisons in greenhouse experiments using clean and nematode-infested soils commonly found in the uplands showed that plants infested with root-knot nematode could give only limited responses to increased nitrogen fertilizer applications. Thus, with root-knot nematode, the greater the amount of nitrogen fertilizer added the greater the gap between the potential yield and yields actually achieved. Rice plants infested with root-lesion nematode were able to give a substantially greater response to added nitrogen fertilizer. Breeding and management studies are therefore concentrating on minimizing root-knot nematode infestation.

FLOOD-PRONE RICE ECOSYSTEM

Expenditure 1993—$700,000
Approved budget 1994—$710,000
Budget planned 1995—$940,000
Internationally recruited staff—3
Nationally recruited staff—10

Program goal

To improve the productivity of rice in flood-prone environments and integrate rice into sustainable production systems that provide for the well-being of farmers and their families.

Projects

- Germplasm improvement
- Improved crop and resource management for flood-prone areas

Rationale

This program deals with adaptation of rice to excess water and related problems. More than 10 million hectares of riceland in South and Southeast Asia suffer from uncontrollable flooding in the low-lying areas of riverine flood plains and deltas, Rice yields are low, and average only about 1.5 tons per hectare because of problem soils and unpredictable combinations of flood and drought, and yet these areas support more than 100 million people. Tidal wetlands occur where water levels in coastal ricefleIds fluctuate under the influence of marine tides. No evaluation has yet been made of the areas of flood-prone ricelands in other important rice-growing regions in China, Africa and Latin America, However, research and experience gained in South and Southeast Asia is applicable to flood-prone riceland in these other regions.

IRRI File Photo

Above: More than 10 million hectares of riceland in South and Southeast Asia suffer from uncontrollable flooding in the low-lying areas of riverine flood plains and deltas.

Highlights

Better rice for flood-prone areas

Traditionally grown rice cultivars in flood-prone areas are well adapted to extreme fluctuations in the water regime and to acid and acid sulfate soils. The program aims to double the yield potential by developing more productive breeding lines that tolerate temporary submergence, or have the ability to elongate their stems during deep floods, that tolerate drought and soil stresses, that have resistance to common pests and diseases, and that produce acceptable grain.

- Elite lines from the program provided to Cambodia, Myanmar, and Vietnam have performed well; sensitivity to daylength at higher latitudes currently causes problems when trying to transfer new plant types from IRRI's main flood-prone rice research base in Thailand to India and Bangladesh.

Surveying farmers' needs

A survey of 889 farmers from 184 villages in 20 provinces covering deepwater rice areas of central, northern, and northeastern Thailand identified general conditions of deepwater rice cultivation, the technologies used, and farmers' feelings on the future for growing deepwater rice. Results included:

- Just under 70 percent of farmers owned the lands they were farming, the area cultivated by each family averaged between 4 and 7 hectares, 72 percent of farmers were using chemical fertilizer, and the mean grain yield over all farms was about 22 tons per hectare.
- Characteristics farmers required in varieties they used included being ready for harvest mid December to early January, high numbers of tillers, a height of 1.5-2 meters, drought and submergence tolerance, the ability to elongate rapidly as the flood waters rise, good "kneeing" ability (the ability to bend upwards from the nodes to keep foliage vertical as flood waters recede), long panicles, and long slender grain with aroma and good cooking quality.
- Eighty nine percent of farmers wish to continue to grow deepwater rice since it is the only crop that can survive in the wet season, and there are few alternative good jobs.

Intensifying cropping systems

In Bangladesh, farmers have switched from using traditional deepwater "aman" type rices that have to survive wet season floods to growing high-yielding modern irrigated "boro" rice varieties in the dry season, using water provided through low-lift pumps from shallow tube wells. The land is left fallow during the monsoon. However, the potential-further changes will soon be exhausted. Yet Bangladesh will need to produce a further 1J million tons each year by 2010, so the land left fallow during the wet season will need to be brought back into cultivation. Studies have assessed features needed in more productive deepwater rice systems. These studies in collaboration with the Bangladesh Rice Research Institute have shown that:

- combinations of modem-variety boro and deepwater rice for the dry and wet seasons can be grown very. successfully on 1.36 million hectares, and possibly a further 2.2 million hectares if constraints on the turnaround time between crops can be eliminated
- region-specific crop and farming systems research is needed to identify appropriate planting times for modem-variety boro and deepwater rices so that both can be grown successfully in consecutive seasons on the same land
- cold-tolerant varieties and tall, submergence-tolerant deepwater rice varieties need to be developed.

Flood-prone rice objectives

- To characterize the changing production environments for possible shifts in research on land use and environmental protection
- To develop improved germplasm that has higher and more stable yield potential than farmers' current varieties
- To develop improved crop and resource management practices

Integrated pest management

Rats and nematodes cause major yield losses in deepwater ricefields. Studies of the feeding preferences of bandicoot rats in deepwater rice fields in Bangladesh have indicated that they prefer snail flesh baits over paddy grains, coconut flesh, or dry fish, and that snail flesh may be effectively used as bait in trapping bandicoot rats from deepwater ricefields. Ufra nematodes have been shown to cause serious damage, especially in southwestern districts of Bangladesh, where infestation rates ranged from 10 to 100 percent, and yield losses from 20 to 100 percent.

Coastal wetlands

Tidal rices are grown on some 4 million hectares of land in coastal areas and along inland estuaries located mainly in Bangladesh, India, Indonesia, Vietnam, and West Africa. Salinity and acid sulfate soils are the main problems.

- Requests for improved germplasm with acid tolerance increased during the year, especially from West African countries; 50 lines were provided to West African countries through the West Africa Rice Development Association (WARDA), and to Cambodia, Indonesia, Sri Lanka, Thailand., and Vietnam.
- Studies of reclamation of large tracts of acid sulfate soils in the Mekong Delta of Vietnam have indicated the extent to which toxic substances leached from the soil can severely pollute surface waters and acidify the canal network. Pollution from newly cleared land varies, depending on the crop -- pollution from crops of yam and pineapples grown on raised beds being about five times more serious than that from rice cultivation. Reclamation projects must be planned carefully to prevent these types of pollution.
- For the first time, the Philippine Seed Board has identified two salt-tolerant cultivars, both IRRI-derived, for prerelease. One of these, the highly promising IR51500-AC11-1, is the first anther culture-derived line identified for release from a cross involving indica rice lines, and probably the first anther culture derivative released for adverse environments.

INFORMATION ECOSYSTEMS

Expenditure 1993—$3,582,000
Approved budget 1994—$3,550,000
Budget planned 1995—$3,950,000
Internationally recruited staff—11
Nationally recruited staff—66

Program goal

To acquire knowledge and tools for use by ecosystem-based research at IRRI and in national systems and to address current or anticipated problems across ecosystems.

Projects

- Assessing the potential of rice germplasm
- Mobilizing biotechnology tools for rice breeding
- Exploiting biodiversity for sustainable pest management
- Quantifying the performance of rice ecosystems through systems approaches
- Agroecological characterization, technology impact, gender, and policy analyses

Rationale

Some research generates knowledge applicable to all or several rice ecosystems, and is thus best conducted within one program. Th e program focuses on forward-looking research emphasize use of new scientific technidques and newly developed tools and applies them in the broadset possible way to rice production throughout the world.

IRRI, R. Kendrick

IRRI, R. Kendrick

The germplasm held as seeds in the IRRI genebank continues to be evaluated for a broad variety of characteristics - from biosystematic studies to evaluation of the DNA of accession, to screening for resistance to diseases, to genetic and chromosomal studies of resistance and other desirable features.

Highlights

Evaluating seeds in the genebank

The germplasm held as seeds in the IRRI genebank continues to be evaluated for a broad variety of characteristics—from biosystematic studies to evaluation of the DNA of accessions, to screening for resistance to diseases, to genetic and chromosomal studies of resistance and other desirable features. Activities take place through the Genetic Resources Center, which includes the IRRI rice genebank (known as the International Rice Germplasm Center) and the International Network for Genetic Evaluation of Rice (INGER

- The Genetic Resources Center took over responsibility for the international rice genealogy data base during 1993. Almost 2,900 records on crosses made in Korea and nearly 18,000 hybrid records from Latin American countries have been added to the data base.
- A rice genome data base called RICE GENES has been created jointly by researchers from IRRI and Cornell University, USA, to accommodate the large diversity of information generated by genetic research on rice and other crops.
- Evaluation of wild rice accessions has identified some resistance to the two viruses causing rice tungro, but high resistance to one (the rice tungro bacilliform virus) has yet to be identified. Screening about 12,000 cultivated rice accessions in the International Rice Germplasm Center for resistance to rice grassy stunt virus failed to identify any suitable source of resistance. Efforts are now being directed to screening wild species in the collection.
- Initial evaluations of 34 wild rice accessions from eight species for resistance to sheath bight suggested that 33 were resistant, and one was moderately resistant. Screening of land races from Cambodia, Myanmar, and Indonesia revealed variable to the known nine races of bacterial blight, but only one (from Cambodia) was resistant to all.

Cross-ecosystems rice research objectives

- To characterize rice germplasm for conservation and identification of useful donors
- To improve the capacity of ecosystem research programs at IRRI to use biotechnology tools in conventional and nonconventional plant breeding to increase and sustain rice yields
- To improve understanding of pest diversity; the plant-pest coevolution process; and the biology and ecology of pests, beneficial insects, and microorganisms in rice production environments for application in developing management strategies for different rice ecosystems
- To develop systems approaches and models that integrate knowledge on favorable and unfavorable environments and predict ecosystem behavior for different scenarios
- To generate knowledge on the interactive effects of agroecology and socioeconomic environments on people and the natural resource base

Manipulating rice genes

Developing improved rice cultivars involves generating new genetic variation and selecting improved lines from among those variants. The wide hybridization program continues to be a major source of useful new genetic variation since it allows movement of chromosome segments from wild species into cultivated rice. Transformation, the process by which alien genes from organisms that cannot form hybrids with rice are extracted and introduced into rice cells, is potentially another powerful way of increasing genetic variation. IRRI began use of a protoplast-based transformation protocol in 1991 and initiated the newer "particle gun", or microprojectile bombardment method, during 1993. Anther culture, in which anthers are removed from the florets, sterilized, and cultured to form plants, is another method of generating and stabilizing genetic variation.

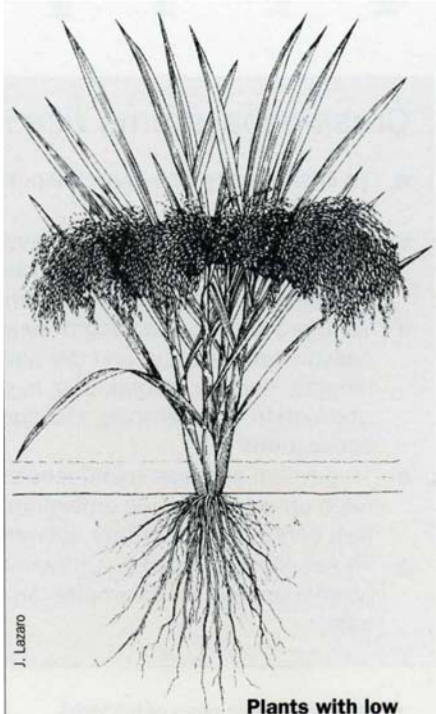
- Protoplast transformation has been successfully applied to Tepi Boro, a rice variety from Bangladesh, and IR43 using both the protoplast-based and the microprojectile methods. The transformed plants expressed two bacterial genes. Transformation of protoplasts from japonica cultivar Xhonghua 6 using two plasmids—one carrying the hygromycin resistance gene from bacteria, the other the soybean trypsin inhibitor gene (Ti3) for resistance to yellow stem borer--yielded plants that contained both genes within their genome. The plants are being tested to determine if the gene expresses itself strongly enough to enhance resistance to yellow stem borer.
- After transformation using the "particle gun", plants of the elite Korean variety Anjungbyeo expressed both the hygromycin resistance and the ß-glucuronidase bacterial genes after regeneration, and. set seed. This development increases IRRI's capacity to produce fertile transformed, plants from a range of rice varieties. This type of study will enable scientists to develop rice plants that express foreign genes at the appropriate time and in appropriate tissues. Production of insecticidal proteins after wounding will be of particular interest.

- Seven hundred and twelve doubled haploid lines were regenerated during 1993 using anther culture of 34 first-generation crosses. The crosses originated from IRRI breeding programs and collaborative work with the Central Soil Salinity Research Institute in India, the Rice Research Station in Sri Lanka, and the Rice Research and Training Center in Egypt. Evaluation in national trials in different saline-prone irrigated lowland areas of a highly promising anther culture-derived line from the cross IR5657/IR4630 indicated the line to be highly tolerant of salinity and to have a higher seasonal average grain yield than IR72.

Systems analysis and modeling

Improving possibilities for greater rice yields and also the efficiency of resource use require a better understanding of both biological and physical aspects of rice production. Simulation and systems analysis provide a means of developing a rational basis for improving crop and resource management and germplasm selection.

- Simulation studies suggest that achieving yields of more than 12 tons per hectare from irrigated tropical rice will require modified plant design. The leaves responsible for trapping the light energy needed for grain filling must not be shaded by the panicle that holds the grain, and serious lodging caused by the greater weight of the grain in the panicles must be prevented. Lowering the height of the panicle provides a solution. Manipulation of the panicle height in glasshouse and field trials (using growth regulators or by using similar genetic lines with different panicle heights) has confirmed that plants with low panicle heights allow leaves in the upper canopy to intercept more light, and these plants produce a significantly greater weight of groin in each panicle compared with normal plants.



Plants with low panicle heights allow leaves in the upper canopy to intercept more light.

- In studies aimed at using nitrogen levels of the leaves to predict the best times for applying nitrogen fertilizer, a hand-held, field-operated chlorophyll meter accurately estimated leaf nitrogen concentrations, and there was a strong positive relationship between chlorophyll meter readings and the rate of photosynthesis at different growth stages. It thus appears feasible to use chlorophyll meter readings to determine throughout the grow-ing season when any cultivar needs more nitrogen fertilizer.
- The effects of climatic change on rice production can now be simulated through use of the ORYZA1 model. (Results appear in the report on the Irrigated Rice Ecosystem Program.)
- Enhancing INTERCOM, a model for simulating crop-weed competition, has made it possible to improve understanding of the complex interactions between rice and the weed grass *Echinochloa crus-galli*. It can now accurately predict yield losses in direct-seeded and transplanted rice in a range of environments.

Managing diseases and pests

Studies are concentrating on research into the epidemiology and control of rice diseases, and into insect pests and their management.

- Contrary to current practices used by farmers, studies in the Philippines on the impact of spraying insecticides on rice-eating insects and their predators in ricefields have indicated that spraying during the first few weeks after planting considerably increases the risk of pest outbreaks. This is because the numbers of their predators are much reduced. In crops sprayed 20, 38, and 49 days after transplanting, predators were much more abundant in unsprayed fields than in the sprayed fields during the spraying period. Sampling showed that sprays resulted in 4 million more herbivores (rice plant eaters) per hectare at each sampling, and by midseason there were 1 million less predators per hectare. Pests increased nearly fourfold in sprayed fields compared with the unsprayed controls. Early spraying may in fact be the root cause of secondary pest problems such as brown planthopper infestation.
- Complementary research in Vietnam involving the participation of farmers has led the Ministry of Agriculture and Food to endorse a new integrated pest management policy of encouraging farmers to forego using early sprays, thus saving at least 20 percent in spraying costs.
- An egg parasitoid, *Anagrus flaveolus,* has been found to be very efficient at searching for brown planthopper eggs in unsprayed fields. The attack rate generally increased with egg density. Natural brown planthopper egg mortality is reduced if fields are sprayed because the parasitoid is extremely susceptible to pesticides.

- Suspensions of spores of two indigenous fungi isolated from the weed grass and sedge species *Echinochloa* crus-*-galli, Cyperus difformis, Fimbristylis miliacea,* and from the semiaquatic weed *Sphenoclea zeylanica* have consistently provided excellent control of these weeds in regulated environment studies. Research on using a leaf blight pathogen on *S. zeylanica* as a potential biological control agent is the most advanced.
- The sheath blight fungus *(Rhizoctonia solani)* isolated and inoculated onto IR72 from plants commonly found in rice-based systems, including maize, sorghum, wheat, sugarcane, *Rottboellia* sp., *Cyperus* sp., cabbage and potato, successfully caused cross infection with all tested plants, with the exception of potato. This information is important in predicting the development of sheath blight epidemics in rice-related cropping systems.

Impacts and constraints on farmers

Investigation of the biological, physical, and socioeconomic constraints farmers face in all types of rice farming permits assessment of their needs and identification of the factors that will allow them to accept new technologies and practices. Studies also look into the impact of new technologies and practices on various socioeconomic groups and members of farm households. They also monitor such factors as production, trade, consumption of rice, and economic conditions, and government policies overall, which affect demand for rice in countries and regions.

- Analysis of what caused increased rice production in Myanmar showed that greater use of chemical fertilizers contributed “almost half of the growth since 1974. Modern cultivars contributed 37 percent; increasing the area under irrigation, 12 percent. A decline in rice production and yield has occurred since 1987 and is due mainly to a rapid increase in the price of fertilizer compared with receipts from rice. This has reduced fertilizer use by about two thirds.
- The productivity of rice farming in Indonesia increased an average of 2.9 percent per year from 1969 to 1989. Studies of the impact of technological change on this improvement showed that adoption of modern rices contributed 28 percent of the growth, while government programs on agricultural intensification contributed 27 percent, and improved literacy rates, 20 percent. Third-generation IRRI varieties IR48 and IR64 (released after 1985) contributed 10 percent to productivity growth, second-generation IRRI varieties, 9 percent, and locally improved varieties, 7 percent. Varietal improvement programs have had, and continue to have, a significant impact on increasing the efficiency of rice cultivation.
- Studies in eastern India on the division of labor between the sexes in farm families show that female workers, particularly those from lower castes contribute considerable amounts of labor, and they must not be ignored. Because of the low productivity of the land, men have to search for work in the cities to supplement the family income, with the result that female *de facto* heads of households will increasingly take over management of rice farms. Increasing rice production through application of new knowledge and technologies will not be achieved if this fact is not taken into account, especially since the majority of female workers are illiterate, and will face competing demands on their time from household duties and agricultural responsibilities—quite possibly to the detriment of their children’s welfare.

India. R. Cabrera

Studies in eastern India show that women are increasingly taking over management of family rice farms. Increasing rice production through application of new knowledge and technologies will not be achieved if this fact is not taken into account.

International Program Highlights

Philippines, H. Conklin

Even after several decades of collecting and conserving the genetic diversity of rice, the need to preserve and share this precious resource continues. IRRI holds collected germplasm in trust and safeguards it in its genebank, the International Rice Germplasm Center.

GERMPLASM CONSERVATION, DISSEMINATION, AND EVALUATION

Expenditure 1993—$944,000
Approved budget 1994—$1,030,000
Budget planned 1995—$1,050,000
Internationally recruited staff—3
Nationally recruited staff—17

Germplasm conservation, dissemination, and evaluation objectives

- To ensure comprehensive conservation of rice genetic resources
- To provide national programs, IRRI and other international centers with a mechanism to facilitate and promote the systematic exchange and use of rice germplasm
- To improve rice germplasm information management and data analysis and management
- To evaluate promising cultivars, elite breeding lines, traditional cultivars and genetic donors through a network of multilocation trials to facilitate the genetic improvement of rice.

Program goal

To strengthen long-term conservation and worldwide dissemination, exchange, and evaluation of rice germplasm to increase sustainable yields and broaden the genetic base of farmer's cultivars.

Projects

- Conservation of rice genetic resources
- International Network for the Genetic Evaluation of RICE (INGER)

Rationale

Even after the major efforts of IRRI and other institutes over several decades to collect and conserve the genetic diversity of rice, the need to preserve and share this precious resource continues. IRRI holds collected germplasm in trust and safeguards it in its genebank, the International Rice Germplasm Center, and by dispatching duplicate sets to other safe centers. The International Network for Genetic Evaluation of Rice (INGER) provides a mechanism for global collaboration among rice breeders. It involves scientists from national rice research programs, IRRI, and other international centers, who work together to improve rice.

Highlights

Conserving the world's rice genes

Renovation and upgrading of the genebank facilities and related services has been going ahead over the past 3 years, although the main phase of the renovation began during 1993 with the construction of a seed-drying room and improved seed-processing facilities.

- Seed inventory and germplasm characterization: completion of the inventory reveals the genebank contains 74,700 *Oryza sativa* samples, 1,330 *O. glaberrima*, and 2,216 wild species; 2,073 *O. sativa* samples were characterized in the field, and panicles from 1,443 accessions were characterized in the laboratory.
- Germplasm distribution: 8,642 accessions of *O. sativa* were distributed to institutions in 29 countries during 1993; some 1,900 accessions of wild rices were also sent out in response to 32 requests from institutions in 12 countries; 62 accessions of *O. glaberrima* were requested by eight scientists from five countries; 14,980 accessions were distributed to IRRI scientists.
- Germplasm acquisition: 326 seed samples were received either by direct collection or donation; collaboration with the regional genebank of the Southern Africa Development Council achieved the first comprehensive collection of wild rices (46 accessions) from Zambia, along with six accessions from Botswana. A satellite-based global positioning system was used for the first time to locate sampling sites accurately.

International Network for the Genetic Evaluation of Rice (INGER)

INGER promotes genetic diversity in rice crops throughout the world. It achieves this by promoting worldwide exchange of seeds of different rice varieties and evaluating promising cultivars, elite breeding lines, traditional cultivars, and genetic donors through a network of trials at many sites in different environments where they are grown under different environmental stresses, such as disease, drought, or adverse temperatures. Each year INGER prepares nurseries (catalogued sets of seeds). Appropriate selections from these are provided to participating institutions for testing and evaluation under local conditions and for use in national breeding programs.

- The INGER Global Advisory Committee's annual review of results from nurseries showed that for the 1992 nurseries, 19 different nursery types – consisting of 638 sets made up of 1,527 test entries originating from 44 national agricultural research systems and four

IRRI's genebank receives rice seed samples from many countries, including Cambodia (top). It currently contains more than 78,000 samples of *Oryza sativa, O. glaberrima* and wild rices. In 1993, a travelling INGER workshop reviewed the need for improved germplasm for problem soils, such as this salt-affected area in Thailand (bottom).

international centers—were assembled, dispatched, and evaluated in 35 countries in Asia, North Africa, sub-Saharan Africa, and Latin America, and also Australia. More than 500 entries were tested in 10 nurseries selected to represent different rice ecosystems, and more than 1,000 entries in nine nurseries selected for evaluation against different environmental stresses were tested over a wide range of conditions.

