www.irri.org

Rice Today

International Rice Research Institute

April-June 2006, Vol. 5, No. 2

STUNNING PHOTO FEATURE
RICE AND RIVERS in the Philippine Cordillera

Mekong special
Lao rice revolution

Linking rice and livestock

Opposites attract
Hunting genes for hardier rice

The direct approach
Moving away from transplanting in South Asia

ISSN 1655-5422

TRAINING

International Rice Research Institute training courses

Giving new skills and knowledge to people from all over the world

IRRI training is tailored to your needs. Each course combines high-quality lectures, hands-on exercises, field work and field visits, testimonials, management challenges, and structured learning activities.

Courses at IRRI in 2006

Skills development

Quality Assurance	22 May - 2 June
Leadership Course for Asian Women in Rice Research and Development	26 June - 7 July
Application of Participatory Approaches to Agricultural Research and Extension	7-18 August

Biometrics

Analysis of Experimental Data using the SAS System	10-14 July
Improving and Assuring Data Quality in Crop Research	24-28 July
Analysis of Mixed Models and Categorical Data Using IRRISTAT	4-6 September

Enroll now!

For more information, Contact IRRI at IRRI-Training@cgiar.org or visit www.training.irri.org.

IRRI

contents

RiceToday
Vol. 5, No. 2

The cover photo shows Alya, a Bangladeshi farmer benefitting from a different approach to planting rice—*see page 12.*

cover photo **Adam Barclay**

publisher **Duncan Macintosh**
editor **Adam Barclay**
art directors **Juan Lazaro IV, Emmanuel Panisales**
designer and production supervisor **George Reyes**
contributing editors **Gene Hettel, Bill Hardy**
news editor **Juanito Goloyugo**
photo editor **Ariel Javellana**
photo researcher **Jose Raymond Panaligan**
circulation **Chrisanto Quintana**
printer **Primex Printers, Inc.**

Rice Today is published by the International Rice Research Institute (IRRI), the world's leading international rice research and training center. Based in the Philippines and with offices in 11 other countries, IRRI is an autonomous, nonprofit institution focused on improving the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes, while preserving natural resources. IRRI is one of 15 centers funded through the Consultative Group on International Agricultural Research (CGIAR), an association of public and private donor agencies. For more information, visit the CGIAR Web site (www.cgiar.org).

Responsibility for this publication rests with IRRI. Designations used in this publication should not be construed as expressing IRRI policy or opinion on the legal status of any country, territory, city or area, or its authorities, or the delimitation of its frontiers or boundaries.

Rice Today welcomes comments and suggestions from readers. Potential contributors are encouraged to query first, rather than submit unsolicited materials. *Rice Today* assumes no responsibility for loss or damage to unsolicited submissions, which should be accompanied by sufficient return postage.

International Rice Research Institute
DAPO Box 7777, Metro Manila, Philippines
Web (IRRI): www.irri.org
Web (Library): http://ricelib.irri.cgiar.org
Web (Rice Knowledge Bank): www.knowledgebank.irri.org

Rice Today editorial
telephone (+63-2) 580-5600 or (+63-2) 844-3351 to 53, ext 2725;
fax: (+63-2) 580-5699 or (+63-2) 845-0606; email: a.barclay@cgiar.org

Why is there an International Rice Research Institute?





Most people in developed countries take food and nutrition for granted. Diets in these countries tend to be diverse—if not always healthy—and food tends to be plentiful. Too much is more often a problem than not enough. Fatty, processed food is prominent in many people's diets and wealthy countries such as the U.S. and Australia are experiencing epidemics of obesity.

On the other hand, millions of people across the rice-producing and rice-consuming countries of Asia, along with many others in Africa and South America, either simply fail to get enough food or, even if their stomachs are not empty, suffer from the hidden hunger of malnutrition. In this light, easy access to a nutritious diet should be truly appreciated by those who have it.

In the cities of the developed world, a widespread disconnection exists between the food people buy and eat and the process required to get it to them. In many developing countries, however, people understand and appreciate the role of farming and its link to the food on their plates. In these countries, agriculture remains the most important industry there is, integral to politics, society, and culture, and directly or indirectly employing more people than any other sector. For around half the world's population, one food assumes importance above all others: rice.