- Seven hundred and thirty six entries from the 1992 nurseries were used as parents in national breeding programs in 16 countries, and a further 505 were evaluated further in eight countries; three INGER entries were released in Cambodia, and one in India.
- For the 1993 nurseries, 776 sets of 15 types of nurseries reached 46 countries—about 600 of these went to 18 Asian countries, and the remainder to four in West Asia, two in North Africa, seven in sub-Saharan Africa, and five in Latin America, and also to Papua New Guinea, the United States, and Italy.
- Site-monitoring visits each year help exchange of information and. ensure the quality of trials. Visits in 1993-1994 have consisted of a disease-monitoring tour to Indonesia and the Philippines to observe and evaluate INGER and. national trials for disease resistance, and a traveling workshop of problem soils, held in Indonesia and Thailand, to review the need for improved germplasm in problem soil areas. Recommendations of the traveling workshop included the observations that the national agricultural systems should provide a wide range of germplasm to broaden the diversity of INGER nurseries for problem soils, and that, while assembling the International Rice Soil Stress Observational Nursery, INGER should give priority to new genotypes developed from improved tolerant lines and traditional cultivars.
- INGER activities in Africa, supported by the German government, were reorganized to take the activities of WARDA into account and to strengthen INGER activities in eastern, central, and southern Africa; screening and evaluation of the African rainfed lowland rice nursery set indicated that more than a dozen lines appeared promising, and appreciable levels of resistance to rice yellow mottle virus and blast were also identified; 15 rice varieties were released, in seven countries, namely Benin, Burundi, Kenya, Mozambique, Malawi, Uganda, and Zambia.
- In South America, 27 rice varieties were released during the 1991-93 period; observational nursery trials indicated 157 lines were suitable for favorable conditions, and 53 for unfavorable conditions.

NETWORKS

Expenditure 1993—$693,000
Approved budget 1994—$300,000
Budget planned 1995—$330,000
Internationally recruited staff—2
Nationally recruited staff—4

Program goal

To strengthen collaboration and facilitatethe exchangeof technologies, research methodologies, and knowledge among national rice research systems, IRRI, and other international centers.

Networks

- Interantional Network on Soil Fertility and Sustainable Rice Farming
- Asian Rice Farming Systems Network
- Integrated Pest Management Network
- Crop and Resource Management Network

Rationale

In recent years, IRRI has coordinated three networks as a means of spreading technologies, research methodologies, and knowledge: the International Network on Soil Fertility and Sustainable Rice Farming (INSURF), supported by the Swiss Development Cooperation; the Asian Rice Farming Systems Network, supported by the Canadian International Development Research Centre (IDRC); and the Integrated Pest Management Network, which has also been supported by the Swiss Development Cooperation. INSURF ended during December 1993.

IRRI's Medium-term Plan has recognized the need for two separate but interlinked types of networks-covering research, and technology evaluation. The previous networks covered both. The research activities of the three networks are therefore being incorporated into the institute's ecosystem-based research programs, research networks and consortia, where, along with the national research programs and other international centers, they will supply prototype technologies. Technology evaluation will be taken over and improved by a new Crop and Resource Management Network.

Highlights

International Network on Soil Fertility and Sustainable Rice Farming (INSURF)

INSURF commenced in 1988, Participating countries included Bangladesh, China, India, Indonesia, Lao PDR, Madagascar, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam. Five initial subnetworks evolved into four topic-based resource centers and four ecosystem-based networks.

The resources centers have concentrated on green manuring practices, especially use *of Sesbania* green manures, based at Tamil Nadu Agricultural University, India; use of azolla, the floating water fern, to increase the soil nitrogen supply, based at the Fujian Academy of Agricultural Sciences, China; maintaining good nutrient balance in the soil, especially sulfur and micronutrients such as zinc, based at the Philippine Rice Research Institute (PhilRice) and. the University of the Philippines Los Baños; direct seeding, based at the Malaysian Agricultural Research and Development Institute.

Subnetworks have focused on acid upland ecosystems, based at the Sukarami Research Institute for Food Crops and the Center for Soil and Agroclimatic Research, Indonesia; unfavorable rainfed lowland systems, based at the Soil Salinity- Research Section of the Royal Thai Department of Land Development; favorable rainfed lowland environments, based at the Sukamandi Research Institute for Food Crops and the Center for Soil and Agroclimatic Research, Indonesia; and irrigated lowlands, based at IRRI, Philippines.

INSURF has:

- trained 274 participants from 25 countries and 115 organizations;
- successfully promoted adoption of ways of improving the efficiency of nitrogen fertilizer use in participating countries;
- provided support to national programs carrying out research into green manuring, yield declines, and the long-term effects of applying chemical fertilizers; and
- promoted improved soil fertility management practices for use with difficult soils.

Asian Rice Farming Systems Network (ARFSN)

The ARFSN collaboration promotes between national researchers, IRRI, and other international centers to identify more productive rice-based farming systems acceptable to small-scale farmers in various rice ecosystems. Most activities have been conducted in farmers' fields with farmer participation, although some component technology research has been done at experiment stations. The network has collaborators in 17 countries- Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Madagascar, Malaysia, Myanmar, Nepal, Pakistan, Philippines, South Korea, Sri Lanka, Thailand, and Vietnam.

The achievements of the network have included:

- institutionalizing the farming systems approach in the 17 participating countries;
- popularizing use of rice-legume, rice-fish, and crop-animal production systems, and also use of improved agricultural tools and equipment for intensive cropping;
- finding out and including the concerns of farmers, especially women farmers,

into rice-based farming systems research; and

- providing training for more than 500 scientists on cropping and farming systems research.

The activities of the network have fallen into five segments: cropping pattern testing, rice-fish farming systems, crop-animal systems research, women in rice farming systems, and use of geographic information systems.

Women in rice farming

Research in collaboration with Indonesia, Nepal, the Philippines, and Vietnam at key sites representing the irrigated, rainfed lowland, and upland rice ecosystems has had two aims-to assess the roles of men and women in different rice ecosystems with special emphasis on identifying the needs of women, and to design and evaluate technologies that increase women's productivity, and enhance their incomes and those of their families. Results included:

- Studies of 200 households in two irrigated villages in Vietnam indicated that one in five women substituted, for male labor and sprayed pesticides; only 2 percent used masks, although more than half took some precautionary measures; and only 11 percent had heard about integrated pest management and the role of natural enemies in controlling pests. Thus women as well as men need training in pest and disease management.
- Studies in the Philippines of the adoption of a portable IRRI-designed rice mill showed that this depended on social factors as well as on technical performance. The mill appeared to be generally well received by women because it reduced the drudgery of hand-milling rice and created income for the women's association, which, in turn, allowed them to obtain low-interest loans, It also improved their status in the family and community by empowering them to make decisions, manage and operate a machine, and to have control of the income generated from the milling services. The amount of rice broken during milling needs reducing, but it is hoped that milling rice can become a small industry for landless people in remote areas.

Women have generally accepted this IRRI-designed portable rice mill because it reduces the drudgery of hand milling, creates income, and improves their status in the family and community.

A Javellana

Integrated Pest Management Network

This network has focused on interdisciplinary research that involved both scientists and extension specialists. Diagnostic workshops have enabled national teams to develop research, extension, and policy priorities, Country teams have also evaluated the farmer-participatory approach as a means of communicating integrated pest management concepts. Results have included:

- During a consultation workshop organized in response to recent outbreaks of brown planthopper and ragged stunt virus in Cantho Province, Vietnam, researchers attributed the sudden outbreaks to planting susceptible varieties.
- As they evaluated the farmer-participatory approach in China, Malaysia, Philippines, Thailand, and Vietnam, rice farmers realized in all cases that early spraying for leaf feeders did not result in higher yields. They subsequently stopped early spraying. In 1993, the Ministry of Agriculture and Food Industries in Vietnam endorsed the "no early insecticide spray" policy as standard practice in rice production.

Crop and Resource Management Network

Preparation for this new network went ahead during 1993. This new technology evaluation network will build on the experience of the previous networks, but will have new aims and operating procedures. It aims to encourage government agencies and non-government organizations in participating countries to try out prototype technologies coming from research, adapt them, and bring them into general use. Thus, in performing its task, the new network will help ensure a smooth flow of relevant technology-and related information from research institutions to the national extension programs,

NATIONAL RESEARCH SERVICES

Expenditure 1993—$1,169,000
Approved budget 1994—$840,000
Budget planned 1995—$910,000
Internationally recruited staff—5
Nationally recruited staff—3

Program goal

To accelerate progress in a selected number of national systems through country- and ecosystem-specific support programs.

Projects
Southeast Asia
South Asia, West Asia, and North Africa
Eastern, Southernb,and Cenral Africa

Rationale

Mutually beneficial scientific collaboration can only take place between strong, effective, and committed partners. In IRRI's experience, close working partnerships grow as the research capacity of national partners increases.

Highlights

Bangladesh

The third and final phase of the Bangladesh Rice Research Institute (BRRI)-IRRI research and training project supported by funds from the United States Agency for International Development and the Canadian International Development Agency ended in June 1993, having contributed to remarkable results that included:

Vietnam, R. Cabrera

Madagascar, R. Kendrick

- Bangladesh becoming self-sufficient in rice production-an achievement that would not have been possible without the BRRI research, which has resulted in paddy production rising from 22.3 million tons in 1985 to 27.8 million tons in 1992 from much the same area of cultivation;
- modern varieties being released by BRRI accounting for 68 percent of the total rice produced in Bangladesh; and
- BRRI being able to take its place as an effective collaborator in rice research and in the international research networks and consortia.

Bhutan

Joint studies by ISNAR and IRRI to assist the Government of Bhutan to refine its research priorities, particularly for rice-based farming, concluded that:

- rice research clearly deserves the greatest attention, compared with research on maize and. wheat;
- the low-altitude rice regions should be of high priority, and reallocation of resources from mid- and high-altitude environments is warranted; and
- research on rice cropping intensification deserves highest priority.

IRRI's collaboration with Bhutan has been supported by IDRC since 1984.

National research services objectives

- To help strengthen the capabilities of selected national agricultural research systems
- To provide, through regional projects, research services to countries with relatively small but important rice production areas
- To develop mechanisms to expand the spillover effects of nationally developed technologies to other countries within the same agroecological zone

Cambodia

The Cambodia-IRRI-Australia Project, formerly called the Cambodia-IRRI Rice Project, accounted for most of IRRI's activities in Cambodia during 1993. These resulted in:

- approval for release of variety IR Kesar (IR48525-100-1-2), a quick-maturing variety suitable for wet and dry season cultivation that performed better than earlier releases and was resistant to local populations of brown planthopper
- the demonstration of a lack of nitrogen and phosphorus in all the main soils used for rice-growing in Cambodia, and a lack of potassium and sulfur in soils representative of more than half the total rainfed rice area.

Egypt

Collaboration continued with the Egyptian Rice Research and Training Center but entered a winding-down phase as the contract ends in June 1994. The 1993 rice crop averaged 7.8 tons per hectare nationally, a slight increase that reflects continued farmer acceptance of new varieties and management practices.

Lao PDR

IRRI has been working with the Lao Government since 1990 to improve productivity in the rainfed lowland and upland rice ecosystems.

- By the end of 1993, the Lao PDR-IRRI Rice Research and Training Project, supported by Swiss Development Cooperation and charged by the Lao Government with development of a national rice research program, had completed establishment of a national rice research network.
- The National Agricultural Training Center was completed in Vientiane late in 1993 with support from the Swiss government; training courses, com-mencing in 1994, will be coordinated through the IRRI Training Center.
- Two glutinous rice varieties known by the local Lao names of "Niaw Thadokham 1" and "Niaw Thadokham 2", and which were derived originally from crosses between IRRI and Thai lines, were released for rainfed lowland and irrigated environments.
- The national rice research program issued fertilizer recommendations for the major soil types in central and southern Lao PDR, following extensive studies by the Lao PDR-IRRI Project.

Madagascar

With financial support from USAID, a four-person IRRI team is working with scientists of the National Center for Applied Research for Rural Development (FOFIFA) to make rice farming more productive and profitable in Madagascar.

- Joint studies by FOFIFA scientists and their IRRI colleagues, produced 69 new crosses, and 60 earlier crosses ad-vanced to the F_2 generation. Also at the request of FOFIFA, a proposal was prepared to facilitate official release of rice varieties in Madagascar.
- Close collaboration with non-govern-ment organizations and development agencies continued to assist rice farmers in different regions.

Mozambique

A diagnostic survey, focusing on the rainfed lowland rice ecosystem, carried out in collaboration with Instituto Nacional de Investigacao agronomica (INIA), and Sementes de Mozambique Lda. (SEMOC) concluded that:

- weeds, drought and crop establishment were high-priority problems for rice growing that could be addressed by research
- raising the productivity of the whole system would require testing of alternative and improved crops for upland gardens and for crops planted after rice.

Myanmar

Collaboration with Myanmar focuses on the uplands, with support from IDRC and Deutsche Welthungerhilfe.

- A survey conducted at Aungban and Kyaukme that focused on the division of labor and household responsibilities among rural men and women in farming systems revealed that draft animal care, land preparation, inter-row cultivation, marketing of farm produce, and threshing are mostly done by men, while planting, weeding, and harvesting are done by women.
- Three pieces of IRRI-designed equip-ment—a treadle thresher, a low-lift water pump, and a rice hull stove—are being manufactured and widely used in Myanmar. The treadle thresher, which was developed at IRRI by a Myanmar scholar, was rapidly adopted, with about 1000 units being manufactured in 1993. An estimated 5000 conical grate ricr hull stoves are in use.

Sri Lanka

A grant from SAREC has been enabling collaboration between scientists of the Sri Lankan Department of Agriculture and IRRI.

IRRI, A. Javellana

IRRI-designed equipment is being manufactured and widely used. In Myanmar, an estimated 5000 conical grate rice hull stoves are in use.

- Rice blast was implicated in yield declines since the race predominant at one location (Batalagoda) was different from that at another (Peredeniya). This indicated the presence of different types of blast pathogen.
- The concern of the Sri Lankan Department of Agriculture that the tungro virus disease complex is involved in “yellowing” disorder appears to have been upheld, following positive reactions for some plants from different areas to tests for the virus using antisera provided by IRRI.

Vietnam

Collaboration has continued in the areas of integrated pest management, integrated nutrient management, and improved water management, with financial support from the Australian Government, Strength-ening of the Cuu Long Delta Rice Research Institute has continued with support from the United Nations Development Program.

- IRRI researchers, in collaboration with researchers at the University of Cantho, have tested a technique for flushing acid sulfate soil using Mekong Delta floodwater as it recedes. Rice yields of between 4.5 and 5.5 tons per hectare were obtained on mildly acid sulfate soils. This method of flushing is superior to conventional leaching by irrigation during the dry season.
- Surveys in the Mekong Delta showed scavengers to be the predominant insect species. Thrip injury was very visible, but on-farm experiments indicated insignificant yield losses. Blast, sheath blight, and. bacterial black rot remained problems in many parts of Vietnam.
- Analyses done at IRRI confirmed severe potassium deficiency is a constraint in rice systems in Vietnam, but more thorough testing is needed to identify those areas where lack of soil potassium limits yields.
- As part of the process of strengthening the Cuu Long Delta Rice Research Institute IRRI scientists completed short-term assignments in hybrid rice, integrated pest management, integrated nutrient management, engineering, gender analysis, training, liaison, and monitoring. Progress was made in rice-based farming systems research and in strengthening the institute’s extension network. Eight staff members of Cuu Long Delta Rice Research Institute came to IRRI for short-term non-degree training at IRRI, and one went to Thailand; four staff members came on a study tour to the Philippines.

Vietnam, R. Cabrera

Dr. Buichi Buu, one of eight staff members of Cuu Long Delta Rice Research Institute who came to IRRI for short-term non-degree training.

TRAINING

Expenditure 1993—$1,104,000
Approved budget 1994—$1,240,000
Budget planned 1995—$1,350,000
Internationally recruited staff—2
Nationally recruited staff—19

Program goal

To train rice scietists and other professionals through traditional and innovative approaches and in close partnership with our client countries.

Projects
- Degree and postgraduate training
- Development of short-term courses
- Courseware development
- Collaborative in-country training

Rationale

IRRI has run training programs since 1962 that boost the capacity of developing-country rice scientists to solve domestic rice production and utilization problems in their own countries. Training courses have evolved from relatively basic courses in rice production and. research methodologies to courses and fellowships that teach new highly sophisticated techniques. Current major program emphases are to provide training opportunities that parallel IRRI's research priorities, to share responsibilities for training, and to promote collaboration among national rice research institutes and universities. Increasingly training is being provided jointly by IRRI and. national trainers at institutions other than IRRI, or in-country by IRRI-trained trainers, with IRRI support.


IRRI, A. Javellana

Highlights

Degree and postgraduate training

Two hundred and fifty six scholars, fellows, and on the-job trainees from 29 countries in Asia, Africa, and the Americas participated in IRRI degree or postdegree programs; 121 completed their training during 1993.

Seventeen new titles were produced in various formats: namely eight pulications, five instructional videos in English and Khmer, and four slide-tape modules.

Short courses at IRRI headquarters

- One hundred and forty seven trainees from 19 countries in Africa and Asia participated in 10 group courses.

Courseware development

- Seventeen new titles were produced in various formats: eight publications, five instructional videos in two languages, and four slide-tape modules.
- Thirteen farming systems research slide-tape modules were translated into Chinese with the assistance of Chinese experts as part of the increasing emphasis on having IRRI training center staff work closely with national counterparts to adapt and translate IRRI-developed materials for use in national training programs.
- IRRI's rice production research course was successfully conducted at Pathum Thani Rice Research Center, Thailand, by a team of Thai and IRRI trainers for the second consecutive year.
- Preparations were made to cant out three other IRRI courses in-country—Irrigation Water Management, at Kasetsart University in Thailand. in collaboration with the International Institute for Irrigation Management (IIMI); Integrated Pest Management, with the National Crop Protection Center at the University of thePhilip-pines Los Baños in the Philippines; and Engineering for Rice Agriculture, with the Indian Institute of Technology., Kharagpur, West Bengal.
- Thirteen courses were run in-country in Thailand, Cambodia, Vietnam, Lao PDR, Bangladesh, Tanzania, Indonesia, and the Philippines; plans were formulated to begin an in-country rice production research training program in Laos PDR in 1994; a nondegree training plan was formulated for rice scientists in Bhutan and China.

Training objectives

- To provide opportunities for doctoral and postdoctoral research, and midcareer training of selected scientists in areas of mutual interest to national programs and IRRI
- To offer group training courses in specialized, upstream areas that parallel IRRI's research activities at headquarters and at consortia key sites
- To develop, evaluate, and share training materials in forms that are readily adaptable and translatable to meet specific national and regional training needs
- To facilitate shifting responsibility for implementing national and regional versions of IRRI-developed courses
- To anticipate and respond to national program training needs by conducting needs assessments and by developing and jointly implementing in-country training programs

Group training collaboration with CGIAR centers

Collaborators	Training course
ICRAF-IRRI	Land Use Systems, BIOTROP, Bogor, Indonesia, April-May 1993
IRRI-CLARM	Rice-Fish Farming Systems, Central Luzon State University, Philippines, December 1993
IRRI-IIMI	Irrigation Water Management, Kasetsart University, Thailand, February-March 1994

Short courses run at IRRI during 1993

Engineering for rice agriculture—6 weeks
Weed control—8 weeks
Hybrid rice seed production—4 weeks
International Network on Soil Fertility and Sustainable Rice Farming (INSURF)—8 weeks
Irrigation water management—6 weeks
Rice biotechnology—8 weeks
Integrated pest management—8 weeks
Rice seed health—5 weeks
Methane emission measurement—3 weeks
Gender analysis and its application to rice-based farming systems research—2 weeks

INFORMATION AND KNOWLEDGE EXCHANGE

Expenditure 1993—$1,913,000
Approved budget 1994—$1,680,000
Budget planned 1995—$1,730,000
Internationally recruited staff—5
Nationally recruited staff—14

Program goal

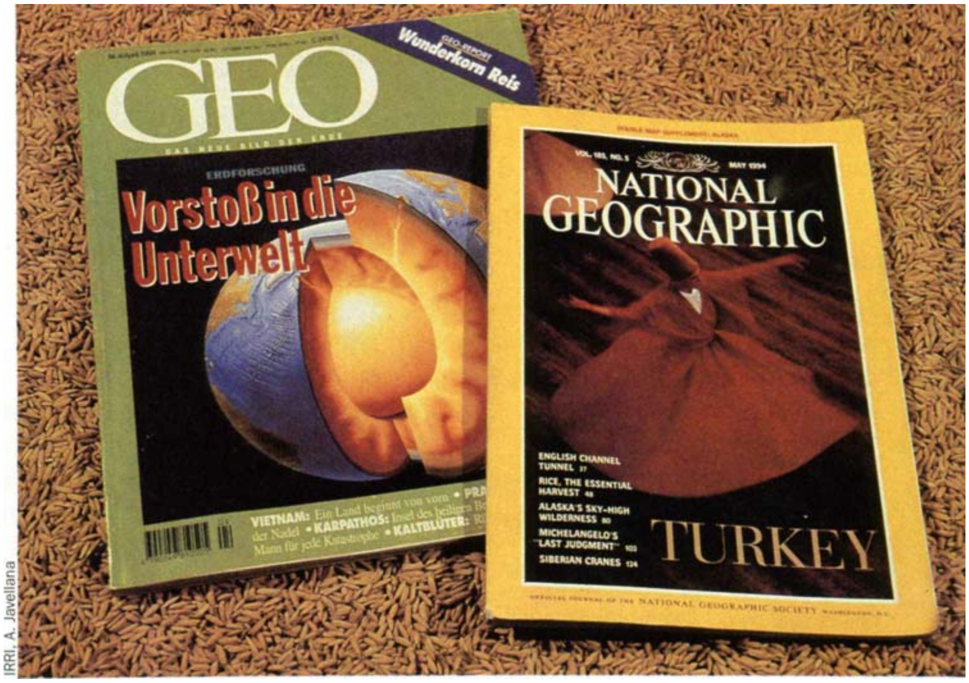
To create an information environment within which all IRRI clients have timely, appropreate, and economical access to rice-related information.

Projects

- Public awareness and general publication
- Scientific publication
- Library and documentation service
- Conference and workshops

Rationale

Research results have little impact unless they are disseminated and the knowledge gained is exchanged. IRRI is specifically obliged to publish and disseminate its research findings, maintain a library that makes the world's literature on rice accessible to scientists everywhere, and organize conferences for discussing current problems, research strategies, and results.



IRRI, A. Javellana

Highlights

Public *awareness*

Three hundred and twenty five news articles about IRRI known to have appeared, in newspapers and magazines around the world as a result of distribution of 35 IRRI press releases and other media activities. The actual number of articles appearing on IRRI was probably much higher since many were instituted by news agencies such as the Associated Press, Agence France-Presse, InterPress, Gemini News Features, New China News Agency, and Depthnews.