Take the example of Bangladesh. More than half of the country's 146 million people rely on agriculture for their livelihood and agriculture employs around two-thirds of the labor force of almost 70 million. Rice, Bangladesh's most important crop, accounts for more than three-quarters of total cropped area and gives the average Bangladeshi around three-quarters of his or her calories. Poor people spend up to half their income on rice alone. Rice farms in Bangladesh are not the sprawling, thousand-hectare expanses of the U.S. or Australia, but rather plots of a hectare or less that often produce no more than enough rice for a single farm family.

Without access to resources and knowledge that can improve their productivity, rice farmers are often trapped in a vicious circle of poverty. Things can be just as bad, if not worse, for the landless poor, who cannot grow their own food. Even when food is available, many simply cannot afford to buy it. In these circumstances, it takes only a small push for things to spiral out of control. If a drought, for example, stalls production, prices go up and employment drops. Children are pulled out of school and expected to help find income as desperate parents are no longer able to afford the c osts of education. And so on, as each effect sets off another.

For many people in the U.S., Western Europe, and Australia, food is something you buy in a supermarket or order in a restaurant. How it got there is not something that tends to cross peoples' minds. For most people in these countries, the idea of not having enough food, of genuine and dangerous hunger—not just mid-afternoon tummy rumbles—is completely unthinkable.

It is imperative that all people, no matter where they are from, understand the role of agriculture in producing the food that we eat and its social, economic, political, cultural, and historical importance. Without farms and farmers, we would still be scrabbling for food in a day-to-day, hand-to-mouth existence.

When I tell people in my home country of Australia that I work for the International Rice Research Institute, one of the most common responses is: "Why is there an International Rice Research Institute? What is there to learn about rice?" The half of the world's people who depend on rice as a staple would not be so naïve.

Adam Barclay
Editor

Reducing poverty through agricultural development

by Takeshi Mizoguchi

MOFA

TAKESHI MIZOGUCHI is a deputy director of the Aid Planning Division of the Economic Cooperation Bureau of Japan's Ministry of Foreign Affairs.

In August 2003, the government of Japan revised its Official Development Assistance (ODA) Charter for the first time in 11 years. Since then, Japan has developed its ODA in line with the new charter, which puts forward five basic policies outlined below.

Supporting self-help efforts of developing countries is the most important philosophy of Japan's ODA. Accordingly, Japan respects developing countries' ownership of development strategies and priorities. Japan intends to provide support in fields such as human resource development; institution building, including the development of legal systems; and economic and social infrastructure building. These themes constitute the basis for development.

To address direct threats to people such as conflicts, disasters, and infectious diseases, Japan attaches particular importance to the *Perspective of human security*, which focuses on individuals. Japan aims to implement ODA that will strengthen the capacity of local communities through human resource development. To ensure that human dignity is maintained at all stages, from conflict to reconstruction and development, Japan's goal is to help protect and empower individuals.

Assurance of fairness—in the formulation and implementation of assistance—ensures that the outcome of ODA fairly benefits the people of recipient countries. In this light, Japan emphasizes environmental and social considerations as well as gender equality.

The *Utilization of Japan's experience and expertise* is an important policy in which Japan's experience in economic and social development, as well as in economic cooperation, is used when assisting developing countries. This policy also emphasizes the need to use Japan's advanced technologies, expertise, human resources, and institutions.

Partnership and collaboration with the international community are important if the international community is to share common development goals and strategies through the initiatives of international organizations. Japan will play an active role in any international dialogues that feature Japanese assistance strategies and philosophies.

In accordance with the basic policies set out above, Japan is tackling four priority issues—poverty reduction, sustainable growth, addressing global issues, and peace-building.

In developing countries—where approximately 70% of the poor live in rural areas and depend on agricultural production—agricultural and rural development allow the rural poor to generate income and so lead to sustainable economic growth and poverty reduction. Agriculture can also contribute to the United Nations Millennium Development Goals by providing the poor, in both rural and urban areas, with affordable food. And, through appropriate management of land, water, and wastes, agriculture can promote environmental sustainability.

Recognizing the importance of agricultural development for poverty reduction, Japan has consistently been a major supporter in this area. In 2003, Japan's ODA in agriculture amounted to US$783 million—the largest contribution among bilateral donors, accounting for nearly 40% of total assistance. Japan's three-pronged strategy on agricultural development is, first, to support capacity building of farmers and the government; second, to raise productivity through infrastructure development and agricultural technologies; and third, to link farmers to markets.

The development of new agricultural technologies will play an increasingly important role in raising both agricultural productivity and the nutritional value of food while at the same time placing a lighter burden on land and water. To enable progress in these areas, Japan has attached high priority to cooperation with the Consultative Group on International Agricultural Research (CGIAR), including the International Rice Research Institute (IRRI).

The Japan-IRRI partnership, which spans more than four decades, is especially strong and fruitful. Japan's long involvement in rice research has yielded numerous successes and had a lasting and positive impact on the lives of countless people. Many Japanese scientists have worked at and collaborated with IRRI on research that spans some of the most crucial issues in the rice-growing and rice-consuming world. Japan's agricultural research institutes have also cooperated closely with IRRI in facing these challenges.

Japan looks forward to continuing to work with developing countries and the organizations—including IRRI and the CGIAR—whose goal is to reduce poverty through agricultural development.

Iron-rich rice reduces malnutrition

Breeding rice with higher levels of iron can have an important impact on reducing micronutrient malnutrition, according to a new study in the December 2005 issue of the *Journal of Nutrition*. The research, conducted by scientists from the Philippines and the U.S., is a major step forward in the battle against iron deficiency, a debilitating and intractable public health problem affecting nearly 2 billion people in the developing world.

The lead authors of the article, Jere Haas from the Division of Nutritional Sciences at Cornell University, John Beard and Laura Murray-Kolb from the Department of Nutritional Sciences at Pennsylvania State University, Angelita del Mundo and Angelina Felix from the University of the Philippines Los Baños, and Glenn Gregorio from IRRI (*pictured with an iron-rich rice panicle*), oversaw a study in which religious sisters in ten convents in the Philippines included nutritionally enhanced rice in their diets. After 9 months, the women had significantly higher levels of total body iron in their blood.

ARIEL JAVELLANA

The iron-dense variety of rice used in the research (known technically as IR68144-3B-2-2-3) was developed and grown at IRRI. The research initiative was originally spearheaded and funded by the Washington-based International Food Policy Research Institute (IFPRI), with support from the Asian Development Bank and the Micronutrient Initiative. HarvestPlus, an international research program focused on breeding crops for better nutrition and led by IFPRI and the International Center for Tropical Agriculture (CIAT), will use the research findings and work with partners to increase the level of nutrient density in rice to be even more effective.

Through a process known as "biofortification," plant breeders are developing staple foods with higher levels of essential micronutrients. This study demonstrates that iron-biofortified rice can raise levels of stored iron in the body and can significantly contribute to reducing micronutrient malnutrition.

"We view this study as a 'proof of concept,'" said IRRI Director General Robert Zeigler. "We now know that, if plants are bred with higher levels of iron and other micronutrients, they will improve the nutritional status of people who consume them. This has dramatic implications."

"In the past, we relied on supplements and fortification to overcome vitamin and mineral deficiencies," said Howarth Bouis, director of HarvestPlus. "Now we know that biofortification also works, giving us an additional tool in this crucial battle."

Crop development efforts get major boost

The long, arduous, and expensive process of developing new crop varieties has received a major boost with the joint launch in Mexico and the Philippines of a new scientific program and facilities that unite key databases and research on the planet's three most important crops—rice, wheat, and maize.

The joint venture between two of the world's leading agricultural research centers—the Philippines-based International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT) in Mexico—is the first major output of an alliance between IRRI and CIMMYT that was formally established last year.

The new lab at CIMMYT will link with existing facilities at IRRI to form the Crop Research Informatics Lab (CRIL), heralding exciting new possibilities for rice research, especially in the development of improved crop varieties. It is expected that the endeavor will not only reduce the time needed to develop new crop varieties by drawing on the three crops' shared characteristics but also reduce the cost of such research. Researchers anticipate that as data are expanded and linked and databases improved, research in areas such as natural resource management and climate change will also benefit.

CRIL scientists are already working on the development of a single crop information system and comparative biology infrastructure for rice, wheat, and maize that will greatly assist in the development of new crop varieties. The three staples provide 60% of global food needs annually, and cover more than 70% of the planet's productive cropping land.