- "Australia-IRRI Day", jointly sponsored in Canberra, Australia, in April 1993 by the Crawford Fund for International Agricultural Research and IRRI, proved very successful in improving public awareness in Australia and beyond on the population, poverty, environmental and food security problems of the world in general, and Asia in particular; proceedings published by IRRI for the Crawford Fund as the book *Food comes first in Asia* were widely distributed around the world. Preparations for a "United Kingdom-IRRI Day" and a "Japan-IRRI Day" were under way.
- Eleven issues of I*RRI Hotline*, a newsletter for decisionmakers and donor representatives issued--Japanese, Bahasa Indonesia, and French editions intorduced; four issues of *IRRI Reporter* newsletter and the IRRI corporate report *Rice in Crucial Environments* published; 10 brochures about cooperation with selected counries published in the *Facts about cooperation* sereis in English and appropriate national languages; new editions of Facts *about IRRI* and *IRRI Rice Facts* published in English, Japanese, and Chinese.
- Visits made to IRRI by 74 international and Philippines journalists among them writers and photographers of *The Financial Times*, *Asiaweek*, Agence

Three hundred and twenty five news articles about IRR are known to have appeared in newpapers and magazines around the world as a result of distribution of 35 IRRI press releases and other Public Awareness activi-ties.

France-Presse, *Joong-Dong Daily News, Guangming Daily,* Philippine News Features, *Le Sillon Roman, Westdeutscbe Allgemeine Zeilung, lnternational Agricultural Development,* and Oregon Public Broadcasting, plus freelance journalists serving publications in Indonesia and Denmark.

- Forty-two local journalists attended a seminar on sustainable agriculture hosted by IRRI and PhilRice in Cebu City, Philippines in May 1993. Fifteen members of the Foreign Correspondents Association of the Philippines, also visited IRRI in June 1993 for a briefing on the Institute, economic trends for rice, genetic resources, increasing rice productivity, and biotechnology. IRRI was also one of five centers that presented the seminar "Cutting Edge Science for Earth-Friendly Farming" to 29 journalists and 73 policymakers at International Centers' Week in Washington, D.C., USA, which led to articles and broadcast features about IRRI in *New Scientist, The Economist,* and other print media, and on CNN International Television and on the U.S. National Public Radio.
- Two public awareness videos produced and distributed within the Philippines and internationally—*Against the Grain* on rice survival in the uplands, and *Creating Rices* on rice breeding for all ecosystems.

Scientific publications

- Twelve new books published in English, including seven as dual imprints, a further three jointly produced with commercial publishers; a further three translations of IRRI books copublished, bringing the number of IRRI books copublished since 1982 to 30—in 45 languages in 30 countries.
- Approximately 56,000 copies of major IRRI publications well distributed.
- *International Rice Research Notes* revamped and four issues distributed to more than 11,000 addresses in 145 countries.
- One hundred and seventy six scientific papers or books by IRRI staff published in the international scientific literature

Library and Documentation Services

- Six thousand citations of the library's latest acquisitions published in four issues of the m designed *Rice literature update* generated 690 requests for reprints from 60 countries.
- The monograph collection (books, pamphlets, reprints and translations) rose by 3,545 titles to 105,500; serial titles increased by 172 to 4470.

Conferences and workshops

- Forty one conferences, workshops, and meetings were hosted or cosponsored by IRRI.

Information and knowledge exchange objectives

- To create, produce, and disseminate information materials that cover rice research and related issues, that create public awareness, and that are accurate, interesting, and useful
- To improve the quality of publication and dissemination of IRRI research results and promote a global exchange of rice research information among scientists
- To make rice research information accessible through electronic communication technologies
- To maintain the IRRI Library and Documentation Services as the world's major repository of rice literature and facilitate access to the collection by rice scientists worldwide
- To serve as a convenor, clearinghouse, and forum for dialogue among IRRI partners and the Institute in setting program strategies and priorities, planning research activities, sharing research results, and promoting discussion on institutional and policy issues

IRRI publications released in 1993

Rice in deepwater. D. Catling 1992. 552 p. (With The Macmillan Press Ltd)

Systems approaches for agricultural development. Edited by F, Penning de Vries, P. Teng and K, Metselaar 1993, 542 p. (With Kluwer Academic Publishers)

Nodulation and nitrogen fixation in rice: potential and prospects. Edited by F. Cuevas-Perez 1992. 288 p. (With ClAT)

Pesticides, rice productivity, and farmers' health: an economic assessment. A. C. Rola and P. L. Pingall 1993. 100 p. (With World Resource Institute)

Rice in human nutrition. B. O, Juliano 1993. 162 p. (With FAO)

Program Report for 1992. 1993. 316p.

1993-1995 IRRI rice almanac. 1993. 142 p.

Modelling crop-weed interactions. Edited by M. J. Kropff and H. H. van Laar 1993. 274 p. (With CAB International)

IRRI 1992-1993: rice in crucial environments. 1993. 65 p.

Conferences/workshops/meetings 1993

Bhutan-IRRI Work Plan Meeting at IRRI
Strategy Review Meeting, at IRRI
SARP Workshop on Simulation of Potential Production in Rice, Aduthurai, India
Training Workshop on Incorporating Gender Concerns in Farming Systems Research and Extension, West Bengal, India
PhilRice-IRRI Annual Work Plan Meeting, at Phil Rice, Philippines
Traveling Workshop to Rice-Wheat Lands in Punjab, Pakistan
Workshop to Review and Synthesize Previous Rice-Wheat Research, Lahore, Pakistan
Symposium on Rainfed Lowland Rice Research Consortium, Semarang, Central Java, Indonesia
AARD-IRRI Work Plan Meeting, Bogor, Indonesia
Disease Resistance Monitoring Tour, Indonesia; Philippines
SARP Workshop on Mechanisms of Bacterial Leaf Blight and their Effects on Yield, Cuttack, India
SARP Steering Committee Meeting, at IRRI
BRRI-IRRI Collaborative Research and Training Work Plan, Dhaka, Bangladesh
Second Workshop, on Projections and Policy Implications of Medium- and Long-Term Rice Supply and Demand at IRRI
SARP Workshop on Agroecological Zonation, of Rice, Hangzhou, China
Crop and Resource Management Network Consultation Meeting at IRRI
Japan-IRRI Seminar and Review of Japan-IRRI Shuttle Research Project, Tsukuba; Japan
ICAR-IRRI Work Plan Meeting, New Delhi, India
Sustainable Agriculture: Toward Farmer-friendly and Environment-friendly Rice Farming, Cebu City
Rice IPM Network Study Visit and Workshops, Thailand; China
Upland Rice Consortium Steering Committee Meeting, at IRRI
Colloquium on Small Farm Equipment Quality, at IRRI
Workshop on Microenterprise Development: Small Farm Equipment Entrepreneurship and Employment, at IRRI
Foreign Correspondents Association of the Phillipines Day, at IRRI
Planning Meeting for Asian Rice Biotechnology Network, Bogor, Indonesia
INSURF Site Visit and Planning Meeting, Fujian, China
Problem Soils Monitoring Tour, Thailand; Indonesia
Winrock-JCIE-IRRI-IDEAL Planning Workshop on Educating New Environmental Leadership for Asia, at IRRI
IRRI/UNDP/GEF/EPA Conference on Methane Emission from Ricefields, at IRRI
Second SARP Steering Committee Meeting, at IRRI
IRRI-ECSA Consultative Meeting, at IRRI
International Workshop on Crop-Animal Interactions, Thailand
ORSTOM-IRRI Collaborative Meeting, at IRRI
GTZ-IRRI Project Planning Workshop on Postharvest Technologies in the Humid Tropics, at IRRI Second Regional Meeting of Southeast Asian Forage Seed Production Project, at IRRI
Apomixis Workshop, at IRRI
Rice Sheath Blight Management Workshop, China
Workshop on current Status and Future Direction of Asian NARS Rice-Related Training Programs, Thailand
Workshop on Rice Tungro Disease Management, Malaysia
Workshop on Rice Yield Potential, at IRRI
ARFSN Planning Meeting on Rice-Based Farming Systems Collaborative Research in the Philippines, at IRRI End of Phase I Workshop: at IRRI Rice-Wheat Project, at IRRI

INFORMATION ADMINISTRATIONS

In 1993 IRRI had to face the reality that it received 17 percent less core funding, expresses as 1993 US dollars, than for 1990, Never-theless, two documents--the *Report of the Fourth External Programme and Management Review of the Interna-tional Rice Research Institute (IRRI),* and IRRI's new Medium-Term Plan for 1994-1998—impressed the CGIAR Technical Advisory. Committee sufficiently for it to recommend that IRRI's core budget over the period 1994-1998 be funded 1.4 percent higher than originally recom-mended. However, the core budget for 1994 was still marginally lower than that for 1993.

To cope with the substantial budget reductions, IRRI implemented a major staff adjustment program and intensive cost-cutting measures.

Staff adjustment

Three hundred and thirty five nationally recruited and 10 inter-nationally recruited staff positions were abolished. This brought the insti-tute's staff complement down to slightly less than 1300 employees — almost 1200 fewer than in 1989.

Consequently, when the further reductions in the 1.994 budget became apparent, IRRI found itself in a better position than some other international agricultural centers since many of the hard decisions had already been taken. Its restructuring activities already enabled it to operate as a leaner institution. Any further staff reductions would adversely affect IRRI's ability to implement the Medium-Term Plan.

IRRI awarded Friendship Order by Vietnam

The President of the Socialist Republic of Vietnam awarded the Friend-ship Order of the Vietnamese Government to IRRI to acknowledge the Institute's "very efficient contribution" to food production in Vietnam. IRRI Director General Klaus Lampe accepted the award during the Vietnam-IRRI Rice Conference held in Hanoi in early May, 1994.

Planting modern, early-maturing rice varieties, improving resource management, and implementing appropriate government policies have accounted for Vietnam's recent production increases. Since 1968, Vietnam has released 42 breeding lines. IRRI-bred varieties now cover 60 percent of the irrigated rice-growing area in the Mekong Delta.

Vietnamese scientists have been working closely with IRRI staff. Since 1970, 338 Vietnamese researchers, scholars, and fellows--many of whom now hold key positions in rice research institutions--have received training at IRRI. Researchers at the Cuu Long Delta Rice Research Institute and IRRI, for example, have been collaborating since 1983 to develop hybrid rice technology for farmers in the Mekong Delta provinces.

IRRI, A. Javellana

Work commenced on construction of a level 4 confine-ment greenhouse for transgenic materials and experiments, following approval from the Philippine Department of Environment and Naturasl Re-sources.

A revision of job rankings and salary scales, taking the increased work load into account, was to be completed by mid 1994.

Cost cutting

Cost cutting measures were recommended by a task force that critically reviewed possible areas for reducing costs, increasing efficiency, and streamlining operations in research, international services, finance, and administration. These included freezing internationally recruited staff positions, controlling supplies, rationalizing purchases of equipment, reducing stock items, delaying vehicle replacements, and controlling vehicle use and fuel consumption.

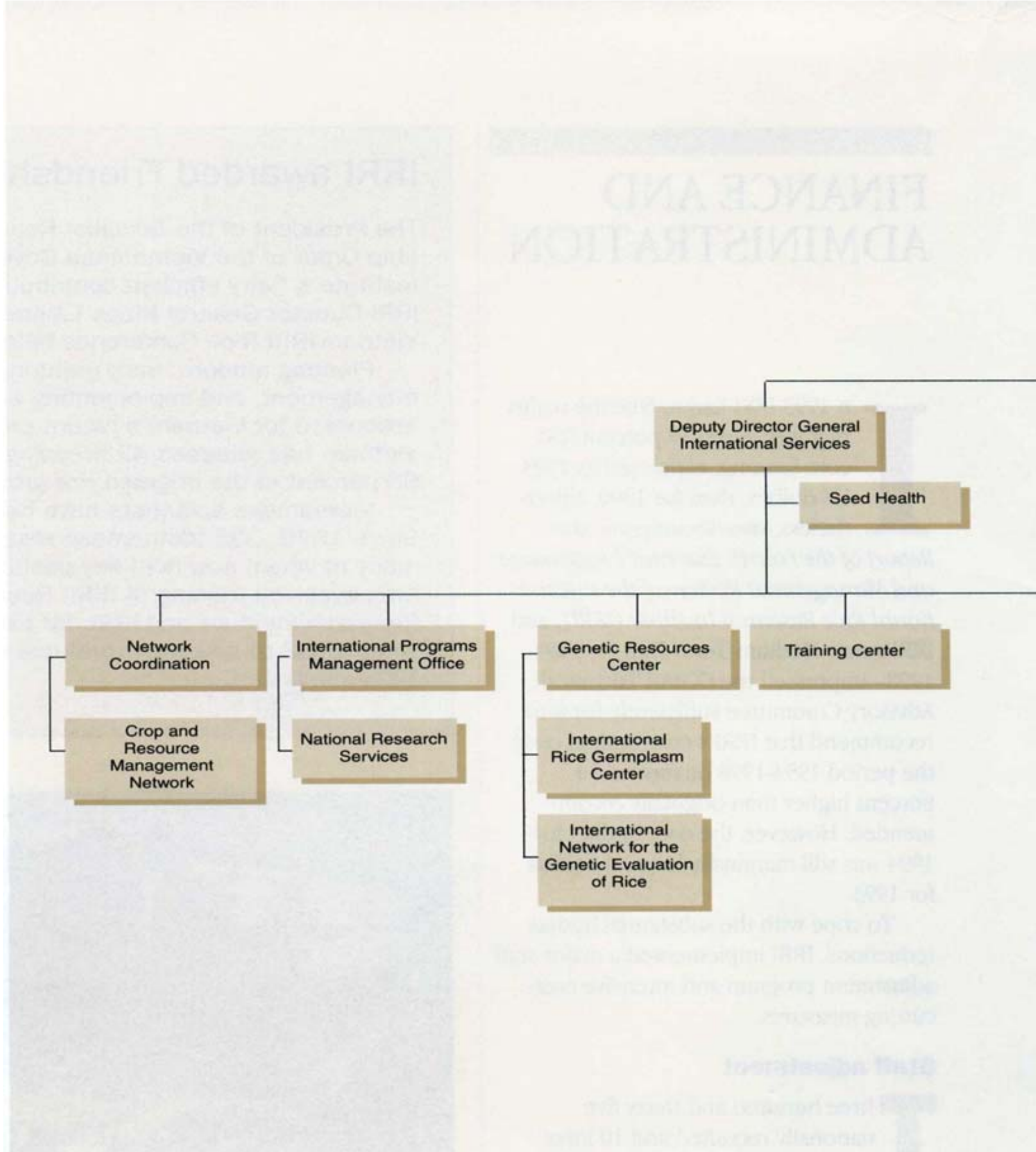
Efforts have been made to reduce the Institute's dependence on overtime, to spend less on telecommunication and postal services, and to reduce travel costs. A computer-based inventory monitoring and control system has been established, and data bases for forecasting material requirements completed. Tighter purchase control, price negotiation, and redistribution of surplus, repairable, and usable materials and equipment has resulted in cost-efficient purchasing.

Staff retirement fund

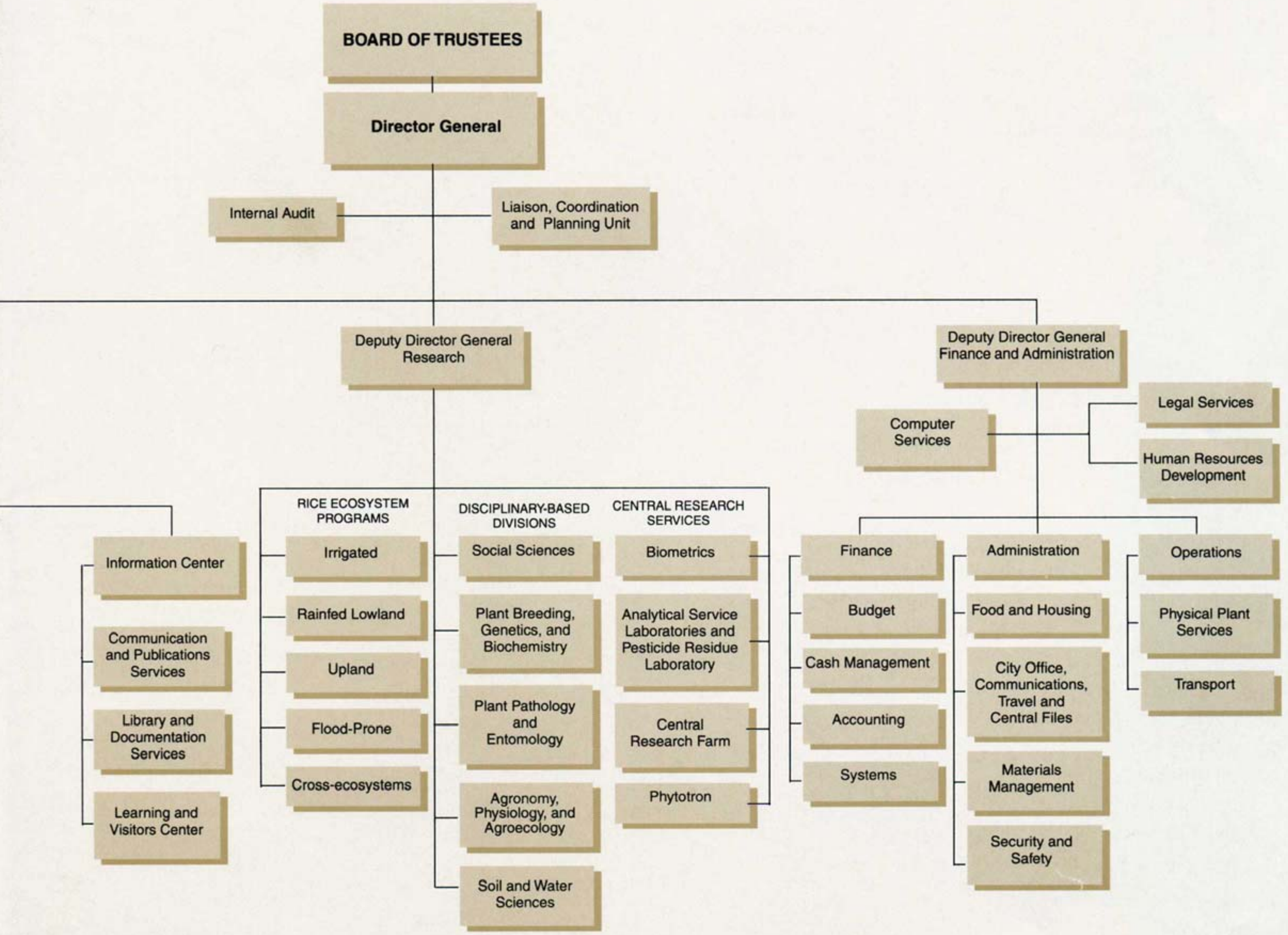
Restructuring of the nationally recruited staff retirement fund in 1992 paid off with enhanced performance in 1993, which resulted in increased accumulations for the staff retirement account.

Renovation and improvement of facilities

The generous support of Canada, the Federal Republic of Germany, France, Italy, Japan, and The Netherlands has enabled rehabilitation, renovation, or upgrading of a number of facilities during the 1993-1994 period. These include:



- completion of renovation of the Phytotron at a cost of $1.7 million—work that has transformed the old unit into one that is state-of-the-art, computerized, energy efficient, and easier and less costly to operate;
- renovation of the Genetic Resources Center, particularly its offices, seed drying room, laboratories, seed packing room, and its active and base collection storage facilities;
- completion of renovation of Chandler Hall, the former administration building following a fire in 1991;
- major upgrading of the library to enhance the physical security of the IRRI collection and to provide more space;
- relocation of Visitors and Conference Services into Chandler Hall;
- preparation of space for a new Learning and Visitors Center that IRRI is establishing;
- completion of construction of the Biotechnology Laboratory in the N.C. Brady Laboratory Annex; and



- upgrading of generator facilities at the IRRI Research Center and installation of an additional generator at IRRI's staff housing.

Work also commenced on construction of a level 4 confinement greenhouse for transgenic materials and experiments, following approval from the Philippine Department of Environment and Natural Resources, after a full review process during 1993 and early 1994.

Computing services

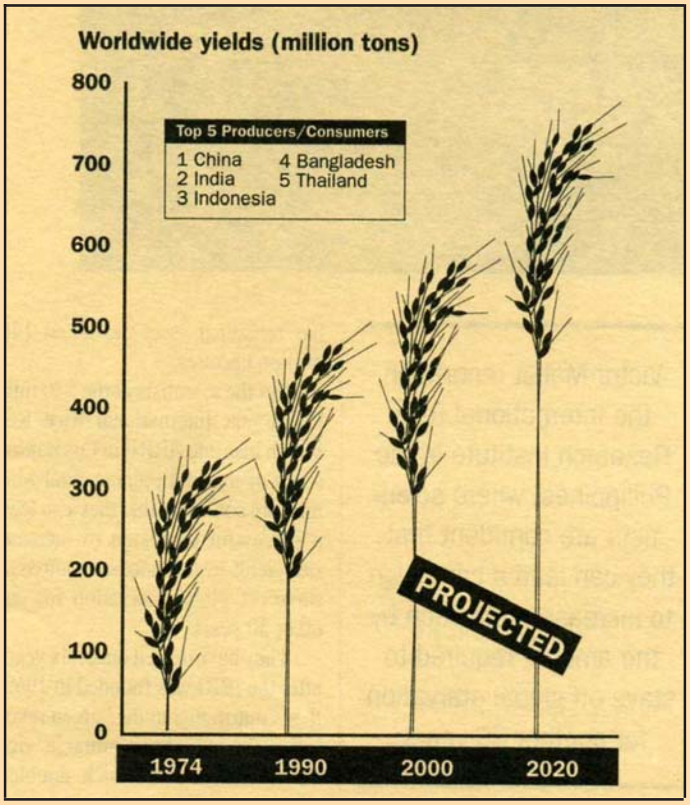
Upgrading of IRRI computer services has continued. Almost every function within IRRI now has access to services on the local area network (LAN), and more than 300 machines are connected. Electronic bibliographies are among new services made available to LAN users. Arrangements have also been made that significantly reduce the cost of electronic communication and allow IRRI to use the evolving features of Internet.

THE STANDARD
(Kenya)
August 2, 1993

Miracle rice may wipe out hunger

Scientists have developed another new breed of super rice. More than a quarter century ago, the discovery of the "miracle rice" IR8 heralded the Green Revolution in Asia. The still unnamed new super rice plant, developed at the International Rice Research Institute in the Philippines, is expected to give a 30 per cent higher yield than current species. The Impact, reports Abby Tan, will be significant for Asia, where 90 per cent of the world rice consumers live.

The gene bank assures that the super rice can be adopted to other rice-producing regions of South America, Africa, Europe and the US.



A new super rice will become a reality by the end of the century--just in time to meet Asia's population boom and a predicted food shortage.

Scientists at the International Rice Research Institute (IRRI), 60 kilometres South of the Philippines capital of Manila, have announced development of a prototype that holds the promise of a dramatic Increase in world rice production.

The breakthrough came 26 years after the first miracle rice, IR8, was developed at IRRI, That heralded the Green Revolution and subsequent higher-yielding pest-resistant varieties have helped avert famine in Asia. No famine has hit the region since the early 1970s.