Bioinformatics specialists Guy Davenport from CIMMYT and Richard Bruskiewich from IRRI say that "Rice forms an ideal model for this research because of its small, sequenced genome. Maize represents an excellent platform for trait studies due to its outbreeding nature and long history of substantial public and private sector investment. Finally, wheat represents a complementary cereal model by virtue of its relatively close relationship to rice and extensive genetic information."

According to Graham McLaren, head of the CRIL team and IRRI's senior scientist in biometrics, "This system will be especially useful for researchers in poorer developing countries who may not normally have access to such detailed information on so many different varieties."

Nutrient management online

IRRI has launched a Web site that provides information on the principles and practices of site-specific nutrient management (SSNM) for rice in irrigated and favorable rainfed systems. By mid-2006, the site is scheduled to contain guidelines and training materials for the development of locally adapted SSNM recommendations for any rice-producing area. IRRI scientists refined the SSNM concept from 2001 to 2004 in partnership with national agricultural research and extension systems (NARES). Visit the new site at www.irri.org/irrc/ssnm.

Indian president visits IRRI

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

On 5 February, as part of an official visit to the Philippines—the first by an Indian president in 15 years—President Kalam was briefed on a range of new technologies aimed at boosting farmer productivity.

"We were honored and delighted by the Indian presidential visit," said IRRI Director General Robert Zeigler. "What was especially impressive about his time at IRRI was how productive it was—we managed to discuss a number of very important issues in depth and to agree to move ahead in several key areas."

Dr. Zeigler said the president was particularly interested in the development of nutritionally enhanced rice varieties and connecting Indian farmers to the Internet. "We also agreed to develop plans to send 50 Indian rice farmers on a special visit to IRRI so they can see the technologies being developed," Dr. Zeigler said.

PRESIDENT A.P.J. Kalam (*second from left*) during his visit to IRRI, flanked by IRRI Director General Robert Zeigler (*left*), Philippine International Trading Corp Chair Robert Pagdanganan (*second from right*) and senior scientist Roland Buresh.

ARIEL JAVELLANA

In comments to IRRI scientists, President Kalam said India had around 176 million hectares of land currently available for cultivation, which, he predicted, would be reduced to 100 million hectares by 2020. He also warned of a looming water crisis and that the next generation of Indian farmers was losing interest in agriculture.

IRRI's senior economist, Mahabub Hossain, highlighted the impact of IRRI's earlier work in India, which showed that 48% of the rice varieties grown in India had some link to IRRI materials.

"However," he said, "India's success in raising rice productivity and reducing poverty has been limited to favorable environments in the country's north and south, while sustaining high yields in irrigated systems has become a major issue."

Dr. Hossain also highlighted the progress of an IRRI-India collaborative effort to develop drought-tolerant varieties that are expected to have a substantial impact on increasing productivity and reducing poverty in eastern India.

Open-source biotechnology alliance

IRRI and CAMBIA have agreed to advance the BiOS Initiative—a new strategy that will galvanize agricultural research focused on poverty alleviation and hunger reduction—under a US$2.55 million grant from the Norwegian Ministry of Foreign Affairs. Based in Canberra, Australia, CAMBIA is an independent nonprofit institute that invents and shares technologies and new practices for life sciences and intellectual property management to further social equity.

The BiOS (Biological Innovation for Open Society) Initiative is also known as Open-Source Biotechnology. The BiOS model has resonance with the Open-Source software movement—well known for successes such as Linux—and has spurred faster innovation, greater community participation, and new robust business models that break monopolies and foster fair competition.

"New technologies are increasingly tangled in complex webs of patent and other legal rights, and are often tailored for wealthy countries and well-heeled scientists," said IRRI Director General Robert Zeigler. "Half the world depends on rice as a staple food—but this also means that half the world's potential innovators could be brought to bear on the challenges of rice production, given the right toolkits—and the rights to use them."

In the joint work, CAMBIA's Patent Lens, already one of the most comprehensive cost-free full-text patent databases in the world, will be extended to include patents in major rice-growing countries, including China, Korea, and India, which are poised to play lead roles in the next generation of biological problem solving.

Patent Lens will also foster capacity in the developing world to create patent maps of the key emerging technologies that could be constrained by complex intellectual property rights worldwide. These patent "landscapes" will be used to guide the development of improved and inclusive technology toolkits.

"It's not so much about getting access to old patented technology—it's about forging collaborations to develop better, more powerful tools within a 'protected commons' to get different problem solvers to the table," said CAMBIA CEO Richard Jefferson.

These could, for example, be tools for new plant breeding methods such as marker-assisted selection or true-breeding hybrid crop varieties that would allow farmers in developing countries to use hybrid seed year after year.

Rice farming by SMS

A mobile phone text-messaging service designed to connect Filipino farmers and extension workers with rice-farming technical experts has been developed by the Open Academy for Philippine Agriculture. With assistance from Smart Communications, farmers send questions to 700-RICE (700-7423). Philippine Rice Research Institute experts then reply within 24 hours. Topics of expertise include fertilizer and nutrient management, hybrid rice production, pest and crop management, the latest rice varieties, and available seed stocks. Farmers can even enroll in a virtual classroom. A 12 January report in the *Philippine Star* said the Farmers' Call Center averages 500 queries per month.

JOSE RAYMOND PANALIGAN

Production shortfall looming


BAGS of imported rice from Vietnam being unloaded at Manila's south harbor.

ARIEL JAVELLANA

A December 2005 Dow Jones Newswire report by Rhea Sandique-Carlos highlighted the continuation of high rice prices in Asia in the face of declining production in the world's two most populous nations, China and India. According to the report, global rice stocks, which are already diminishing, will be further strained in 2006.

Mahabub Hossain, head of IRRI's Social Sciences Division, commented on China's impending transition from rice exporter to importer. "There has been less and less land allocated to rice cultivation because farmers see a lot of opportunity for nonrice crops, such as fruits and vegetables, because of growth in income. China simply can't come back to its surplus position," he said.

The report added that India is in a similar situation, exacerbated by many farmers' dependence on monsoon rains. Dr. Hossain said, "Unpredictability of weather patterns makes it difficult for India to achieve its previous level of production. Irrigation, which accounts for 20–25% of production cost, is a big problem."

In Thailand, meanwhile, 2006 exports are expected to drop to 7.2 million tons, down about 0.3 million tons from 2005. The 2005 level is itself almost 30% lower than 2004's record 10.1 million tons of exports.

According to Dow Jones, uncertain global weather patterns are likely to keep rice prices from falling. Mamadou Ciss, managing director of the Geneva-based global rice trading company Ascot Commodities, NV, was quoted as saying that "the current situation anticipates a major weather disaster [...] it could be an *El Niño* or *La Niña*. Global temperature is getting warmer and, based on temperature in Brazil, Russia, Argentina, we are already in a dry spell."

Commenting on China's current low rice stocks, Ciss said: "If a major weather catastrophe happens, that will take rice prices to the moon."

Gregorio Tan, administrator of the Philippine National Food Authority, a state-owned grains trading company, was reported as saying that Philippine rice imports in 2006 could hover around 1 million tons despite record paddy output of around 14.5 million tons in 2005, when the country imported 1.8 million tons of rice as dry weather conditions limited domestic supply.

Water conservation support

The Asian Development Bank has given US$1 million toward the development and dissemination of water-saving rice technologies in the drought-prone and water-short regions of South Asia.

The total cost of funding is estimated at $2.306 million, with IRRI executing the technical assistance and contributing $566,000, while the national agricultural research and extension systems (NARES) of Bangladesh, India, Nepal, and Pakistan are shouldering $740,000 in the form of staff time, land, and research facilities.

It takes around 3,000 liters of water to produce a kilogram of rice. Twelve million hectares of South Asia's irrigated rice are at risk of severe water shortage, with serious consequences for regional food security and social stability.

IRRI estimates that a 10% reduction in water use for rice irrigation would free 150 billion cubic meters, or 25% of the total fresh water used in Asia for nonagricultural purposes.

As well as supporting the development of new technologies based on improved IRRI rice varieties, the technical assistance will help the NARES to develop locally adapted water-saving rice technologies, sponsor visits to IRRI, organize an international workshop, conduct a series of training courses, and develop a regional network for information exchange.

BRIEFLY

Boost for reductions campaign

The Three Reductions, Three Gains—*Ba Giam Ba Tang* in Vietnamese—continues to receive support from the Vietnamese Ministry of Agriculture and Rural Development. The ministry has allocated US$434,000 of the country's 2006 agricultural extension budget to *Ba Giam Ba Tang*, a strong indication that the Vietnamese government has adopted the campaign's principles of reducing farmers' nitrogen-fertilizer rates, seed rates, and pesticide applications.