The still unnamed super rice plant will have 60 per cent edible rice and 40 per cent straw, a more vigorous root system, sturdy, thicker stems and 25 to 30 per cent higher yields than current species.

The most popular strain cultivated in many Asian countries, IR46, yields 10 tonnes per hectare. The super rice will yield up 13 tonnes per hectares.

It is the result of crass-breeding from 150 varieties taken from five countries — China, Japan, Burma, Thailand and Indonesia.

IRRI started breeding the species In 1989. Experimental lots in Los Baños are to be planted this year to multiply the seeds. Testing will continue in the next five to seven years.

"The super rice will be ready by the lure of the century," said Dr. Gurdev Khush, chief of genetics at IRRI, who has been with the institute since 1966 when Ilt8 was introduced.

Ninety per cent of the world's rice consumers live in Asia. The International Food Policy Research institute In Washington predicts a food shortage at the end of the decade when the world population would hit 6,2 billion. Food production by then may not keep pace with population growth.

Current rice production in Asia, which is growing at 60 per cent, is slightly ahead of the 55 per cent population growth, Khush said; "We hope that the new rice will lead to Increased productivity so the gap between food production Increase will closed."

World rice production by the end of the century will be 580 tonnes per year, "This Is Just enough for population growth," he noted. "But in the 21st Century, that won't be enough unless new strains come in."

A crucial problem is stagnating productivity. Dr Prabbu Pingali, IRRI agricultural economist, pointed out that production in India's Punjab state has been stagnate since 1970s. In two states of southern India, It fell drastically from the 1970s to 1988.

He attributes the cause to lower nitrogen output from fertilisers, increases in pests that affected root growth, Intensive irrigation that led to water logging and salinity build-up. He said: "There are changes in the soil chemistry and this affects yield over time."

Added to this are Government cuts on investments in irrigation infrastructures and fewer subsidies on agriculture Inputs like fertilisers. The Green revolution, Pingali pointed out, enjoyed wide success largely due to massive Government subsidies of fertilisers.

The IRRI will attack related scientific problems as well. Director General Dr, Klaus Lampe said: "We are growing rice and rice and rice … permanently, sometimes three crops a year. We may use the second crop to grow non-rice." The Institute, set up in 1960 as a philanthropic endeavour of the Rockefeller and Ford Foundations to help the newly independent countries of Asia, now moves from seed-based technology to knowledge-based technology,

IRRI has the world's largest rice gene bank, Some 80,000 samples of cultivated and wild rice species are kept at sub-zero temperatures in vacuum packs for 50 years.

Samples are being sent to the world's largest gene bank, the Na- tional Seed Storage Laboratory at Ford Collins, Colorado, in the United States, where they can be preserved for 100 years.

The IRRI gene bank assures continuiy of Asia's rice species. They could be lost in times of war and civil strife. Dr. Michael Jackson, head of IRRI's gene bank, said samples of Cambodian rice were recently repatriated to Phonom Penh to help farmers grow again the species they lest during the Country's two decades of civil war. The same was done for Sri Lanka and two states of India.

Samples of the cereal have been sent over the years to IRRI by rice-producing countries for research and safe-keeping. The IRRI has a unique role in perpetuating forever the cultivation of rice, which began 10,000 years ago, Jackson explained: "We hold the materials in trust. That trusteeship-requires us to provide storage conditions for long term preservation."

The gene bank assures that the super rice can be adopted to other rice-producing regions of South America, Africa Europe and the US.

Bangkok Post
Established in 1946

Raising rice output to stave off starvation

April 24, 1993

Victor Mallet reports on the International Rice Research Institute in the Philippines, where scientists are confident that they can lead a campaign to increase production by the amount required to stave off global starvation for another 30 years.

To the uninitiated, it sounds like an impossible task: in the next three decades the annual global rice harvest must rise by 60% to about 760 million tonnes to feed the world's fast-growing population.

This surge in production, furthermore, will probably have to be achieved without increasing the land area presently under rice. There is little room for expansion in Asia where most of the world's inhabitants and most rice-eaters live and in some countries urban sprawl has actually reduced rice acreages. Since 1980, the total area cultivated for rice has remained steady at about 146 million hectares.

Yet the scientists at the $30 million-a-year International Rice Research Institute (IRRI) in Los Baños, south of the Philippine capital Manila, are confident that they can lead a successful campaign to increase rice yields by the amount required to stave off global starvation for another 30 years.

They have done it once; six years after the IRRI was founded in 1960, they contributed to the "green revolution" by releasing a "miracle"' rice variety called IR8 which doubled and tripled yields and helped to avert famines predicted for the 1970s and they think they can do it again.

Gurdev Khush, an IRRI veteran with 25 years service at the institute, who heads the plant breeding, genetics and biochemistry decision, says the first step is to make further improvements to the "architecture" of the rice plant.

By cross-breeding stiff-strawed, dwarf varieties with larger plants that respond well to fertiliser but tend to collapse under the weight of their own grain, scientists have already succeeded in reducing the proportion of straw to grain in the plant to 50:50 from 70:30, and he believes that they will be able to increase the grain s share of the plant's weight to 60%.

The IRRI also plans to help increase the total rice harvest by shifting some of its attention from high yielding, irrigated rice where most advances have been made to date and concentrating on raising yields in rain-fed areas and marginal zones affected by such constraints as salinity and deep water.

According to IRRI officials, it should be possible to raise yields for deep water rice to about 3.5 tonnes per hectare from about one tonne now, and to double yields for upland rice to 2.5 tonnes. By comparison, typical maximum yields for irrigated rice are about seven tonnes in the wet season and 10 tonnes in the dry season. IRRI wants to raise the maximum to 15 tonnes by 2010.

The institute has made great strides in breeding rice varieties that are resistant to salinity, insect pests and other adverse conditions. But the organisation is finding it harder to further increase maximum yields because genetic and other factors that determine yield are highly complex.

One way of raising yielda is to use first-generation hybrids (Dr. Khush says this can increase yield by another 25 %) rather than varieties selectively bred by the IRRI through six or seven generations. The hybrid method has been successfully adopted by China, but the problem is that farmers have to buy new seeds each time they plant the crop, because subsequent generations lose the yield advantage.

Genetic engineering may provide a solution. Dr. Khush is hoping that it will be possible to put an “apomixis” gene (such as the one found in millet) into flee, which would allow the hybrids to reproduce asexually and therefore maintain their high yield.

Rice might benefit in other ways from the young science of genetic engineering. John Bennett, IRRI’s senior molecular biologists is interested in introducing genes from barley which instruct the plant to produce fungus-resistant proteins.

“The reason for the emphasis at the moment on this sort of approach resistance to biotic stresses is that we know how to do it,” says Dr. Bennett. The problem with yield is that we have only a very rudimentary understanding of what controls yield.”

The institute does not confine itself to technology. Mohabub Hossain, the agricultural economist who heads IRRI’s social science division, warned recently that falling unit prices for rice paid to Asian farmers and higher labour costs could threaten the growth of rice production.

“It is time to ask whether Asian countries will be able to meet the future demand for rice of their still rapidly growing populations, given present prices and current technology,” he said. “The easy gains from modem rice technology have already been achieved, particularly in irrigated rice.”

China, the world’s largest rice producer and consumer, has already adopted modem technology, irrigated much of its rice and is producing high yields. “They have done a fantastic job,” says Keith Ingrain, an IRRI agronomists. “There is not much room for improvement”.

IRRI scientists nevertheless believe they can increase yields sufficiently to meet projected Asian demand in the year 2020, although they admit there will be environmental costs and other pitfalls as farmers move into marginal areas.

They have noticed that paddy fields subjected to three crops a year with no time to lie follow have started to produce less for a given amount of fertiliser, possibly because of mineral deficiencies. “We don’t understand this phenomenon,” says Dr. Khush. “We are mining these soils”.

Only about 3% of world rice production is currently traded internationally, but the idea of growing rice in the (relatively) uncrowded countries of Latin America or Africa and shipping it in the vast quantities to Asia is already being mooted.

IRRI scientists think they can hold the line for another three decades by helping to increase yields. But they say that the next stage after 2020, if the world population keeps growing rapidly, will be much more difficult.

International Herald Tribune

PUBLISHED WITH THE NEW YORK TIMES AND THE WASHINGTON POST

December 13, 1993

Q & A: Warning Signs for East Asia’s Agriculture

As millions of people in rural Asia flock to towns and cities in search of work and a better life, questions are being raised about the ability of the world’s most populous region to feed itself. Klaus Lampe, a German who is director-general of the International Rice Research Institute in the Philippines, discussed this with Michael Richardson of the International Herald Tribune.

Q. Why is agriculture important for the future of East Asia, where industrialization is the chosen path to prosperity?

A. Asia’s future is certainly in manufacturing. But even if half the region’s population is living in cities, what will happen to the other half?. People need food to survive. They cannot eat microchips.

To produce that food with less land, water, fertilizer, pesticides and labor is a tremendous challenge for farmers, governments and agricultural research institutes.

Q. What are the most worrying trends in East Asian agriculture?

A. The loss of land from urban encroachment and many forms of carelessness. Erosion and declining soil fertility are just two of the warning signs. About two and a half million hectares of forest are disappearing each year along with hundreds of thousands of hectares of arable land.

The dynamic people in the countryside who could build a modem agricultural sector are moving to the towns and cities. It is predicted that in 13 Asian countries in the next 10 years there will be more than 400 million new migrants into the urban centers.

Q. How can people be persuaded to stay in the countryside?

A. We need much more public awareness about the problem. Governments must make the fight decisions to reverse the trend toward megacities. Decentralization is a key policy. Industries should be moved to rural areas to provide work for landless laborers.

Living conditions in the countryside should be made much more attractive. Asia is losing rural cultures and ideals as well as land. For example, rice production is not just about food but about storing water and managing its flow.

Q, Why are mountains and uplands important in the cycle of sustainable agriculture?

A. The lowlands, where most of the food is grown depend on the water storage capacity of the higher areas. The water is collected in places that have permanent vegetation and released when it is needed for cultivation in the lowlands.

The upland damage in East Asia is extensive. Most of the floods and natural disasters in and around the lowland cities are bills being paid for upland deforestation and other abuses of the ecosystem.

Q. With population increasing and arable land diminishing, will Asia be able to feed itself in the next century?

A. This part of the world has tremendous intellectual potential, dynamism and will power to get things done. But I am concerned that there may not be enough time left to make the drastic changes which are needed.

If East Asian countries continue to do business in the next 30 years as they have in the last 30, it will be to the detriment of the environment not only for this region but perhaps for the rest of the world.

Even with a population of 5 billion, Asia should be able to feed itself. The question is with what and how. Will the systems that axe chosen be stable enough to avoid social unrest, bearing in mind that at the beginning of the next century less than 20 percent of the region’s population will be classified as rich. The rest will be poor, very poor. The patience of Asia’s poor is admirable, but not endless.

Q. Can science produce new, high yielding types office and other crops to help Asia produce the food it needs?

A. I am very confident we can. I am also sure that food production can be done in a much more sustainable and environmentally conscious way than at present.

The International Rice Research Institute, which was created 35 years ago by the Rockefeller and Ford Foundations and is now supported by more than 25 donors, is trying to develop a perennial, high yield rice strain so that the small farmer will not have to replant each year. This is part of a major research effort to make rice cultivation more productive and attractive, even in marginal areas. Only a farmer who thinks he has a good future will be able to convince his children to stay on the land.

The Rice World

(USA)
June, 1993

Women critical for Asian rice

Canberra, Australia—Women in Asia are taking on greater responsibilities in rice farming, says Thelma Pads, a social scientist with the International Rice Research Institute.

"More than 560 million rural women in the world live below the poverty line, and two-thirds of them are in Asia. They are among the poorest and most vulnerable people in the world and rice is central to their daily lives," Ms. Paris says. 'They carry a major load of producing Asia' s staple crop, rice, which they then feed to their families."

Women often make up one-third of the rice farming labor in Indonesia, Thailand and the Philippines, and fully one-half in Nepal and India. The rising population pressure on the land, increasing poverty, migration of men seeking employment, land degradation, decreasing fuel-wood supplies and economic risk in the rainfed lands are forcing women to take on greater responsibilities in rice farming, which they carry out in addition to their household and child-rearing tasks.

Ms. Paris, speaking at the Aus tralia-IRRI Day Seminar held in Can berra entitled "The Food Time Bombe in Asia," described IRRI's activities to reduce the burden on rural women through its Women in Rice Farming Systems (WIRFS) program started in 1986 to incorporate a broader appreciation of the role of women and gender issues in rice farming systems.

"IRRI research helps rural women increase the rice supply, provide employment and raise incomes in irrigated rice growing areas," says Ms. Paris. "IRRI's WIRFS program carries out research in gender analysis, nutrition and socioeconomics in fanning systems which has facilitated the development of 'women friendly' farm equipment and technologies and sensitized researchers to the role of women in farming. Small scale machines are being designed by IRRI engineers to enhance the women's working conditions and improve the lives of their families.

For example, a rice micromill cuts transport costs for rice processing and increases incomes especially when operated by women within a community setting. The micromill replaces hand pounding - a tedious difficult job. "Women using the machine have found it relieves them from the drudgery of pounding rice for home consumption, and it helps them gain some economic dependence through extra income," she says.

The micro-mill is being tested in various Philippines locations and has been sent to other countries, including Bangladesh, Indonesia and Thailand to be adapted to the village rice milling needs of each country.

Like all IRRI-developed machines, blueprints of the rnicromill are available free of charge to encourage local manufacturing. During the past four years, 700 small, private companies have received 30,000 design sets to make IRRI machines economically available to farmers—many of whom are women.

日本經濟新聞

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フォーラム

日本でコメ不足騒ぎが起きるなかフィリピン・マニラ郊外のロス・バニオスにある国際稲研究所（IRRI）は、「将来、アジアでコメ不足が起きる」との報告書をまとめた。IRRIはかつてミラクルライスと呼ばれる多収穫品種

国際稲研究所所長
クラウス・ランペ氏

「IR8」を開発したことで有名。クラウス・ランペ所長（63）にアジアのコメ生産の展望を聞いた。

——アジアでは将来、コメが不足する、と発表したが。

発展がアジアにコメ不足もたらす

九一年に三十一億人だったアジアの人口は二〇二五年には四十億人に達する。毎年五千百万人、つまりオーストラリアの人口の三倍ずつ増えていく勘定だ。特にインド、パキスタン、バングラデシュ、フィリピンの人口はこのままのペースでは今後四十年間に倍になると予測されている。二〇二五年の世界の人口を養うためには七億六千五百万㌧のコメが必要だが、これは現在の収穫量の一・七倍であり、現状のままでは需要を満たすのは難しい。

——人口増にコメ生産が追い付かない理由は。

世界のコメ生産の八五%を占めるアジアの経済発展の結果、米作に適した耕地が次々に住宅地や工場用地に転用され、作付面積が減っている。灌漑（かんがい）農業の結果、土地がやせて塩害も増え、稲作適地が減少している。現在、稲作地の七割が多収穫米を栽培しているが、土地が疲弊し、一定量の収穫を維持するにはますます多くの肥料が必要となっている。

——品種改良や農業技術の向上に期待できるか。

食料不足の悲劇を避けるには、穀物生産のための耕作地を倍に増やさねばならないし、現在の稲作技術は根本的に見直す必要がある。IRRIは設立後三十四年を迎えるが、その間の研究の蓄積で理想的な稲作を描けるようになった。アフリカ、インドネシア、パンジャブ、日本など各地の稲の品種を掛け合わせて超多収穫米を開発しつつある。これが成功すれば一㌶当たり十三―十五㌧の収穫が見込め、コメ不足を防ぐことができる。

（マニラ＝平野慶一郎）

Frankfurter Allgemeine
ZEITUNG FÜR DEUTSCHLAND

(Germany)
March 26, 1994

Grüne Revolution rettete Millionen Menschenleben

DieErnährungssituation in Asien bleibt trotzdem unsicher / Von Erhard Haubold

NEU-DELHI, im März. Indien und Indonesien, die ,,Giganten" Asiens, sind heute Selbstversorger, kommen weitgehend ohne Importe vo Reis und Weizen aus, haben in manchen Jahren überquellende Lagerhäuser: Das ist das wichtigste Ergebnis der ,,grüen Revolution", zu schweigen von der damit direkt verbundenen politischen Unabhängigkeit und dem nationalen Stolz von Drittwelt-Ländern, die erst seit ein paar Jahrzehnten unabhängig sind. Viele Inder erinnern sich noch an die große Dürre von 1966, die zu Hunger und zu einigen zehntausend Hungertoten geführt hätte wären da nicht Amerika und seine Getreidelieferungen, rund zehn Millionen Tonnen im Jahr, gewesen, die freilich mit einigen harschen Auflagen verbunden waren, darunter die Abwertung der Rupie und die Forderung Präsident Johnsons nach der Unterzeichnung eines ,,grüne Revolution" genannten "Pakets von Sofortmaßnahmen". Dazu gehörte die Einführung ,,hochertragreicher" Weizen- und Reissorten, die Nobelpreisträger Norman Borlaug und andere (nicht zuletzt im Internationalen Reisforschungsinstitut IRRI in Los Baños bei Manila) entwickelt hatten. Dazu gehörte der großzügige Einsatz von Wasser, von Düngemitteln und Pestiziden, Aufgegeben wurde die seit der Unabhängigkeit 1947 vertretene Meinung. daß die Industrialisierung kräftiger Investitionen bedürfe, die Landwirtschaft sich aber weitgehend von selbst entwickele - solange Fortscritte bei der Bodenreform, der Flurbereinigung und der Abschaffung des ,,zamindari" genannten Systems von Großgrundbesitzern und Unterverpachtung erzielt würden.

„Wir wollten Ergebnisse, höhere Erträge pro Hektar möglichst rasch", so sagt es ein indischer Wissenschaftier..Und wir erreichten unser Ziel, weil wir uns auf Gewinner stützten, auf bereits einigermaßen wohlhabende Bauern, auf Gegenden mit Bewässerung, Elektrizität und Straßen." Bei den an der Subsistenzgrenze lebenden Menschen hätte ,,es zuviel aufzuholen gegeben, wären die Zuwachsraten aufgegesen worden". Der Punjab mit seinen fleißigen Sikhs wurde zum Symbol einer beispiellosen Erfolgsgeschichte, zur Kornkammer in einem armen Subkontinent, den viele im Westen bereits als ,,hoffnungslos" abgeschrieben hatten. 1973 gab es in Indien mehr Weizen, als konsumiert werden konnte, wurde über den Export zur Entlastung gigantischer Lagerbestände diskutiert. Dank der Wundersaaten und hatter Arbeit wurde der Punjab zum reichsten Unionsstaat Indiens mit einem beinahe zehnmal höheren Pro-Kopf-Einkommen als im Landesdurchschnitt. Die durchschnittliche Zuwachsrate der Getreideproduktion zwischen 1952 und 1993 betrug 2,7 Prozent im Jahr, mehr als die Zunahme der Bevölkerung, die sich mehr als verdoppelt hat und heute beinahe 900 Millionen Menschen beträgt.

Sic können ernährt werden, weil die Ernten seit den achtziger Jahren um durchschnittlich mehr als vier Prozent wachsen, vorher waren es nur 2,8 Prozent. Hunger, gar Hungersnot, kommt im Sprachschatz der jüngeren Generation der Stadtbewohner nicht mehr vor. Die Dürren der Jahre 1986 bit 1988 konnten ohne Importe bewültigt werden. Dennoch ist Indiens Erfolg weiterhin in Gefahr. Der Erfolg der ,,grünen Revolution" könnte dazu beigetragen haben, daß der enorme demographische Druck bis heute vernachlässigt wurde. Die Verfügbarkeit von Getreide pro Kopf der Bevö1kerung hat seit den fünfziger Jahren lediglich von 150 Kilogramm auf 175 Kilogramm zugenommen. Kalorienmangel, Unterernährung und damit verbundene Mangelerscheinungen sind weit verbreitet, vet allem in den Dörfern, wo die Mehrzahl der asiatischen Armen, fund eine Milliarde Menschen, lebt. Andererseits läßt wachsender Wohlstand der städtischen Mittelklasse den Bedarf an Getreide - auch für die Produktion von Fleisch und Milch - überproporlional stark anslcigen.

Vor allem aber sind an der Jahrtausendwende mehr als eine Milliarde Menschen zu versorgen, muß die Getreideernte von gegenwärtig 180 Millionen Tonnen auf 225 bis 240 Millionen Tonnen gesteigert werden, eine ,,enorme Herausforderung", sagt der Agrarwissenschaftler M. S. GilL Er und andere weisen auf den ,,Hoffnungsschimmer" hin, auf die Möglichkeit, die landwirt. schaftliche Produktivität im Osten Indiens, etwa in Westbengalen und Orissa, noch wesentlich zu steigern. In Bihar liege der Wasserspiegel nur einen Meter unter der Erde. in Punjab würden seit 1980 Jahr für Jahr sieben Prozent Zuwachs erzielt, das Potential für Elektrifizierung und Bewässerung sei bei weitem nicht ausgeschöpft. Pro Hektar erzielen hundert Millionen Bauernfamilien in Indien im Durchsehnitt zwei Tonnen Reis, in anderen Ländern sind es fünfzehn Tonnen.

,,Die grüne Revolution war ein Fehlschlag. Sie hat die genetische Vielfalt der Pflanzen reduziert und sie anfälliger für Schädlinge gemacht. Sie hat zu Bodenerosion und Wasserknappheit geführt, zu geringerer Fruchtbarkeit des Bodens und seiner wachsenden Kontaminierung. Der einheimischen Bevölkerung stehen weniger nahrhafte Getreidesorten zur Verfügung, eine große Zahl von Bauern ist von ihrem Land vertrieben worden. Die Gewinner waren die großen Chemickonzerne, die Hersteller landwirtschaftlicher Masehinen, die Großgrundbesitzer und die mit dem Bau von Staudäimmen befaßten Firmen." Das schreibt die indische Ökologin Vandana Shiva. Sie kritisiert, daß alte landwirtschaftliche Traditionen in Indien über den Haufen geworfen wurden, auf ,,Druck", wie sie meint, von Weltbank und amerikanischen Stiftungen wie Ford und Rockefeller, die in den sechziger Jahren der Ausbreitung der kommunistischen Revolution von China aus eine grüne Revolution hätten entgegensetzen wollen. Wenige andere Fachleute sprechen so harsch über die ,,imperialistischen Wundersaaten", aber viele, vor allem außerhalb Indiens, urteilen nachdenklich bis skeptisch über die Ernährungssicherheit in Asien nach dem Jahr 2000.

Klaus Lampe, der Leiter des Reisforschungsinstituts bei Manila, spricht von einer ,,geheimnisvollen Bedrohung: der deutlichen Produktivitätsabnahme in besonders intensive genutzten Reisgebieten". Das könnte die Stagnation der Ernten zu einem Zeitpunkt bedeuten, da die Bevölkerung noch einmal dramatisch wächst - um eine Milliarde in jeweils zehn Jahren bis zum Jahr 2025. Um die Menschen ausreichend mit Reis ernähren zu können, müssen die Bauern weltweit ihre Produktion um siebzig Prozent steigern.

Diese nächste große Herausforderung wird nicht mit den Methoden der grünen Revolution zu bewältigen sein. Denn bei ihr fallen die Emtezuwächse immer geringer aus, der Grundwasserspiegel sinkt (im Punjab um einen Meter im Jahr), die Bodenerosion erfaßt immer größere Flächen. Als großes Problem der hochertragreichen Sorten erweist sich der große Wasserbedarf in der Landwirtshaft, die für den ,,Wunderweizen" etwa dreimal soviel Wasser benötigt wie für die traditionellen Sorten. Ein Drittel des künstlich bewässerten Landes in Indien ist durch Versalzung beretts unbrauchbar geworden. Angesichts eines Bevölkerungszuwachses um 590 Millionen auf 1,44 Milliarden Menschen bis zum Jahr 2030, mehr als in China, müsse Indien an eine dramatische Intensivierung der Familienplanung denken, sagen Fachleute. Lampe sp.richt von einem gordischen Knoten aus Uberbevölkerung, Arbeitslosigkeit und einer auf Raubbau basierenden Agrarproduktion in der Dritten Welt.

Indische Bauern verwendeten einstmals an die 30 000 Reissorten, heute werden drei Viertel der Ernten mit weniger als zehn Sorten erzielt. Solche Monokultur birgt große Gefahren, die durch den Treibhauseffekt noch erhöht werden könnten. Eine Veränderung des Niederschlags, hervorge. rufen durch globale Erwärmung, könnte große Agrarflächen in China, Indien, Indonesien oder Burma ,,auslöschen" und Millionen von Menschen zu ,,ökologischen Flüchtlingen" machen. Das wurde während eines Seminars in Manila gesagt, auf dem auch zu hören war, daß schon ein kleiner Rückgang der Reisernten zu ,,Massenhunger" führen könnte. Weil das Ackerland weltweit als Folge von Indusgstrialisierung, Häuser- und Straßenbau zurückgeht, muß der gewaltige Zusatzbedarf der nächsten Jahrzehnte an Reis – Grundnahrungsmittel für die Hälfte der Weltbevölkerung und der Mehrheit in Asien – auf immer kleinerer Fläche, mit immer geringeren Zusätzen von Düngemitteln und Pestiziden erzeugt werden. ,,Regenwald kann man nicht essen", sagt Klaus Lampe. ,,Gelingt e suns nicht, die Flächenproduktivität zu erhöhen, wird der Regenwald dem Bevölkerungsdruck nicht standhalten können. Durch Industrialisierung, Urbanisierung, Versteppung und Versalzung gehen jährlich mehrere Millionen Hektar landwirtschaftlicher Nutzfläche verloren." Um die neue Herausforderung zu bewältingen, wird eine Pflanze mit neuer genetischer Struktur benötigt, an der bei IRRI in Manila fieberhaft gearbeitet wird. Die Supersorte soll lange Wurzeln haben und eine hohe Widerstandsfähigkeit gegen Schädlinge. Pro bewässertem Hektar soll sie einen Ertrag von 13 bis 15 Tonnen hochwertigen Getreides liefern. Die Frage ist nur, ob die Wissenschaftler von Los Baños den Wettlauf mit der Zeit gewinnen.

GLOBAL HUNGER
WorldWise
"The International Newspaper"

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Parlaying Palay into a Bonanza for San Bartolome

SOUTH-NORT NEWS SERVICE

San Bartolome—If you told Juan Domingo that the Green Revolution was a flop, as some critics have charged, he would probably laugh in your face.

Juan, in his late 60s, is a Filipino farmer in the small rural village—or *barangay* in the Filipino language--of San Bartolome (population 1,400), some 70 miles north of Manila, the capital.

Growing rice *(palay)* on two hectares (5 acres) of land, he has seen his life change dramatically since he began farming more than 50 years ago. The credit, he would tell you, belongs mostly to the new, improved rice developed at the international Rice Research Institute (IRRI), near Manila.

Until the early 1970s, when the Green Revolution began sowing the seeds of change there, San Bartolome (pronounced san-bar-TOL-oh-may) was nothing more than a collection of bamboo shacks along the Camiling River. The streets were dirt roads that turned into mud in the rainy season. There were no sidewalks or shops or any town services.

"It was like to Old West," says Dr. Robert E. Huke, a retired Dartmouth College professor of geography who has frequently visited San Bartolome as an IRRI consultant over the past 20 years.

"There was even the equivalent of the oldtime snake-oil salesman, who rumbled into town with potions for every ailment as well as other goods for people to buy."

Today, San Bartolome enjoys an affluence that oldtimers like Juan couldn't have dreamed of when they were kids.

Juan's house is a neat cinder-block-and-wood bungalow with five rooms and louvered glass windows. It has electricity, water, even an indoor bathroom with modern plumbing. In the evenings, Juan and his wife watch television on a set that occupies a central place in their living room.

Juan had only a grade-school education, because he had to leave school to work in the fields with his brothers and sisters. But his own three children have been much more fortunate. All of them are high-school graduates or better,

Besides their industriousness and skill, the Domingos' relative prosperity is due to the new, high yield strains office developed at the Institute, as well as to the advisers--Filipino and American—who taught them how to grow them.

Back in the early 1970s, when Huke first began visiting San Bartolome, farmers like Juan were severely limited in how much rice they could plant. Existing strains grew slowly and depended heavily on water, a precious commodity during the long dry spells that follow San Bartolome's summertime monsoon rains.

But then, says Huke, along came the new, faster-growing strains, with names like IR5 and IR20, developed by the plant breeders at IRRI (pronounced EAR-ee).

These could be harvested in just 125 days. By contrast, the old strains took 160 days, or more than a month longer, to mature.

To the savvy farmers of San Bartolome, the message was clear, says Huke: If they could grow rice in less time, they could plant more crops. This meant they'd wind up with more rice than they needed to feed their families and they Could sell the rest.

"Many of these men may not be able to read or write, but they know their business," says Huke, who notes that yields more than doubled, from 1:7 metric tons per hectare in 1965 to 3.6 tons in 1980. (A metric ton is equal to 2,204 lbs.)

Instead of wasting their profits on frivolities, he says, Juan and his fellow farmers invested them in digging new wells, so they'd have more irrigation water. Now they plant two crops a year.

In addition, they have built storage bins, which means they don't-have to sell all their rice at the height of the harvest season, when the market is glutted and prices are low. Instead, they keep some of it in storage until prices climb again.

Herald INTERNATIONAL Tribune
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March 18, 1994

Asian Population Growth is Overtaking Rice Output

MAHARUB HOSSAIN

Manila- The race to avoid a collision between population grwoth and rice production in Asia goes on, amid worrying signs that gains of the recent past may be lost over the next few decades.

In the past quarter-century, populations of countries where rice is a staple food grain have increased by an average of 70 percent, but this increase was matched by higher yields, thanks to the spread of new rice technology. Global rice production doubled, world rice prices fell by more than 40 percent and per *capita rice* consumption rose by an average of 25 percent.

But while the populations of major rice-consuming nations continue to swell, growth in rice production has slowed dramatically in the 10 countries that account for 85 percent of global output. If these trends continue, demand for rice in many parts of Asia will outstrip supply within a few years. Changes in diets in some industrializing nations, where people are eating less rice, will not alter this trend.

Alleviation of poverty is an additional force behind the rising demend for rice. Millions of Asians and Africans sitll have rice only once a day, if at all. The need for rice will be an estimated 70 percent higher in 2025 than it is today. Yields must more than double just to maintain current consumption levels. They must increase still more if malnutrition and poverty in Africa and South Asia are to be overcome.

Yet complacency seems to be growing. In some places, attention is shifting from raising productivity to protecting natural resources. Donor agencies are allocating more of their limited research funds to projects that aim to conserve the natural resource base. Less money is directed to projects designed to raise food production. Both are needed, in a mutually supporting framework.

Policymakers in less developed countries are also shifting emphasis. Many governments are withdrawing subsidies from fertilizers and other agricultural supplies. They are reducing investments in water-resource development and agricultural research and extension. They are adopting programs that promote crop diversification at the expense of food production. Financing to develop and maintain the irrigation and drainage systems that helped spread modern strains office in the 1960s and 1970s has fallen dramatically.

Declining real prices on the world market have added to the complacency about rice production. But world trade involves a mere 4 percent of global output. International price trends do not reflect the shaky balance between overall supply and demand. For example, China and India consume 55 percent of world rice supplies. If a series of natural disasters forced either country to import just a small fraction of national demand, international rice prices would rice substantially.

Growth in rice output in the last 30 years has been achieved primarily by increasing yield. But yield gains appear to be flattening. Reversing that trend will not be easy.

The equation is complicated by a reduction in the area of rice cultivation. Prime rice land is being lost to industrialization and urbanization in the faster-growing Asian countries. In the late 1980s, the harvested area of rice declined in China, Japan, Burma and the Philippines.

If environmental concerns result in policies that remove marginal lands from rice production and hasten the shift from intensive to less intensive cropping systems, the area under rice cultivation will decline even faster. This will intensify pressure to raise yields to meet the anticipated increase in demand.

Irrigated rice accounts for almost 75 percent of the total. Most farmers plant high-yielding modern rice varieties, and output is approaching the ceiling attainable through modern scientific techniques. For the last three decades, yields in Japan and South Korea have fluctuated between 6 and 6.5 tons per hectare (2.5 acres). Yields in China, on the main Indonesian island of Java and in Punjab and Tamil Nadu in India will soon reach that level.

In the tropics, the gap between yields and experimental yield potential is still large because of such natural forces as floods, droughts, heavy rainfall and salinity.

Most of the increase in rice yields in the favorable environments of the last 25 years was achieved by planting genetically improved varieties designed to respond well to chemical fertilizer and agrochemicals. What is needed is a new generation plant type as well as cropping technology that relies less on inputs from off the farm and more on knowledge-based management to maintain the natural resource while raising yields.

Studies show that per capita rice consumption depends largely on income. Rice is a luxury for the world's poorest. They rely more on low-cost foods: coarse grains and sweet potatoes. When their incomes rise, their rice consumption goes up. Rice becomes less important only when incomes increase to a point where people can afford meat, fish, bread and vegetables.

In Asia, per capita rice consumption has declined only in high- and middle-income countries, such as Japan, South Korea, Malaysia and Thailand. The income threshold at which higher-quality, more varied foods are substituted for rice has not yet been reached for China, India, Indonesia and Bangladesh—which account for 70 percent of world rice consumption and dominate growth in demand for rice.

The writer, head of the Social Sciences Division at the International Rice Research Institute based in Los Baños, Philippines, contributed this comment to the Herald Tribune.

MANILA BULLETIN
THE NATION'S LEADING NEWSPAPER

(Philippines)
May 11, 1994

Heightened alarm over rice price

Agronomists: Shortage in Asia looms

KUNDA DIXIT
Inter Press Service

Los Baños, Laguna (IPS)—The international price of rice has risen by 50 percent in the past six months, and Asia's rice stocks are at their lowest since the 1970s. Together, the two facts points to an ominous food future for Asia, agronomists say.

The rise in rice price has so far mainly affected the high quality variety, and was triggered by a 30 percent drop in Japan's production because of cold weather.

Japan has imported some 2.5 million tons of rice in the past months from the United States and Thailand. (This coincided with the stepped up US pressure this year to open up Japan's market to rice imports, but Tokyo would have needed to import rice anyway.)

Compared to the total worldwide rice production, the volume of Japanese import this year is not much but it represents nearly 30 percent of the total rice traded internationally.

The price hike has also effected the domestic markets in the world's two largest producers—India and China—where rice is dearer by up to 30 percent over the past four months.

National rice stocks of various Asian countries have shrunk to a 20-year low as rising population and plateauing productivity forced countries to dig into their reserves to meet supply shortfalls.

Agronomists say the volatility of the rice market and depleted stocks are warming signs of a looming shortage in the region's main staple grain.

"The re-emergence of a food crisis in South Asia and the Philippines is a real possibility unless rice research succeeds in making a breakthrough in high-yielding varieties," says Mahabub Hossain, head of the Social Sciences Division of the International Rice Research Institute (IRRI) in Los Baños, near Manila.

IRRI is working on a breed of "super-rice" to boost yields by up to 30 percent and on a variety of tropical hybrid rice. But the new seeds are not expected to be available for another six years.

In the past 25 years, global rice production has doubled, thanks largely to the high-yield Green Revolution seeds that IRRI developed. Countries like India, Bangladesh, Indonesia and the Philippines became self sufficient in rice production.

"This dramatic progress has allowed a mood of complacency to set in regarding Asia's ability to handle the food population equation," Hossain, who is a Bangladeshi, told IPS in an interview. The Green Revolution breakthrough are beginning to plateau off.

Japan and Korea have the highest rice productivity, growing 6.5 tons office per hectare. China, which was growing only four tons per hectare in the 1970s, now produces up to six tomes per hectare, Indonesia is reaching the 5.5 ton per hectare range.

India's average is still only 2.7 tons per hectare, but areas like Punjab and Tamil Nadu produce up to 5.2 tons. Bangladesh's delta paddies grow an average of three tomes per hectare.

"There is room for improvement, but at six tonnes per hectare we are reaching the upper threshold of what can be achieved with present technology," Hossain says.

THE TIMES OF INDIA

March 4, 1994

Rice output in lowlands still poor

RATAN MANI LAL

Rice production the world over has nearly doubled in the last 27 years and while higher yield accounts for 80 per cent of the rise, only 20 percent has been because of an increase in the area under rice cultivation. The Manila-based International Rice Research Institute (IRRI), according to its deputy director general, Dr. Kenneth S. Fischer, has contributed significantly to this development.

Dr. Fischer, who is in Lucknow to attend the international conference on rainfed lowland rice research, says that one of the most significant outcomes of research has been that the price of rice globally has remained more or less stable.

In an informal conversation on Thursday at the conference venue, Dr. Fischer, Dr. Robert S. Zeigler, program leader rainfed lowland rice ecosystem at IRRI, Dr. Mahabub Hossain, economist and head, social sciences division, IRRI and Dr. M. D. Pathak, director general, UP Council for Agricultural Research, who are among the 76 delegates from India and abroad talked at length about the advances in rice research and the need for laying stress on rainfed lowland rice cultivation.

THE CONSORTIUM: The rainfed lowland rice research consortium (RLRRC) was set up five years ago with an initial six members, and later four more member-countries joined it. The present chairman of its steering committee is Dr. R. K. Singh, director (research) at the Narendra Dev University of Agriculture and Technology (NDUAT), Kumarganj, Faizabad, Its aim is to identify the needs of rice growers and their problems. Social scientists are also integrated into the projects to look into the non-agricultural factors and their advice is then made workable by the biological scientists working at the research stations, said Dr. Hossain, who is from Bangladesh.

Dr. Zeigler, a plant pathologist, said that in the 1960s, any increase in global rice production was considered almost impossible but consistent efforts to persuade rice farmers to use improved technology and related practices and diversify had led to tremendous improvement. However, to a specific question, Dr. Fischer said that it was not possible to tackle the global hunger problem only by an increase in rice production as the problem was one which requited a joint global effort.

Rice, being the staple diet the world over, is the base over which an overall improvement in social and living conditions can be based, said Dr. Hossain. For instance, Japan, Korea, Thailand and Taiwan, the major industrialised countries in southeast Asia, first went in for increasing rice productivity, which later led to land reforms, diversification and higher incomes. That was what led to the state of intensive industralisation which now prevails in these countries.

UNEQUAL SHARE: Of the total area under rice cultivation in the world, half is irrigated land and the rest is raided lowland. However, the productivity in the former accounts for 75 per cent of the total production whereas the latter accounts for the rest. "That shows the poor productivity of raided lowlands which necessitated the formation of the consortium," said Dr. Fischer. The problems encountered in lowlands are frequently occurring drought and submergence conditions, soil salinity and acidity and the countries affected are those in the Indochina region, including Myanmar, Thailand, Indonesia, Philippines, Bangladesh, Nepal.

The tools utilized for improvement are biotechnology for better pest and disease control and modern, computerized analysis of farm practices, said Dr. Zeigler. The effort is also to steadily reduce flee cultivation in rainfed lowlands and diversify in other crops, said Dr. Pathak. A network of the rice-producing countries has been formed and mutually beneficial research notes are exchanged between other international farm research bodies such as the centre for research in wheat and maize in Mexico, for vegetables in Taiwan, for tropical forage grasses in Latin America and the International Crop Research Institute for Semi-Arid Tropics (ICRISAT).

BASIC FACTORS: The basic factors for increasing productivity are better irrigation and high yielding varieties and use of better chemical fertilisers, according to Dr. Fischer, who added that the integrated pest management (IPM) technique initiated by Dr. Pathak had contributed a great deal in tackling the pest problem. The resistance to insects and pests had increased because of IPM practices.

The current conference also included a workshop on the physiology of drought and submergence, the annual technical meeting of RLRRC, field visits to consortium research sites and the RLRRC steering committee meeting, the programmes having begun on February 28 will conclude on March 5. The IRRI, the Indian Council for Agricultural Research (ICAR) and NDUAT have jointly organized it with support from the Manila-based Asian Development Bank. The participants are from organizations in India, Bangladesh, Philippines, Vienam, Australia, Indonesia, Thailand, USA, UK, Laos, Cambodia, and Madagascar.

While the likelihood of a dramatic breakthrough in new rice in the next decade is slim, paddy fields across Asia are being eaten up by urban sprawl, there is less money for infrastructure and improper irrigation has salinated large tracts of farmlands in South Asia.

There is one positive sign. As countries get richer, **it** has been observed that their rice consumption falls. Per capita rice consumption has fallen in Japan, Thailand, South Korea and Malaysia over the past 20 years.

In poorer countries like China, India, Indonesia, rice is still a luxury and growing incomes will lead to a rise in rice consumption.

While richer Asian countries where rice consumption is falling eat only 10 percent of the region's production, China, India, Indonesia and Bangladesh—which have yet to reach the income threshold where rice consumption drops—consume more than 70 percent of the total rice in the world.

Asia's three billion population is expected to increase by 55 percent in the next 35 years.

Warns Hossain: "Without a continuing growth in rice productivity, it will be difficult to maintain the food-population balance in Asia."

Rice production is also threatened by other uncertainties such as climate change caused by the greenhouse effect and ozone depletion, which could cut harvests drastically in the poorest regions of Asia.

IRRI recently organized an international symposium on Climate Change and Rice in Los Baños, where scientists exchanged their latest findings on whether rice plants can adapt to warmer conditions.

The climate change specialist from the United Nations Environment Programme (UNEP), Peter Usher, told participants that Asia was already on a food security tightrope: "The spectre of famine has not touched the Asian continent in the way it has blighted Africa. Yet the current situation has whispered a warning which we ignore at our peril."

1993 FINANCIAL STATEMENTS

The International Rice Research Institute
(A NONSTOCK, NONPROFIT ORGANIZATION)

FINANCIAL STATEMENTS
DECEMBER 31, 1993

Report of Independent Accountants

To the Board of Trustees of
The International Rice Research Institute
(A nonstock, nonprofit organization)

We have examined the statement of financial position of The International Rice Research Institute (a nonstock, nonprofit organization) as of December 31, 1993 and the related statements of activities and of cash flows for the year. Our examination was made in accordance with generally accepted auditing standards in conformity with international audit guidelines as issued by the International Federation of Accountants and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As explained more fully in Note 2, the Institute's financial statements are prepared on the basis of accounting practices prescribed for international agricultural research centers seeking assistance from the Consultative Group on International Agricultural Research. Such practices conform with generally accepted accounting principles.

In our opinion, the financial statements referred to above present fairly the financial position of The International Rice Research Institute as of December 31, 1993 and its acitivities and its cash flows for the year, in conformity with generally accepted accounting principles which have been applied on a basis consistent with that of the preceding year except for the change, with which we concur, in the method of accounting for accruals of liabilities as described in Note 2 to the financial statements.

Our examination was made for the purpose of forming an opinion on the basic financial statements taken as a whole. The supplementary schedules of grant revenue, fixed assets, capital expenditures, capital fund movement and details of operating expenses for the year ended December 31, 1993 are presented for purposes of additional analysis and are not a required part of the basic financial statements. The information in such supplementary schedules has been subjected to the auditing procedures applied in the examination of the basic financial statements and, in our opinion is fairly stated in all material respects when considered in relation to the basic financial statements taken as a whole.