Tsunami rehabilitation

The Food and Agriculture Organization of the United Nations and the World Food Program have released a 2005 report on food supply and demand in Indonesia's Aceh Province and Nias Island. The report stated that, of the 37,500 hectares of farmland damaged by the 26 December 2004 tsunami, some 29,000 hectares have been rehabilitated. Surplus production of rice in Aceh is expected to be around 200,000 tons for the 2005-06 marketing year. In spite of this, farmers in the heavily affected areas lost two consecutive seasons of paddy production in 2005. The recovery process in Nias and Simeulue on the northwest coast of Sumatra has been slower than in Aceh.

Maize gene set to help rice

Kansas State University researchers, led by Bingyu Zhao, have discovered a maize gene that, when transferred to rice, confers resistance to bacterial streak, an important disease of rice in Asia. As any particular cereal species tends to be resistant to diseases of other grasses, these results—reported in the 25 October 2005 issue of the Proceedings of the National Academy of Sciences of the USA—suggest that transferring resistance genes from one cereal to another may be a feasible strategy for controlling diseases.

Iranian biotech lead

Iran made headlines recently by becoming the first country to commercialize genetically modified rice. According to a 23 January report in the *Washington Farm Report*, 500–1,000 Iranian farmers are believed to have grown the crop in 2005, with full commercialization taking place this year on 20,000 hectares.

Rice malt genome sequenced

Japan's Corporate News Network on 26 December reported the completion of the genome sequencing of rice malt, *Aspergillus oryzae*, a fungus widely used in Japanese fermented foods, including sake, bean paste, and soy sauce. The research—by a team of scientists from the Institute for Biological Resources and Functions, the Computational Biology Research Center of the National Institute of Advanced Industrial Science and Technology, and the National Institute of Technology and Evaluation—showed that the *A. oryzae* genome has about 38 million base pairs and 12,000 genes. The sequencing is expected to aid development of applications for rice malt.

Infrared heat versus pesticides

Scientists from the University of Arkansas Division of Agriculture are investigating the use of infrared energy to kill insects in stored rice, instead of pesticides. Northwest

African rice news

Prize for Africa Rice Center scientist

Moussa Sié, a lowland rice breeder from the Africa Rice Center (WARDA), has become the first African to receive the prestigious Koshihikari International Rice Prize. Dr. Sié (*pictured at right*), from Burkina Faso, was recognized for "Development and extension of lowland NERICAs (New Rice for Africa) for sub-Saharan Africa." He shares the prize with Akihiko Ando, visiting professor at São Paulo University Agricultural Nuclear Power Center in Brazil, who was recognized for "Development and dissemination of plant breeding by mutation induction."

Removing Gambian hurdles

The Daily Observer reported on 22 December significant progress made by the National Agricultural Research Institute in searching for technologies to alleviate crop production constraints experienced by farmers in Gambia. NARI, for example, did research on restoring soil fertility through agroforestry techniques, developing suitable drought-tolerant crop varieties, and promoting the production of NERICA (New Rice for Africa). Musa Bala Gaye, Secretary of State for Finance and Economic Affairs, in his 2006 budget presentation before the National Assembly, noted that the country's total paddy rice production increased from 31,221 metric tons in 2003-04 to 34,304 metric tons in 2004-05, which indicated an increment of 10%.

Sierra Leone food security

The *Awareness Times* quoted High Commissioner Alhaji Morikeh Fofana on 2 February saying that, about 80% increases were recorded in the production of paddy rice, millet, and sweet potato in Sierra Leone. "The agricultural data on rice production indicates that about 40,000 acres of land for rice cultivation is now available. These are positive signs geared towards a clear-cut reduction in the importation of rice into Sierra Leone. Food security is thus an economical strategy. The current trend of rice production in this nation is setting the pace for rice farmers to be able to buy equipment on loan within the next three years. The production of rice is tedious. It involves total commitment. Food security is, however, a viable venture."