Price Waterhouse
Makati, Metro Manila, Philippines
February 28, 1994

STATEMENT OF FINANCIAL POSITION
DECEMBER 31, 1993

	Note	1993	1992
ASSETS		(US Dollar 000)	
CURRENT ASSETS			
Cash and cash equivalents	2 and 3	40,821	36,362
Accounts receivable			
Donors	4	2,908	5,977
Employees		198	237
Others	5	1,036	1,295
Inventories	2	1,332	1.556
Prepaid expenses		179	181
Total current assets		46,474	45,608
FIXED ASSETS (EXHIBITS 3, 3A AND 3B)			
Property and equipment		59,352	50,298
Less: Accumulated depreciation		(25,472)	(24,516)
Total fixed assets - net	2 and 6	33,880	25,782
Total assets		80,354	71,390
LIABILITIES AND FUND BALANCES			
CURRENT LIABILITIES			
Loan payable		2,500	-
Accounts payable			
Donors (Exhibit 1)	7	6,466	12,262
Employees	8	5	44
Others	9	1.643	1,150
Accruals and provisions	10 and 12	14,821	17,968
Total current liabilities		25,435	31,424
LONG-TERM LIABILITIES			
Accounts payable			
Employees	8	3,744	4,507
Others	9	1,385	1,375
Total long-term liabilities		5,129	5,882
Total liabilities		30,564	37306
NET ASSETS			
Capital invested in fixed assets (Exhibits 3, 3A and 3B)			
Center owned	12	32408	25,206
In custody	12	1,472	576
Capital hind (Attachment 1)	12	10,666	4,992
Operating fund	12	4,489	2,739
Self-sustaining hinds	12	876	836
Total net assets		49,911	34,349
Cumulative translation adjustments	2	(121)	(265)
Total liabilities and net assets		80,354	71,390

(See accompanying notes to financial statements)

STATEMENT OF ACTIVITIES
FOR THE YEAR ENDED
DECEMBER 31, 1993

	Note	Core			Complementary	Self-Sustaining Activities	Total	
		Unrestricted	Restricted	Total			1993	1992
				(US Dollar [XXI)				
Revenues								
Total grants - (Exhibit 1)	2	22,060	4,853	26,913	17576		44,489	41,201
Other revenues		1,219		1,219		1,285	2,504	3,985
Total revenues		23.279	4,853	26,132	17,576	1,285	46,993	45,186
Operating expenses								
Research programs		7,852	2,722	10,574	4,575		15,149	14,804
International programs		4,422	1,401	5,823	8,247		14.070	12,728
Research support		1,445		1,445			1,445	1,910
General administration		3,453	343	3,796			3.796	3,823
General operations		5,149	307	5,536	4,754	1,123	11.413	9,358
Depreciation	2	1,139		1,139		122	1,261	2,612
Staff adjustment program		2,517		2,517			2,517	-
Total operating expenses		25,977	4,853	30,830	17,576	1,245	49,651	45,235
Recovery of indirect costs		(2491)	-	(2,491)	-	-	(2,491)	(1,626)
Total expenses (Exhibit 2 and Attachment 11)		23,486	4,853	28,239	17,576	1,245	47,160	43,609
Excess of revenue over expenditures	12	(207)	-	(207)	-	40	(167)	1,577
Allocated as follows:								
Operating fund	12	(207)		(207)			(207)	1,401
Other funds (self-sustaining)	12	-				40	40	176
		(207)		(207)		40	(167)	1,577
MEMO ITEM								
Operating expenses - By natural classification								
Personnel costs		15,125	1,270	16295	2,558	287	19,240	17,069
Supplies and services		8,730	3,097	11,827	13,718	834	26,379	22,891
Operational travel		983	486	1,469	1,300	2	2,771	2,663
Depredation of fixed assets		1,139	-	1,139		122	1,261	2,612
Recovery of indirect cost		(2,491)	-	(2,491)			(2,491)	(1,626)
Total operating expenses (Exhibit 2 and Attaclunent II)		23,486	4,853	28,339	17,576	1,245	47,160	43,6119

(See accompanying notes to financial statements)

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED DECEMBER 31, 1993

	1993	1992
CASH FLOWS FROM OPERATING ACTIVITIES	(US Dollar '000)	
Excess (deficit) of revenues over expenses -		
core operations and self-sustaining activities	(167)	1,577
Adjustments to reconcile net cash provided		
by operating activities:		
Depredation	1,261	2,612
Disposals and write - off of property and equipment	45	42
Decrease (increase) in assets		
Accounts receivable		
Donors	3,069	1268
Employees	39	60
Others	259	(65)
Inventories	224	234
Prepaid expenses	2	34
Increase (decrease) in liabilities:		
Accounts payable		
Donors	(5,796)	(1,601)
Employees	(802)	460
Others	503	618
Accruals and provisions	(3,147)	(2,115)
NET CASH (USED IN) PROVIDED BY OPERATING ACTIVITIES	(4,510)	3,124
CASH FLOWS FROM INVESTMENT ACTIVITIES		
Acquisition of property and equIpment		
Center owned	(8,508)	(7,569)
In custody	(896)	-
Funds invested in property and equipment	8,098	4,915
Increase in capital fund	5,674	3,159
Increase in operating fund	1,957	-
Cumulative translation adjustments	144	(853)
NET CASH PROVIDED BY (USED IN) INVESTING ACTIVITIES	6,469	(348)
CASH FLOWS FROM FINANCING ACTIVITIES		
Loan proceeds from World Bank	2,500	-
NET CASH PROVIDED BY FINANCING ACTIVITIES	2,500	-
NET INCREASE IN CASH AND CASH EQUIVALENTS	4,459	2,776
CASH AND CASH EQUIVALENTS		
Beginning	36,262	33,586
End	40,821	36,362

(See accompanying notes to financial statements)

Note 1 - General

The International Rice Research Institute (Institute) was established in 1960 to undertake basic research on the rice plant and applied research on all phases of rice production, management, distribution and utilization with the objective of attaining nutritive and economic advantage or benefit for the people of Asia and other major rice-growing areas.

As a nonstock, nonprofit organization under Republic Act No. 2707 and an international organization under Presidential Decree No. 1620, the Institute was conferred the status of an international organization in the Philippines and was granted, among other privileges and prerogatives, the following tax exemptions:

a) exemption from the payment of gift, franchise, specific, percentage, real property, exchange, import, export, documentary stamp, value-added and all other taxes provided under existing laws or ordinances. This exemption extends to goods imported and owned by the Institute to be leased or used by its staff;

b) exemption from payment of gift tax; all gifts, contributions and donations to the Institute are considered allowable deductions for purposes of determining the income tax of the donor; and

c) exemption from payment of income tax of non-Filipino citizens serving on the Institute's technical and scientific staff on salaries and stipends in United States dollars (US$) received solely from, and by reason of, service rendered to the Institute.

The Institute receives support from various donor agencies and entities primarily through the Consultative Group on International Agricultural Research (CGIAR). CGIAR is a group of donors composed of governments of various nations and international organizations and foundations.

Note 2 - Basis of financial statements presentation and significant accounting policies

The accompanying financial statements, expressed in US$, are prepared on the basis of accounting practices prescribed for international agricultural research centers seeking assistance from the CGIAR. The CGIAR - prescribed accounting practices conform with generally accepted accounting principles.

The CGIAR discontinued the accounting of commitments as actual liabilities and adopted the accrual method of accounting for expenditures in accordance with generally accepted accounting principles effective January 1, 1993. The effect of the change is shown as a prior period adjustment to the December 31, 1992 fund balances. (Note 12)

CGIAR adopted a new set of format of financial statements effective December 31, 1993. Certain accounts in the 1992 financial statements have been reclassified/restated to conform with the 1993 financial statements presentation.

A summary of the Institute's significant accounting practices is set forth to facilitate the understanding of data presented in the financial statements.

Cash equivalents - *Cash equivalents* are short-term, highly liquid investments that are readily convertible to known amount of cash with original maturities of three months or less.

Foreign currency transactions - Philippine peso and other foreign currency-denominated transactions are translated to US$ for reporting purposes at standard bookkeeping rates which approximate the exchange rates prevailing at the dates of the transaction. Exchange differences resulting from (a) the collection of foreign currency-denominated receivables and, (b) the settlement of foreign currency-denominated obligations at rates which are different from which they were originally booked are credited/charged to operations. Exchange differences resulting from the translation of balances of foreign-currency denominated accounts are carried in the "Cumulative Translation Adjustments" account.

Revenue - Revenue from unrestricted core grants are pledged on an annual basis and are recognized in the accounts when there is probability of collection in the year the grant is pledged. If the pledge is later judged to be uncollectible, it is written off against revenue of the year in which it is determined to be uncollectible. These grants are utilized to fund core programs and the regular operating requirements of the Institute.

Restricted core grants and grants for complementary projects are recognized as income when funds are committed or received from the donors to the extent of expenses actually incurred. Disbursements from these sources are limited by conditions embodied in agreements with donor organizations. Excess of grants received over expenses, representing grants applicable to succeeding years, is classified as Accounts Payable - Donors in the Statement of Financial Position.

Inventory of materials and supplies - Inventory of materials and supplies is stated at cost using the moving average method. Materials in transit are stated at invoice cost.

Property and equipment - Property and equipment acquired prior to 1991 are carried at cost or estimated value; acquisitions starting 1991 are stated at cost. Replacement and renovation of assets and property are financed through reserves funded primarily by depreciation. Depreciation of all assets which are owned by the Institute is computed On the straight-line method over the following estimated useful lives of the related assets:

Category Description	Estimated Life	
	1993	Prior years
	Years	
Physical facilities		
Building and improvements	60	40
Electrical equipment	12	8
Infrastructure and leasehold		
Site improvements	60	5
Furniture and equipment		
Farming		
Farm machinery and equipment	15	7
Shop machinery and equipment	12-15	6-10
Laboratory	10	8
Office	5-12	4-10
Auxiliary units	10	6-8
Computers	5-8	3
Vehides	6-10	4-7

Assets in custody are financed by restricted and complementary funding and remain the property of respective donors until the expiration of the agrement/ contact after which decisions on disposition are made by donors. Such assets are shown as a separate item in the statement of financial position.

Effective January 1, 1993, assets in custody are no longer depreciated.

Note 3 - Cash and cash equivalents

Cash and cash equivalents at December 31 consist of:

	1993	1992
	(US Dollar 000)	
Unresificted	4,489	2,739
Restricted	36,332	33,623
	40,821	36262.

The restricted cash balance includes $10,666 thousand as of December 31, 1993 (1992- $4,992 thousand), which represents funds set aside for replacements of or improvements on property and equipment.

Note 4-Accounts receivable - donors
Accounts receivable from donors consist of unreleased balances of approved grants and expenses advanced at December31 and are classified as follows:

	1993	1992
	(US Dollar '000)	
Core grants		
Unrestricted	216	3,096
Restricted	-	200
Complementary project grants	2,692	2,681
	2,908	5,9

The Secretariat of CGIAR assists the Institute in following up the release of core grants by donors.

Notes -Accounts receivable - others
Other receivables at December31 consist of:

	1993	1992
	(US Dollar '000)	
Advances to projects	143	819
Advances to suppliers	488	-
Others	405	476
	1,036	1,295

Note 6 -Property and equipment leases
Property and equipment at December31 are classified under the following accounts:

	1993	1992
	(US Dollar '000)	
Owned		
Cost		
Physical facilities	28,026	25,740
Infrastructure and leasehold	6,379	3,560
Furnishing and eluipment	22,969	19,916
	57,374	49,216
Accumulated depredation		
Physical facilities	10,803	10,417
Infrastructure and leasehold	101	97
Furnishing and equipment	14,062	13,496
	24,966	24,010
Net book value	32,408	25,206
In Custody		
Cost		
Physical facilities	247	16
Furnishing and equipment	1,731	1,066
	1,978	1,082
Accumulated depreciation (Note 2)	506	506
Net book value	1,472	576
	33880	25782

The land used as site for research activities is leased for a period bf 25 years up to year 2000 from the University of the Philippines for a nominal rent and is renewable upon mutual agreement of the parties. Pursuant to the Memorandum of Understanding between the Government of the Republic of the Philippines and the Institute, all the physical plant, equipment and other assets belonging to the Institute shall become the property of the University when the Institute's operations are terminated.

In support of any expansion of the agricultural research progran[1] of the institute and the University, the Philippine Government authorized the University to acquire by negotiated sale or by expropriation certain private agricultural property under Presidential Decree No. 457.

The Institute also leases land and other property from third parties for project experimental sites for periods ranging from one to five years.

Note 7 -Accounts payable - donors

Accounts payable to donors at December 31 consist of grants received in

	1993	1992
	(US Dollar '000)	
Unrestricted core	1,000	2,000
Restricted projects	2,200	3,016
Complementary projects	3,266	7,246
	6,466	12,262

Note 8-Accounts payable - employees

The current and long-term accounts payable to employees consist of accumulated leave earned by and payable to Internationally and Nationally Recruited Staff upon termination of services in addition to repatriation costs of Internationally Recruited Staff.

Note 9-Accounts payable - others

The current and long-term accounts payable-others represent accrual of training charges of post-doctoral scholars, research fellows and trainees such as stipend, board and lodging and other direct expenses to be incurred by the Institute.

Note 10- Accruals and provisions

Accruals and provisions at December31 consist of:

	1993	1992
	(US Dollar '000)	
Capital projects	4,828	7,425
Staff benefits	2,282	1,011
Others	7.711	9532
	14,821	17,968

Note 11 - Staff benefit plan

The Institute maintains a non-contributory provident fund for the benefit of its Nationally Recruited Staff. Monthly contribution to the fund is computed at 105% of the employees' basic salary. The plan provides for lump-sum payment to qualified employees/members upon their separation from the Institute, under certain conditions.

Contributions to the fund amounted to $414,281 in 1993 (1992- $555,730).

Note 12- Changes in fund balances; prior period adjustment

	Fund Balances							
	Capital invested in Fixed Assets							
	Center owned	In Custody	Capital	Working Capital	Core Operations	Operating Fund,	Self-sustaining	Total
			(US Dollar ‘000)					
Balance, January 1, 1992	20,866	-	1,834	2,719	(1,381)	-	660	24,698
Additions, net	4.916	-	3,158	-	-	-	-	8,074
1991 Deficit offset against 1992 operations	-	-	-	-	1,401	-	-	1,401
Excess of revenue over expenses	-	-	-	-	-	-	176	176
Balance, December 31, 1992								
As reported	25,782	-	4.992	2,719	20	-	836	34,349
Reclassfficatlon	(576)	576	-	-	-	-	-	
Prior period adjustment	-	-	2,978	-	1,957	-	-	4,935
As restated	25206	576	7.970	2,719	1,977	-	836	39,284
Additions, net	7,202	896	2,696	-	-	-	-	10.794
Excess (deficit) of revenue overexpenses	-	-	-	-	(207)	-	40	(167)
Reclassification to operating fund	-	-	-	(2,719)	(1,770)	4,489	-	-
Balance,December 3l,1993	32,408	1,472	10,666	-	-	4,489	876	49,911

As mentioned In Note 2, the Institute adopted the accrual method of accounting for expenditures in accordance with generally accepted accounting principles effective January 1,1993. Accordingly, obligated expenditures contracted for goods or services to be received or performed at a future date as of December 31, 1992 were adjusted as prior period adjustment to the beginning fund balances in the current year.

THE INTERNATIONAL RICE RESEARCH INSTITUTE
SUPPLEMENTARY INFORMATION
DECEMBER 31, 1993

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The International Rice Research Institute EXHIBIT I
Schedule of Grant Revenue
For the Year Ended December 31, 1993

Donors	Total Funds Available	Accounts Receivable	Advance Payment	Grant 1993	Grant 1992
	(a) (US Dollar '000)				
Core Unrestricted					
International-European Economic Community	2,122			2,122	2,289
World Bank	2,000		(1,000)	1,000	2,500
Australia	621			621	646
Belgium	-	112		112	150
Canada-Canadian International Development Agency	1,135			1,135	1.384
China	90			90	80
Denmark-Danish international Development Agency	667			667	784
Finland	-			-	193
Germany-BMZ	768			768	837
india	98	2		100	100
indonesia	-	50		50	-
Italy	-			-	69
Japan	7,974			7,974	6,228
Korea	200			200	200
Norway	100			100	122
Philippines	84	28		112	123
Spain	30			30	30
Sweden-Swedish Agency for Research Coaperation	662			662	856
United Kingdom-Overseas Development Administration	1,317			1,317	1,554
United States-Ford Foundation	-			-	150
USAID	5,000			5,000	5,400
Sub-total	22,868	192	(1,000)	22,060	24,195
Core Restricted					
Internahorial-Asian Development Bank	68		(1)	67	348
United Nations Development Programme	1,933		(111)	1,822	1,521
Australia	2		(1)	1	16
Belgium	177		(45)	132	109
Denmark-Danish international Development Agency	41		(34)	7	-
France	674		(640)	34	-
Italy	541		(212)	329	315
Japan	2,022		(889)	1,133	643
Korea	58		(27)	31	32
Netherlands	267		-	267	269
Switzerland	717		(158)	559	396
United States-The Ford Foundation	133		(67)	66	75
Rockefeller Foundation	420		(15)	405	392
Sub-total	7,053		(2,200	4,853	4,116

The International Rice Research Institute EXHIBIT I

Schedule of Grant Revenue

For the Year Ended December 31,1993

Donors	Total Funds Available	Accounts Receivable	Advance Payment	Grant	
				1993	1992
	(a)				
Complementary Grants	(US Dollar '000)				
International-Asian Development Bank	1,897	-	(362)	1,535	1,300
Food and Agricultural Organization	13	-	(6)	7	9
United Nations Development Programme	1,068	194	(66)	1,196	68
Australia	1,654	332	(268)	1,718	1,393
Belgium	'206	-	(138)	68	72
Canada-Canadian International Development Agency	156	-	-	156	281
International Development Research Centre	495	35	(155)	375	546
Denmark	339	-	(255)	84	46
Cermany-BMZ/GTZ	6,118	139	(790)	5,467	3,007
Japan	639	-	(235)	404	-
Korea	84	-	(51)	33	53
Netherlands	394	19	(5)	408	381
Sweden	334	-	(219)	115	141
Switzerland	1409	902	(214)	1,797	1,181
United Kingdom-Overseas Development Administration	333	17	(11)	339	272
United Stats-Environment Protection Agency (EPA)	573	151	-	724	1,052
Ford Foundation	100	-	(12)	88	84
Rockefeller Foundation	1,092	2	(409)	685	594
USAID	1,160	711	(3)	1,868	2,035
Others	488	88	(67)	509	375
Sub-total	18,252	2,590	(3,266)	17,576	12,390
Total grant revenue	48,173	2,782	(6,466)	44,489	41,201

(a) Includes 1992 balance ol grants applicable to succeeding years and 1993 receipts.

The International Rice Research Institute EXHIBIT 2

Schedule of Restricted and Complementary Funding

For the Year Ended December 31. 1993

Donor & Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	1993	Total
	(US Dollar '000)				
A. Restricted Core					
International					
ADB					
TA#5349-Strengthening Rice Crop Protectton	29/l0/89 - 31/12/93	850	783	67	850
UNDP					
Development of Sustainable Rice Production Systems	01/07/91 - 30/06/96	8,000	1,893	1,822	3,715
Australia					
Nitrogen Fixation by Green Legumes	01/01/91 - 31/01/93	42	42	1	43
Belgium					
Assodation of Phytopathogenic Bacteria with Rice	01/05/88 - 31/12/92	671	545	132	657
Denmark					
Women in Rice Farming Systems	01/0l/93 - 31/12/94	94	-	7	7
France					
IRRI/France Collaborative Project	01/01/88 - 31/12/93	1,322	803	34	837
Italy					
Establishment of Biofertilizer Germplasm Conservation Center for Rice	0l/01/87 - 31/12/93	1,000	672	329	1,001
Japan					
Rice Double Cropping Systems	0l/12/89 - 30/11/94	1,949	1,165	386	1,551
Project or. Policy Implications on Rice Supply and Demand	01/01/91 - 31/12/94	758	43	533	576
Shuttle Research-Phase l	01/10/90 - 30/09/93	450	238	214	452
Shuttle Research-Phase 2	01/10/93 - 30/09/94	200			
Korea					
Support for Core Collaborative Project	01/01/93 - 31/12/93	30	31	31	
Netherlands					
Supportfor Rainfed Rice Production Programme	01/01/93 - 31/12/93	267	267	267	
Switzerland					
International Network on Soil Fertility and Sustainable Rice Farming-Phase II	01/01/91 - 31/12/93	1,240	970	559	1,529
United States-Ford Foundation					
Women in Rice Farming Systems	01/01/91 - 31/12/94	200	66	66	132
United Stales-Rockefeller Foundation					
Diflerential Impact Study-India	01/06/88 - 31/12/93	90	62	23	85
Wide Hybridization Project	01/04/92 - 31/03/94	361	149	206	355
TransgenicRiceforStemflorer	01/04/92 - 31/03/94	285	91	176	267
Total Restricted Core Grants		17,809	7,522	4,853	12,375

The International Rice Research Institute EXHIBIT 2

Schedule of Restricted and Complementary Funding
For the Year Ended December 31, 1993

Donor & Program/Project	Grant Period (DD/MM/YV)	Grant Pledged	Expenditures Prior Years	Expenditures 1993	Expenditures Total
		(US Dollar '000)			
B. Complementary					
International					
ADB					
TA#5511 - Establishment of Asian Rice BiotechnologyNetwork	01/01/93 - 31/12/95	900		157	157
TA#5414 - Decentralized Participatory Research for Less Favorable Rice Ecosystems and Rice Wheat Systems of Asia	01/03/91 - 31/12/93	3,000	1,553	1,378	2,931
FAO					
PestSurveillance	01/01/92 - 31/12/93	15	3	7	10
UNDP					
MethaneEmission	0l/01/93 - 31/12/97	4,403	1	982	983
Strengthening Cuu Long Delta Rice Research Institute	01/06/92 - 30/06/94	481	66	214	280
Australia					
Translation into Vietnamese of IRRI Publications	01/07/85 - 30/06/93	38	35	3	38
Cambodia-IRRl Rice Project (Phase3)	01/07/91 - 30/06/96	7,834	1,572	1,518	3,090
Vietnam - IRRI Rice Research & Training Project	01/07/91 - 30/06/94	6(11	158	197	355
Belgium					
IRRI/UCL - Collaborative Project on the Environmental Requirement for Azolla Growth	01/01/87 - 30/11/94	235	167	46	213
Rice Seedhorne Diseases	01/01/91 - 31/12/93	120	31	22	53
Canada-CIDA					
IRRI/BRRlcollaborativeProject	01/01/88 - 30/06/93	1,480	1,278	156	1,434
Canada-IDRC					
Data Management	01/04/89 - 30/06/94	179	1341	5	135
IRRI-Burma Rice Farming systems	01/01/89 - 31/07/93	591	636	(42)	594
Rice Farming Systems-Bhutan	01/04/90 - 31/12/93	339	218	45	263
IRRI/Vietnam Agricultural Economics capacity	01/05/91 - 30/04/93	91	71	36	107
IRRI-University of Laval Collaborative Project	01/01/92 - 31/03/94	24	8	11	19
Asian Rice Farming Systema Network	01/04/92 - 31/03/95	532	44	183	227
IRRI-Myanniar Upland Farming Systems (Phase II)	01/08/92 - 31/07/94	196	20	137	157
Denmark-DANIDA					
Women in Rice Farming Systems (Training & Tours)	04/01/89 - 31/12/90	117	57	60	117
Women in Rice Farming Systems	01/01/91 - 31/12/92	75	51	24	75
Germany-BMZ/GTZ					
Integrated Pest Management in an Irrigated Lowland - Ricefield Ecosystems: Potential of Fish as Biological Agent	01/01/90 - 31/12/93	61	30	11	41
Evaluation of Aquatic Legumes	01/01/90 - 31/08/93	94	87	5	92
Strengthening the International Network for Genetic Evaluation of Rice (INGER) in Africa	01/07/90 - 31/12/93	536	396	137	533
IRRI/WARDA Collaborative Project	01/08/88 - 31/07/91	332	115	217	332
Cambodian Refugee Training course	01/01/91 - 31/12/93	54	28	17	45
Disease Management	01/11/91 - 31/10/95	156	25	71	96
BMZ Renovation Program	01/01/92 - 31/10/93	6,716	2,338	4,378	6,716
Post-harvest Technologies for Paddy in HumidTropics	01/04/92 - 30/06/93	25	14	6	20

The International Rice Research Institute EXHIBIT 2
Schedule of Restricted and Complementary Funding
For the Year Ended December 31, 1993

Donor & Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	1993	Total
	(US Dollar '000)				
Modelling of Soil Fertility-University of Leipzig	01/05/92 - 30/04/94	187	48	42	90
Strengthening the International Network for Genetic Evaluation of Rice in Africa (INGER)-ECSA	01/08/92 - 31/07/95	801	13	385	398
IRRI/ICLARM /Univ. Gottingen Collaborative Project	01/07/92 - 30/06/95	20		3	3
GTZ - Asian Rice Biotech Network	01/01/93 - 31/12/95	1,380		174	174
GTZ/University of Liebig - IRRI Project on Nitrogen Dynamica in lowland Rice	01/03/93 - 30/04/96	135		13	13
Post-harvest Technologies for Paddy in Humid Tropics	01/07/93 - 30/06/96	104		8	8
Japan					
African Training Program	01/05/90 - 31/12/93	141	111	28	139
Biofertilizer Germplasm BuIlding	01/10/87 - 31/12/92	1,950	1.574	376	1,950
Korea					
IRRI/RDA Collaborative Project	01/11/88 - 31/12/93	101	63	25	88
Seed Multiplication Project	01/01/91 - 31/12/93	43	32	8	40
Netherlands					
WAU-Natural Enemies	01/07/90 - 31/12/93	118	75	10	85
IRRI/NRI collaborative-RiceTungro Disease	01/01/91 - 31/12/93	312	190	59	249
IRRI/CABO Collaborative Research	01/01/92 - 31/12/95	1,277	218	339	557
Sweden					
IRRI/Sri Lanka-DOASL Collaborative Project	01/07/90 - 30/06/95	770	405	115	520
Switzerland					
lntegrated Pest Mansgesnent- Network- Neem	01/01/90-30/06/93	757	424	288	712
Lao-IRRI Rice Research & Training Project (Ph.2)	01/01/90-30/06/93	2,910	1,713	737	2,450
International Network on Soil Fertility and Sustainahie Rice Farming - Subnetworks	01/01/91 - 31/12/93	550		397	397
Lao - IRRI Rice Research & Training Project (Ph. 2)	01/07/93 - 30/06/96	3,540		375	375
Safeguarding & Preservation of Hiodiversity of Rice	01/11/93 - 31/12/98	3.286			
United Kingdom-ODA					
Development of Salinity: Tolerant Using Rice Cultivars Physiological Traits	01/04/90 - 31/03/93	295	226	51	277
Enviromnental Impactof Rice Technology	01/01/92 - 31/12/93	34	20	14	34
Development of Small Farm Stripper Harvesting System	01/04/92 - 30/06/93	34	17	28	45
Rice Genetic Manipulation	01/10/91 - 30/09/94	241	72	189	261
Rice Production and Potential Longevity of Seed	01/04/92 - 31/03/93	53	46	45	91
Methane Generation and Consumption in Ricefields	01/03/93 - 31/03/96	23		10	10
Molecular Markers and their Use in Organizing Plant Germplasm Collection ODA/R5049	01/01/93 - 31/12/95	27		2	2
United States-EPA					
IRRI - Environmental Protection Agency Collaborative Project	01/10/90 - 30/09/95	5.033	1991	724	2,715
United States-Ford Foundation					
FF#890-0880 - Fanning Systems Research in Eastern India	17/08/89 - 30/11/94	529	336	88	424

The International Rice Research Institute EXHIBIT 2

Schedule of Restiicted and Complementary Funding

For the Year Ended December 31, 1993

Donor & Program/Project	Grant Period (DD/MM/YY)	Grant Pledged	Expenditures Prior Years	1993	Total
	(US Dollar '000)				
United States-Rockefeller Foundation					
Biotechnology Project in lndia	01/10/90 - 31/12/93	97	64	19	83
Environmental Research-Fellowship	01/03/92 - 31/03/94	142	81	49	130
Bacillus thuringiensis	01/04/92 - 31/03/93	91	60	33	93
RFLP shuttle Research	01/04/91 - 31/03/93	259	168	91	259
RF Molecular Biology	01/04/91 - 31/03/93	230	137	102	239
RF BiotechTraining/Workshop	01/06/92 - 31/05/93	51	35	11	46
Terminal Sequencing of Mapped Rice Genome	01/01/93 - 31/12/94	98		37	37
Study on Rice Research Prioritization	01/04/93 - 30/06/94	125		17	17
Molecular Biology Techniques	01/04/93 - 31/03/94	130		47	47
Bacillus thuringiensis Project	01/04/93 - 31/03/94	89		37	37
Genome Mapping and Molecular-Assisted Plant Breeding	01/04/93 - 31/03/94	154		129	129
Establishment of Ubon Drought Facility	01/04/93 - 31/03/96	79		20	20
Technology Transfer Training	08/01/93 - 31/07/93	271			
RF-Training Programs	01/09/91 - 23/04/95	195	43	93	136
United States-USAID					
IRRI/Malagasy Rice Research Project (Phase 3)	0l/01/90 - 31/12/94	5,600	2,537	812	3,349
AID- IRRI/Egypt Collaborative Project	01/03/87 - 30/06/94	4,000	2,848	545	3.393
AID-CIDABRRI/IRRI Rice Research Training	01/01/88 - 04/06/93	2,890	2,050	467	2,517
Effect of contintious, lrrigated Rice Cropping	16/09/92 - 29/09/94	50		25	25
IRRI - Michigan State University Collaborative Project	01/01/93 - 31/12/94	54		19	19
Others					
Chemical Grants		173	104	68	172
IFAD-Bangladesh Collaborative Project	01/01/89 - 31/12/93	510	238	114	352
IRRI-CSIRO Project Collaboration	01/05/93 - 01/07/94	S		5	5
IRRI/China ASSP Project	01/05/93 - 30/04/96	784		237	237
IRRI/Iran Collaborative Project	01/01/87 - 31/12/93	426	287	45	332
Apornixis on Rice Workshop	1993	30		40	40
Total Complementary Grants		70,409	25258	17,576	42.934
Grand Total		88,218	32,880	22,429	55,309

The International Rice Research Institute EXHIBIT 3

Schedule of Fixed Assets

For the Year Ended December 31, 1993

	Balance January 1,1993	Additions	Transfers	Disposals	Balance December 31,1993
	(US Dollar ‘000)				
Physical facilities	25,756	1,623	919	(25)	28,273
Infrastructure and leasehold	3,560	3,738	(919)	-	6379
Furnishing and equipment					
Farming	2,424	471		(4)	2,901
Laboratory and scientific	6,231	1,228		(59)	7,400
Office	1,354	366		(7)	1713
Auzillary units	1,310	206		(5)	1.511
Computers	4,415	9,641		(64)	5,311
Vehicles	5,238	812		(186)	5,864
Sub-total	20,982	4,043		(325)	24,700
Total cost	541,298	9,404		(350)	59,352
In custody	1,082	896			1,978
Accumulated depredation					
Physical facilities	(10,417)	(403)		17	(10.803)
Infrastructure and leasehold	(97)	(4)		-	(101)
Furnishing and equipment	(14,1102)	(854)		288	(14,568)
Total accumulated depreciation	(24,516)	(1,261)		305	(25.472)
Incustody	(506)	-	-	-	(506)*
Net book value					
Physical facilities	15,339	1,220	919	(8)	17.470
Infrastructure and leasehold	3,463	3,734	(919)	-	6,278
Furnishing and equipment	6,980	3,189		(37)	10,132
	25,782	8,143	-	(45)	33.880

*Effective January 1,1993, no depredation is recognized on fixed assets in custody.

The international Rice Research Institute EXHIBIT 3A

Schedule of Capital Expenditures

For the Year Ended December 31,1993

	1993				
	Physical Facilities	Infrastructure and Leasehold*	Furnishing & Equipment	Total	1992
I. Cost	(US Dollar '000)				
Balance, January 1	25,756	3,560	20,982	50,298	43,285
Current period:					
Additions	1,623	3,738	4,043	9,404	7,569
Transfers	919	(919)	-	-	-
Disposals	(25)	-	(325)	(350)	(556)
Balance, December 31	28,273	6,379	24,500	59352	50,298
(Of which are in custody)	247	-	1,731	1,978	1,062
It Acenmulated Depreciation					
Balance, January 1	(10,417)	(97)	(14,002)	(24,516)	(22A18)
Current period:					
Depredation	(403)	(4)	(854)	(1,261)	(2,612)
Of transfers	-	-	-	-	-
Of disposals	17	-	288	305	514
Balance, December31	(10,803)	(101)	(14,568)	(25,472)	(24,516)
(Of which are in custody)	-	-	(506)	(506)	(506)***
III. Net Book Value	17,470	6,278	10,132	33,880	25,782

* Indudes construction in progress

** Includes self-sustaining activities such as staff housing, guesthouse and dormitory.

*** Effective January 1,1993, no depreciation is recognized on fixed assets in custody.

The International Rice Research Institute EXHIBIT 3B
Schedule of Capital Expenditures
For the Year Ended Decenīber 31,1993

	Balance January 1	Additions	Transfers	Disposal	Balance December 31
I. Cost	(US Dollar '000)				
A. Physical facilities	25,756	1,623	919	(25)	28273
B. Infrastructure & leasehold*	3,560	3,738	(919)	-	6,379
C. Furnishing and equipment					
Farming	2,434	471	-	(4)	2,901
Laboratory & scientific	6,231	1,228	-	(59)	7,406
Office	1,354	366	-	(7)	1,713
Auxiliary units**	1,310	206	-	(5)	1,511
Computers	4,415	960	-	(64)	5,311
Vehicles	5,238	812	-	(186)	5,864
Sub-total	20,982	4,043	-	(325)	24,700
Total Cost	50,298	9.404	-	(350)	59,352
(Of which are in custody)	1,082	896	-	-	1,978
II. Accumu1ated depreciation	(24,516)	(1,261)	-	305	(25,472)
(Of which are in custody)	(506)	-	-	-	(506)***
III. Net Book Value	25,782	8,143	-	(45)	33,880

* Includes construction In progress
** Includes self-sustaining activities such as staff housing, guesthouse and donnitory.
*** Effective January 1,1993, no depreciation is recognized on fixed assets in custody.

The International Rice Research Institute
Capital Pund Movement
For the Year Ended 31 December 1993

	1993 (US Dollar '000)				
	Physical Facilities	Infrastructure and Leasehold	Furnishing & Equipment	Total	1992
A. Balances January 1					
As reported	1,272	65	3,655	4,992	1,834
Prior period adjustment	1,832	-	1,146	2,978	-
As adjusted	3,104	65	4,801	7,970	1,834
B. Sources:					
Depredation charges	403	4	854	1,261	2,612
Gains on disposal			7	7	12
Additional allocations			1,767	1,767	542
	403	4	2,628	3,035	3,166
C. Uses:					
Replacement			337	337	8
New acquisition			2	2	-
	-	-	339	339	8
D. Balances December 31	3,507	69	7,090	10,666	4,992

The International Rice Research Institute ATTACHMENT II

Details of Operating Expenses

For the Year Ended 31 December 1993

A. Core	1993						1992
	Research	Research Support	Information Services	General Administration	General Operations	Total	
	(US Dollar '0001						
1. Unrestricted					(a)		
Personnel costs	5,742	1,029	2,665	2,296	3,393	15,125	13,565
Supplies & Services	1,620	410	1,503	940	4257	8,730	9,959
Operational Travel	490	6	254	217	16	9S3	1,003
Depreciation	-	-	-	-	1,139	1,139	2,603
Total Operating Expenses	7,852	1,445	4,422	3,453	8,805	25,977	27,130
Recovery of Overhead	-	-	-	-	(2.491)	(2491)	(1,626)
Sub-total	7,852	1,445	4,422	3,433	6214	23,486	25,504
2. Restricted							
Personnel Costs	757	-	513	-	-	1.270	1,124
Supplies & Scrvices	1,523	-	505	-	387	2,415	1902
Operational Travel	316	-	170	-	-	486	422
Total operating Expenscs	2596	-	1,188	-	387	4,171	3,448
Indirect Cost	126	-	213	343	-	682	656
Sub-total	2,722	-	1,401	343	387	4,853	4,104
Total Core	10,574	1,445	5,823	3,796	6,701	28,339	29,6418
B. Complementary							
Personnel Costs	729	-	1,829	-	-	2,538	2,064
Supplies & Services	2,886	-	4,286	-	4,754	11,926	8,303
Operational Travel	321	-	979	-	-	1,300	1,237
Total Operating Expenses	3,936	-	7,094	-	4,754	15,784	11,604
lndirect Cost	639	-	1,153	-	-	1,792	1,286
Total Complementary	4,375	-	8,247	-	4,754	17,576	12,890

(a) - Includes Staff Adjustment Program

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TERENCE WOODHEAD, Ph *D, physicist and liaison scientist/rice-wheat coordinator*

Agronomy, Plant Physiology and Agroecology

KENNETH G. CASSMAN, *Ph D, agronomist and head*
LISA BEAN, *MS, consultant*[3]
QUIJIE DAI, Ph *D, consultant*[3]
ANNE HMNG, Ph *D, consultant*[3]
THOMAS GEORGE, *Ph D, visiting scientist*[1]
WILHELMINO T. HERRERA, *Senior Assistant Scientist, Agroecology*
KEITH T. INGRAM, Ph *D, agronomist*[2]
W. JOENJE, *Ph D, consultant*[3]
PIERCE H. JONES, *Ph D, consultant*[3]
MARTIN J. KROPFF, *Ph D, agronomist/ crop modeler*
ROBIN B. MATTHEWS, Ph *D, visiting scientist*
KEITH MOODY, Ph *D, agronomist*
DANIEL OLK, Ph *D, visiting scientist*[1]
SHAOBING PENG; Ph D, *associate crop physiologist*[7]
TIMOTHY L. SETTER, *Ph D, plant physiologist*
UPENDRA SINGH, Ph *D, visiting scientist*
VIRENDRA PAL SINGH, *Ph D, agronomist*[7]
KAZUKIYO TETSUKA, *Ph D, visiting scientist*
GUY TREBUIL, *Ph D, visiting scientist*[1]
H. H. VAN LAAR, BS, consultant[3]
LEONARD J. WADE, *Ph D, agronomist*[1]
CURTIS WELDON, *BS, consultant*[3]
MARCO WOPEREIS, 2V/S, *consultant3*
MINORU YAMAUCHI, *Ph D, plant physiologist*

Entomology and Plant Pathology

DALE G. BOTTRELL, Ph D, *entomologist and head*[2]
TWNG W. MEW, *Ph D, plant pathologist and head*
FRANCISCO A. ELAZEGUI, *senior assistant scientist, plant pathology*
MA. LUZ C. GEORGE, *Ph D, consultant*[3]
MARVIN K. HARRIS, Ph *D, visiting scientist*[3]
KONG LUEN HEONG, Ph D, *entomologist*
HIROKI KOGANEZAWA, *Ph D, plant pathologist*
FILOMENO G. MEDRANO, *senior assistant scientist, entomology*
CHRISTOPHER C. MUNDT, Ph *D, visiting s cientist*[2]
REBECCA J. NELSON, *Ph D, plant pathologist*[7]
JEAN-CLAUDE PROT, *Ph D, visiting scientist*
PETER J. REIMERS, *Ph D, consultant*[3]
SERGE SAVARY, Ph *D, visiting scientist2*
KENNETH SCHOENLY, Ph D, *associate visiting scientist*[3]
PAUL S. TENG, Ph *D, plant pathologist and program leader, cross-ecosystems research*
REY LUIS VELASCO, *Ph D, visiting scientist*[2]
ALAN WATSON, *Ph D, visiting scientist*
MICHAEL J. WAY, *Ph D, consultant*[3]
ROBERT S. ZEIGLER, *Ph D, plant pathologist and program leader, rainfed lowland rice ecosystem research*

Plant Breeding, Genetics, and Biochemistry

GURDEV S. KHUSH, Ph *D, principal plant breeder and head*
RODOLFO C. AQUINO, *senior assistant scientist*
MICHEL A. ARRAUDEAU, Ph *D, visiting scientist and program leader, upland rice ecosystem research*
JOHN BENNETT, *Ph D, senior molecular biologist*
DARSHAN S. BRAR, *Ph D, plant breeder*[7]
BRIGITTE COURTOIS, *Ph D, visiting scientist*[1]
SWAPAN K. DATTA, Ph D, *tissue culture specialist1*
NING HUANG, Ph *D, plant molecular geneticist*
RYOICHI IKEDA, *Ph D, plant breeder2*
TOKIO IMBE, Ph D, *plant breeder1*
BIENVENIDO O. JULIANO, *Ph D, chemisl*[2]
MOO SANG LIM, Ph *D, visiting scientist2*
SUSAN R. MCCOUCH Ph *D, associate geneticist*
N. PANDA, *Ph D, consultant*[3]
NAM KYU PARK, *Ph D, visiting scientist*[1]
SURAPONG SARKARUNG, Ph *D, plant breeder*

GERARD SECOND, *Ph D, visiting scientist*[2]
DHARMAWANSA SENADHIRA, Ph *D, plant breeder*
SANT SINGH VIRMANI, Ph D, *plant breeder*
FRANCISCO JAVIER ZAPATA, Ph *D, tissue culture specialist2*

Social Sciences
MAHABUB HIOSSAIN, *Ph D, agricultural economist and head*
MUBARIK ALI, Ph *D, associate visiting scientist2*
JAMES S. FUJISAKA, Ph D, *social scientist*
ELEANOR H. HIUKE, *BFA, visiting scientist*[3]
ROBERT E. HUKE, Ph D., *visiting scientist*[3]
ELEAZER D. HUNT, Ph *D, associate visiting scientist2*
SUSHIL PANDEY, Ph *D, agricultural economist*[1]
THELMA R. PARIS, *Senior Assistant Scientist*
PRABHU L PINGALI, Ph *D, agricultural economist and program leader*
SARAH J. TISCH, Ph D, *visiting scientist*

Soil and Water Sciences
HEINZ-ULRICH NEUE, Ph D, *soil chemist and head*
JONATHAN R. M. ARAH, *Ph D, visiting scientist*[3]
SADIQUL I. BHUIYAN, Ph *D, agricultural engineer*
KEVIN BRONSON, Ph *D, associate visiting scientist*
GUY JOSEPH DUNN KIRK, Ph *D, soil chemist*
JAGDISH K. IADHA, Ph *D, soil microbiologist*
RHODA S. LANTIN, *senior assistant scientist, soil science*
TO PHUC TUONG, Ph *D, water management engineer*
RUINER WASSMANN, Ph D, *visiting scientist*[1]

Biometrics
CHRISTOPHER G. MCLAREN, Ph *D, visiting scientist and acting head*[1]
BONGHO CHOE, Ph *D, consultant*~

Genetic Resources Center
MICHAEL T. JACKSON, Ph *D, head*
SANG-WON AHN, Ph *D. plant pathologist*
RAM CHET CHAUDHARY, Ph D, *global coordinator, international network for genetic evaluation of rice*[6]
V. SESHU DURVASULA, Ph *D, plant breeder and global coordinator, international network for genetic evaluation of rice*
GENOVEVA C. LORESTO, *senior assistant* scientist
DUNCAN A. VAUGHAN, Ph *D, rice geneticist*[2, 7]

Information Center
ROBERT D. HUGGAN, MS, *communication specialist and head*[1]
THEODORE HUTCHCROFT, Ph D, *visiting scientist and acting head*[2]
RAMIRO C. *CABRERA, production manager, CPS*
CAROLYN DEDOLPH, *MS, science editor and writer*
CRISPIN C. MASLOG, Ph *D, consultant*
LARUE POLLARD, Ph D, *editor*[2]
WALTER ROCKWOOD, MS, *consultant2*
LESLIE ROSE, *MS, visiting scientist2*
WILLIAM H. SMITH, BS, *consultant2*
MARINUS CORNELIS VAN DEN *BERG, BS, head, computer services*
LINA M. VERGARA, M*S, librarian*[2] IAN WALLACE, MLS, *consultant1*

International Programs Management Office
GLENN L. DENNING, Ph *D, scientist-international collaboration and head*
ACHMAD M. FAQI, Ph *D, consultant*[3]

Network Coordination
ERNESTO L. ARAGON, Ph *D, associate agronomist and coordinator, international network on soil fertility and sustainable rice farming (INSURF)*[2]
VIRGILIO R. CARANGAL, Ph *D, agronomist and coordinator, asian* ri*ce farming systems network (ARFSN)*
HARDJOSUBROTO SUBAGJO, Ph *D, consultant*[3]

Training Center
ELLIS L. MATHENY, Jr., Ph *D, head*
ROBERT T. RAAB, Ph D, *training and courseware specialist*

[1]Joined during the year
[2]Left during the year
[3]Joined and left during the year
[4]On study leave
[5]Died during the year
[6]Transferred from Cambodia-IRRI Rice Research Project
[7]Promoted

Consultative Group on International Agricultural Research (CGIAR)

The CGIAR is a worldwide network of research centers supported by an international donor group. IRRI is part of this global system. Through research and education, the CGIAR helps make farming in developing countries more productive-the first stepping stone out of poverty. For farmers and the rural poor, increased agricultural production leads to better nutrition, higher incomes and improved standards of living. In-creased and more stable production of food staples also leads to lower prices, which allow poor people in the cities to satisfy more of their food needs.

Some 1,000 internationally recruited scientists representing 60 different nationalities conduct research at CGIAR centers and in collaboration with national program scientists in some 40 developing countries.

Mission of the CGIAR
Through international research and related activities, and in partnership with national research systems, to contribute to sustainable improvements in the productivity of agriculture, forestry and fisheries in developing countries in ways that enhance nutrition and well-being, especially of low-income people.

CIAT—Centro Internacional de Agricultura Tropical, with headquarters in Colombia. Focus on germplasm development in beans, cassava, tropical forages and rice for Latin America, and on resource management in humid ecosystems in tropical America (hill-sides, forest margins and savannas).

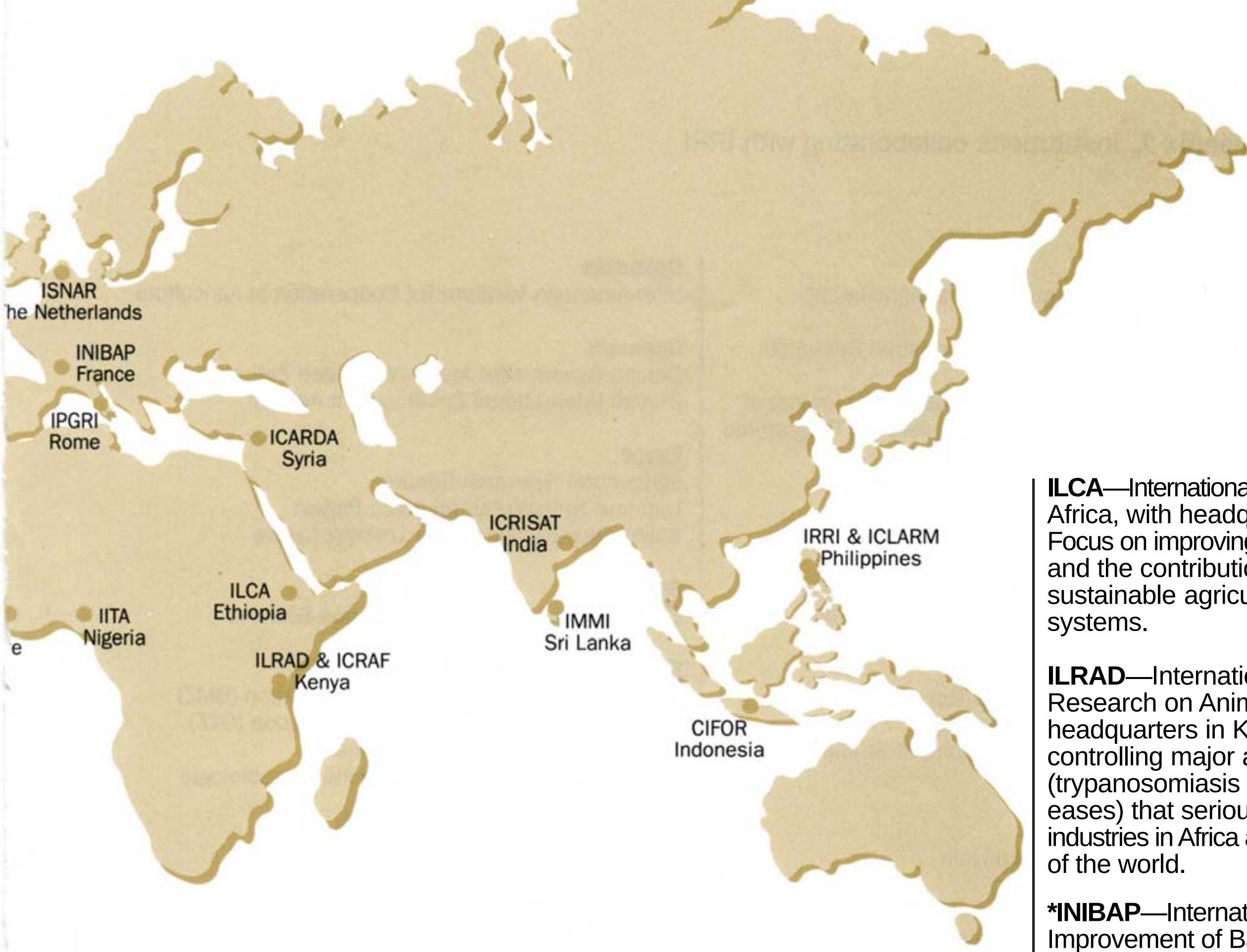
CIFOR—Center for International Forestry Research, with headquarters in Indonesia. Focus on conserving and improving the productivity of tropical forest ecosystems.

CIMMYT—Centro Internacional de Majoramiento de Maiz y Trigo, with headquarters in Mexico. Focus on increasing the productivity of resources committed to maize, wheat and triticale in developing countries.

CIP—Centro Internacional de la Papa, with headquarters in Peru. Focus on potato and sweet potato improvement, and on natural resource conservation in the Andean region.

ICARDA—International Center for Agricultural Research in the Dry Areas, with headquarters in Syria, Focus on increasing the productivity of farming systems involving wheat, barley, chickpea, lentils, pasture legumes and small ruminants in North Africa and West Asia.

ICLARM—International Center for Living Aquatic Resources Management, with headquarters in the Philippines. Focus on improving production and management of aquatic resources in developing countries.



ICRAF—International Centre for Research in Agroforestry, with headquarters in Kenya. Focus on mitigating tropical deforestation, land depletion and rural poverty through improved agroforestry systems.

ICRISAT—International Crops Research Institute for the Semi-Arid Tropics, with headquarters in India. Focus on contributing to more sustainable agricultural production systems through improved productivity of sorghum, millet, chickpea, pigeonpea and groundnut.

IFPRI—International Food Policy Research Institute, with headquarters in the United States. Focus on identifying and analyzing policies for meeting the food needs of developing countries, in particular the poorer countries.

IIMI— International Irrigation Management Institute, with headquarters in Sri Lanka. Focus on strengthening the development, dissemination and adoption of lasting improvements in the performance of irrigated agriculture in developing countries.

IITA—International Institute of Tropical Agriculture, with headquarters in Nigeria. Focus on contributing to sustainable and increasing food production in the humid and subhumid tropics, in particular in maize, cassava, cowpea, plantain, soybean and yam, and in partnership with African national agricultural research systems.

ILCA—International Livestock Center for Africa, with headquarters in Ethiopia. Focus on improving livestock production and the contribution of livestock to sustainable agricultural production systems.

ILRAD—International Laboratory for Research on Animal Diseases, with headquarters in Kenya. Focus on controlling major animal diseases (trypanosomiasis and tick-borne diseases) that seriously limit livestock industries in Africa and many other parts of the world.

***INIBAP**—International Network for the Improvement of Banana and Plantain, with headquarters in France. Focus on increasing the productivity and stability of banana and plantain grown on small farms in developing countries.

IPGRI—International Plant Genetic Resources Institute, with headquarters in Italy. Focus on conserving gene pools of current and potential crops and forages.

IRRI—International Rice Research Institute, with headquarters in the Philippines. Focus on generating and disseminating rice-related knowledge and technology of long-term environmental, social and economic benefit.

ISNAR—International Service for National Agricultural Research, with headquarters in the Netherlands. Focus on institutional development and strengthening of national agricultural research systems.

WARDA—West Africa Rice Development Association, with headquarters in Côte d'Ivoire. Focus on improving rice varieties and production methods among smallholder farm families in the upland/inland-swamp continuum, the Sahel and mangrove swamp environments.

* Merging with IPGRI

Appendix 1. Institutions collaborating with IRRI

Australia
Australian Centre for International Agricultural Research (ACIAR)
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Global Change and Terrestial Ecosystems Project of the International Geosphere-Biosphere
Programme University of Western Australia
Yanco Agricultural Research Institute

Bangladesh
Ministry of Agriculture:
- Bangladesh Agricultural Research Council
- Bangladesh Agricultural Research Institute
- Bangladesh Rice Research Institute

Bangladesh Academy of Rural Development
Bangladesh Agricultural University
Bangladesh Institute of Development Studies

Belgium
Rijkuniversiteit Gent
Universite Catholique de Louvain

Bhutan
Research and Extension Division, Department of Agriculture

Botswana
Southern African Centre for Cooperation in Agricultural Research (SACCAR)

Brazil
Brazilian Institute for Agricultural Research (EMBRAPA)
Centro Nacional de Pesquisa de Arroz e Feijao

Cambodia
Department of Agronomy, Ministry of Agriculture

Canada
Canadian International Development Agency (CIDA)
International Development Research Centre (IDRC)

People's Republic of China
Anhui Academy of Agricultural Sciences
China National Rice Research Institute
Chinese Academy of Agricultural Mechanization Sciences
Chinese Academy of Agricultural Sciences
Department of Agriculture
Fujian Academy of Agricultural Sciences
Guangdong Academy of Agricultural Sciences
Guangxi Academy of Agricultural Sciences
Hunan Academy of Agricultural Sciences
Jiangsu Academy of Agricultural Sciences
Jiangxi Academy of Agricultural Sciences
Rice Research Institute of China
Sichuan Academy of Agricultural Sciences
Soil and Fertilizer Research Institute
South China Agricultural University
Zhejiang Agricultural University

Colombia
Inter-American Institute for Cooperation in Agriculture

Denmark
Danish Government Institute of Seed Pathology
Danish International Development Agency

Egypt
Agricultural Research Center
National Agricultural Research Project
Sakha Rice Research and Training Centre

Equador
Centro de Planification y Estudious Sociales

Federal Republic of Germany
Federal Ministry for Economic Cooperation (BMZ)
German Agency for Technical Cooperation (GTZ)
Justus Liebig-University of Giesen
Max-Planck-Institut für Terrestriche Mikrobiologie
University of Liepzig

Guinea
Institut de Recherche Agonomique de Guinea
Minister du Development Rurale et Pischerie

India
Indian Council of Agricultural Research (ICAR)
- Central Rice Research Institute
- Central Soil Salinity Research Institute
- Directorate of Rice Research
- Indian Agricultural Research Institute
- Indian Institute of Technology
  National Bureau of Plant Genetic Resources

Central Rainfed and Upland Rice Research Station

Avinashilingam Institute of Home Science and Higher Education for Women
G. B. Pant University
Haryana Agricultural University
Indira Gandhi Agricultural University
Narendra Deva University of Agriculture and Technology
Punjab Agricultural University
Rajendra Agricultural University
Tamil Nadu Agricultural University

Indonesia
Agency for Agricultural Research and Development (AARD)
- Center of Agricultural Research
- Central Research Institute for Food Crops (CRIFC)
  — Banjarbaru Research Institute for Food Crops
  — Bogor Research Institute for Food Crops
  — Sukamandi Research Institute for Food Crops
  --Sukarami Research Institute for Food and Crops
- Centre for Agro-Socioeconomic Research
- Maros Agricultural Research Institute

Iran
Ministry of Agriculture:
- Mazandazam Agricultural Research Center
- Rice Research Institute of Iran
- Seed and Plant Improvement Institute
- Soil and Water Research Institute

Agricultural Research Center of Guilan
Iran Institute of Science and Research Expansion

Japan
Ministry of Agriculture, Forestry and Fisheries
Japan International Research Center for Agricultural Sciences
National Agricultural Research Center
University of Tsukuba
Kyoto University
Kyushu University

Kenya
Kenya Agricultural Research Institute

Korea, Democratic People's Republic
Rice Research Institute of the Academy of Agricultural Sciences

Korea, People's Republic
Rural Development Administration (RDA)
- Crop Experiment Station, Suweon
- Agricultural Sciences Institute, Suweon
- Honan Crop Experiment Station, Iri
- Yeongnam Crop Experiment Station, Milyang

Rice Research Institute (RRI)

Lao PDR
Department of Agriculture:
- National Agricultural Research Center

Madagascar
Ministry of Scientific Research and Technology for Development:
- National Center for Applied Research on Rural Development (FOFIFA)
  — Department of Research Development
  — Department of Rice Research

Malaysia
Malaysian Agricultural Research and Development Institute
Muda Agricultural Development Authority
Universiti Pertanian Malaysia

Malawi
Ministry of Agriculture:
- Agricultural Research Office

Mali
Ministry of Agriculture

Mexico
Campo Experimental de Zacatepec (CIFAP)
Instituto Nacional de Investigaciones Forestales y Agropecuarias

Myanmar
Ministry of Agriculture:
- Central Agricultural Research Center
- Myanmar Agriculture Service

Nepal
Department of Agriculture:
- National Agricultural Research Center
- National Agricultural Research and Service Center
- National Rice Improvement Programme

Nigeria
Federal Ministry of Science and Technology
National Cereals Research Institute

Pakistan
National Agricultural Research Center
Pakistan Institute of Development Studies
Pakistan Agricultural Research Council
Pakistan University of Agriculture

Philippines
Department of Agriculture :
- Bureau of Agricultural Research
- Bureau of Plant Industry
- National Irrigation Administration
- National Post-Harvest Institute for Research and Extension
- Philippine Rice Research institute

Department of Science and Technology:
- Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development

Central Luzon State University
Mariano Marcos State University
University of the Philippines Los Baños
- National Crop Protection Center
- Institute of Plant Breeding
- Institute of Biotechnology and Applied Microbiology
- Farming Systems and Soil Resources Institute
- Research Management Center

Visayas State College of Agriculture
International Institute for Rural Reconstruction
Philippine Institute of Development Studies

Sri Lanka
Department of Agriculture:
- Central Agricultural Research Institute
- Central Rice Breeding Station
- Regional Agricultural Research Center
- Rice Research and Development Institute

Sweden
Swedish Agency for Research Cooperation with Developing Countries (SAREC)

Switzerland
Swiss Development Agency
Swiss Development Cooperation

Taiwan
Taiwan Agricultural Research Institute

Tanzania
Ministry of Agricultural and Livestock Development:
- Research and Training Division
- Rice Research Institute (Ifakkara)

Thailand
Department of Agriculture:
- Farming Systems Research Institute
- Rice Research Institute
  --Huntra Rice Experiment Station
  --Pathum Thani Rice Research Center
  --Prachin Buriice Research Center
  --Ubon Rice Research Center

Land Development Department:
- Soil Salinity Research Section

Royal Irrigation Department

Kasetsart University
Khon Kaen University

Thailand Development Research Institute Foundation

The Netherlands
Centre for Agricultural and Biological Research
Wageningen Agricultural University

United Kingdom
Natural Resources Institute
Overseas Development Administration
University of Nottingham
University of Bristol

United States of America
Environmental Protection Agency
United States Agency for International Development
Cornell University
Ford Foundation
Kansas State University
Missouri State University
Oregon State University
Purdue University
Rockefeller Foundation
Stanford University
Texas Tech University
University of California, Davis
University of Florida
University of Minnesota

Vietnam
Ministry of Agriculture and Food Industry:
- Institute for Food Crops Research
- Institute for Soils and Fertilizer
- Institute of Science and Technology
- Vietnam Agricultural Sciences and Technology Institute
- Cuu Long Delta Rice Research Institute
- Southern Institute for Food Crops
- Vietnam Agricultural Sciences and Technology Institute

Cantho University
Hanoi University
University of Agriculture and Forestry

Zambia
Ministry of Agriculture

International/Regional Organizations or Centers
Asian Development Bank (ADB)
Asian Vegetable Research and Development Center (AVRDC)
Centro Internacional de Agricultura Tropical (CIAT)
Food and Agriculture Organization (FAO)
International Center for Genetic Engineering and Biotechnology (ICGEB)
International Center for Living Aquatic Resources Management (ICLARM)
International Center for Research and Agroforestry (ICRAF)
International Centre of Insect Physiology and Ecology (ICIPE)
International Food Policy Research Institute (IFPRI) International Fund for Agricultural Development (IFAD) International Institute of Tropical Agriculture (IITA) International Irrigation Management Institute (IIMI) International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)
International Service for National Agricultural Research (ISNAR)
Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA)
United Nations Development Programme (UNDP)
West Africa Rice Development Association (WARDA)

Appendix 2. Ongoing IRRI Complementary Projects (at 1 July 1994)

Donor	Title	*Funding (US$)	Duration
International Institutions			
Asian Development Bank	Decentralized ParticIpatory Research for Less Favorable Rice Ecesystems and Rice-wheat Systems of Asia	3,000,000	1991-1994
	Asian Rice Biotechnology Network	900,000	1993-1995
Food and Agriculture Organi-zation	FAO-IRRI Collaboration and Participation in Pest Management	15,000	1992-1994
International Fund for Agricultural Development	Development of Reinfed Production in Bangladesh	510.000	1987-1994
	Collaborative Research and Development of Sustainable Rice Farming Systems in Southern Asia (Phase II)	1,379,000	1994-1996
United Nations Development Programme	Strengihening the Cuu Long Delta Rice Research Institute	481,000	1992-1995
	An Inter-regional Program on Methane Emission from Rice Fields	4,403000	1993-1997
World Bank	China-IRRI Agricultural Support Services Project	784,000	1993-1996
Australia			
Australian Contra for Inter-national Agricultural Research	Assessment of the Active Barrier System for Rodent Control at Ie-8	8,000	1993-1994
	Analysis of Nitrogen and Starch in Tro-pical Crops Using NIR Spectroscopy	21,000	1994-1995
Australian International Devel-opment Assistance Bureau	Cambodia-IRRI-Australia Rice Project (Phase III)	7,834,000	1991-1996
Belgium			
Administration Generale de Ia Cooperation at Developpement de Belgique	IRRI-UCL Project on Azolla (Phase II)	235,000	1987-1994
	Rice Seedhorne diseases	120,000	1992-1994
Canada			
International Development Research Centre	Data Management for On-farm trials	179.000	1989-1994
	Asian Rice Farming Systems Network	532,000	1992-1995
	IRRI-Myanmar Low Cost Sustainable Rice-Based Farming Systems Project for Hilly Regions of Myanmar	311,000	1992-1995
	Bhutan-IRRI Rice Farming Systems (Phase II)	339,000	1990-1995
	University Leval Collaborative Project	24,000	1992-1994

AppendIx 2 continued

Donor	Title	*Funding (US$)	Duration
Denmark			
Government of Denmark	Assessing Opportunities for Biological Nitrogen Fixation in Rice	610,000	1994-1996
	Managing Weeds With Less lAerbicides- Allelopathic Activity of Rice Germplasm	625,000	1994-1996
Germany			
BMZ/GTZ	Disease Management in Rainfed Lowland Rice with Special Reference to Characlarization of Microenvironment for Extrapolating Technology	156,000	1991-1995
	Nitrogen Dynamics in Lowland Rice as Affected by Organic Farming Practices	107.000	1993-1996
	Strengthening tIGER in Africa (ECSA)	800,000	1992-1995
	Asian Rice Biotechnology Network: Part 2	1.380,000	1993-1995
	Upland Rice Consortium in South and Southeast Asia Phase II)	471,000	1994-1996
	Postharvast Technologies br Rice in the Humid Tropics (Phase II)	104,000	1993-1996
	Field Variabilites of Soil & Plant: Impact on Rice Productivity & Use in Modeling of Soil Kinetics & Rice Yield	187.000	1992-1995
	Appraisal Consultant: Post Harvest Technology	12,000	1994-1994
GTZ	Permanent Rice Exhibition at IRRI	73,000	1994-1994
Deutsche WeThungerhilfe	Cambodian Refugee Training Support Project	54,000	1991-1994
	Improving Farming Systems Productivity and Sustainabilily in the Hilly Regions or Myanmar	65.000	1994-1995
Iran			
Government of Iran	Iran-IRRI Collaborative Project	500.000	1994-1995
Japan			
Government of Japan	Training and Professional Advancement of Rice Fanning Systems Scientists in Africa	110,000	1992-1994
	Improving Sustainability through Increasing Rice Productivity in the South and S. F. Asian Uplands	400,000	1994-1998
	Assessing Opportunities for Nitrogen Fixation in Rica	300,000	1994-1995

Appendix 2 continued

Donor	Title	*Funding (US$)	Duration
Korea			
Government ot Peoples Republic of Korea	IRRI-Rural Development Administration Collaboration Project	37.000	1993-1994
	Seed Multiplication Project	18.000	1993-1994
The Netherlands			
Directorate General for International Cooperation	Systems Analysis and Simulation for Rice Production	1277,000	1992-1995
	Rainfed Lowland Rice Research Consortium	129,000	1994-1995
Sweden			
Swedish Agency for Research Cooperation with Developing Countries	Developing Research for Increasing Yield in a Sustainable Rice Production System (Phase II)	744,000	1990-1995
Switzerland			
Swiss Development Cooperation	Safeguarding and Preservation of the Biodiversity ot the Rice Genepool (Phase!)	3.286,000	1993-1998
	Lao-IRRI Rice Research and Training Project (Phase III	3,540,000	1993-1996
	Integrated Pest Management Research Network (Phase II)	968,000	1994-1996
	Reversing Trends of Declining Productivity in Intensive Irrigated Rice Systems A Mega Project	763,000	1994-1996
United Kingdom			
Overseas Development Administration	IRRI-NPI Collaborative Research on Rice Tungro Disease: Epidemiology and Vector Ecology	323.000	1991-1994
	Rice Genetic Manipulation for Improved Yield, Stress Tolerance and Disease Resistance Using Protoplasts	241,000	1991-1994
	Methane Generation and Consumption In Ricetields	23,000	1993-1996
	Characterization and Evaluation of Key Seedborne Fungal Patbogens of Rice	298.000	1994-1997
	Molecular Markers and Their Use in Organizing Plant Germplasm Collections	27,000	1993-1995
United States			
Environmental Protection Agency	Effects of IJV-B and Global Climate Change on Rice	6.473.000	1990-1995
Ford Foundation	Development of Ecosystems Analysis and Farming Systems Research in Eastern India Phase II)	529,000	1992-1994

Appendix 2 continued

Donor	Title	*Funding (US$)	Duration
Rockefeller Foundation	Administrative Support for the Biotechnology Program in India	112,000	1992-1994
	Environmental Research Fellowship	24.000	1992-1994
	Fellowship in Rice Biotechnology	88,000	1993-1995
	Terminal Sequencing of Mapped Rice Genornic Probes	98,000	1993-1994
	Rice Research Prioritization	125000	1993-1994
	Establishment of an International Rice Drought Screening Facility at ubon Rice Research Center	79,000	1993-1996
	Training and Technology Transfer Fellowships in Rice Biotechnology	271,000	1993-1996
	Molecular Techniques for Problems in Rice Pathology	130,000	1993-1994
	Research on Bacillus thuringiensis	89,000	1993-1994
	Genome Mapping and Molecular Marker-assisted Plant Breeding	154.000	1993-1994
	Developing Marker-aided Selection Techniques for ldentifing Flood Tolerant rice Genotypes	74,000	1994-1998
USAID	IRRI-Malagasy Rice Research Project Phase III)	5.600,000	1990-1994
	Effects of Continuous, Irrigated Rice Cropping on the Chemical Composition of Soil Organic Matter	50,000	1992-1994
	Induction of Nodules on Rice Roots by Rhizobium (subcontract from Michigan State Unkersity)	54.000	1993-1994
	crop Residue Decomposition and Trichoderma for Disease Management in Rice-based Cropping Systems (subcontract from The Hebrew University of Jeniselem)	110,000	1993-1997
	Development of Sustainable Production Systems for Different Landscape Positions in the Pulangi River Watershed Bukidnon. Philippines: Soil and Water Resource Management Conseivation (SANREM CRSP subcontract from The University of Georgia)	183,000	1994-1995

* Rounded to The nearest Thousand

Appendix 3. IRRI proposals needing special donor funding (at 1 July 1994)

Proposal title	Indicative budget (US$ million)	Expected duration (years)
A Sustainable System for the Uplands: Developing a Perennial Upland Rice (BMZ)	0.9	3
A Sustainable System for the Uplands: Developing Perennial Upland Rice (EC)	1.6	4
A Systems Research Network for Sustainable Resource Management and Increased Productivity of Rice-based Systems in the Asian Region	4.7	5
Assessing Opportunities for Nitrogen Fixation in nice: Establishment of Endosyrobiosis	0.5	3
Crop and Resource Management Network (CREMNET): A Tool for Accelerating Technology Adaptation	1.5	3
Developing Sustainable Rica Production Technologies for Flood-affected Ricelands of Asia	0.7	3
Eastern, Cenlral and Southern Africa: Research Collaboration in Rice Research and Tramming	5.0	3
Global Climate Change: Es ante Analysis of Mitigating Options fcr Rice Systems	0.3	3
Improving Land and Water use Efficiency in the Irrigated Rice Ecosystem of Asia	VS	4
INGER 2000-The International Exchange and Evaluation of Rice Germplasm	5.1	5
Maintaining Habitat Oiversity for Sustainable Pest Management	1.3	3
Managing Rice Ecosystems to Reduce the Incidence of Water-Related Human Diseases	1.7	3
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The black and white prints by Eduardo Masferré come from his many photographs, taken mostly between 1934 and 1956, of the peoples, cultures and environments around Sagada, Bontoc and Banaue in the rugged mountains of the Gran Cordillera Central of northern Luzon, Philippines. They appear in the book *E. Masferré People of the Philippine Cordillera,* and are printed with the permission of the photographer and Jill Gale de Villa.

The black and white prints by the American anthropologist Harold Conklin are from a photographic collection that he took during field work around Banaue in the early 1960s, and donated to IRRI.

The color photos by Robb Kendrick are selected from the large number that he took on assignment for *National Geographic* Magazine for an article on rice that appeared in the May 1994 edition. Photos printed with the permission of Robb Kendrick.

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