Côte d'Ivoire stockpiles rice

Inter Press News Agency reported on 4 February that rice growers in Côte d'Ivoire, with GTZ assistance, have stockpiled bags of rice at a depot in Korhogo, a town in northern Côte d'Ivoire, to prevent famine and counter a major reduction in rice imports. Also, according to the Ivorian Bureau of Development Assistance Training, improvements to arable land produced 27,000 tons of irrigated rice twice a year in the north. The Africa Rice Center (WARDA) said that 8% of the Ivorian population grows rice on an average plot of 0.8 hectare of irrigated land.

Arkansas' News Source reported that food science professor Terry Siebenmorgen and biological engineer Derek Schluterman, working with Frank Arthur of the U.S. Department of Agriculture, used infrared light to heat weevil-infested rice samples to temperatures of 50, 60, and 70 degrees Celsius. They then incubated the infested rice, including an untreated control sample, for 6–7 weeks to see if weevils hatched out of the rice. All weevils were killed at 70 degrees. The infrared treatment appeared to have little effect on food quality or sensory characteristics.

Changes to Malaysia's rice fields

A corporatization plan pilot project, involving about 5,000 hectares of rice lands in Kedah, Malaysia's rice bowl, is scheduled to begin in June 2006. A *New Straits Times* editorial on 12 February, *Sowing the seeds of change*, pointed out the plan's benefits: "Larger farms make more money, can deploy assets for capital-intensive investment, and are more disposed to innovation and professional management. By trading land for shares in a joint-stock corporation, farmers are given a choice, too. They can opt to stay put or leave a dead-end occupation with the surety of having equity in the bank." One of the first challenges is convincing farmers that corporatization will make the land more useful.

The king of rice

Taiwan Headlines reported on 25 January that 2005 champion rice farmer, Hsu Pang-chun, 24, from Luyeh township in Taidong, has been nicknamed Taiwan's "youngest king of rice" after winning third place in a nationwide rice competition in early January. Hsu began cultivating his father's rice paddies at the age of 13.

Doomsday seed bank

The Norwegian government plans to build a "doomsday vault" inside a mountain on the arctic island of Spitsbergen to hold a bank of around 2 million seed samples of the world's crops, the *Financial Times* reported. The move is designed to forestall the destruction of the planet's sources of food in the event of global catastrophes like nuclear war or natural disasters. The Global Crop Diversity Trust is organizing the seed collection.

First hydroponic rice

A group of farmers in Tokyo has, according to a report in *The Times*, cultivated the world's first crop of hydroponically grown rice. According to the story, "The 60 kilograms of Koshihikari rice reaped yesterday may fill only a single regulation-sized sack, but its significance is huge. The rice has grown to maturity without natural light or a paddy field." If the process can be commercialized, says the group, farmers could grow up to four rice crops per year and avoid the vagaries of the weather.

Philippine hybrid rice benefits

A 9 December article in *CropBiotech Update* stated that the Philippine government benefited from its hybrid rice commercialization program through savings of US$23.23 million that would otherwise have been spent on rice importation. The report, quoting statistics from the Philippine Rice Research

Zero tillage in India

Farmers from Haryana, Punjab, and other parts of northern India have turned to zero or minimum tillage in rice production by using new machinery. Actually an old concept adapted during the Green Revolution days, zero tillage is being promoted by the Rice-Wheat Consortium (RWC) for the Indo-Gangetic Plains, in partnership with IRRI and the International Crops Research Institute for the Semi-Arid Tropics. The Asian Pacific Centre for Agricultural Engineering and Machinery is promoting the development of new farm machinery. India's *Financial Express* reported on 26 December that farmers who use the technologies save an average of 2,000 rupees (US$45) per acre (1 hectare is 2.47 acres) on costs for labor and inputs. However, according to the article, farmers are complaining about the machines' expense—even with a 25% government subsidy—and weeds. Scientist Samar Singh, who works on the RWC program, advised farmers to grow *Sesbania* along with rice to help prevent weeds.

DANIELE MARECHAL

EXOTIC BLACK RICE, such as the pictured Lao variety, is growing in popularity in Solano, Nueva Viscaya, Philippines, according to a 25 January report in the *Manila Standard Today*. Black rice tends to be more aromatic and sticky than usual commercial varieties.

Making waves

Ripple
IRRC

The Irrigated Rice Research Consortium (IRRC) launched its new quarterly newsletter, *Ripple*, in January. *Ripple* stands for Rice Research for Intensified Production and Prosperity in Lowland Ecosystems. IRRC staff produced the newsletter to enhance communication between national agricultural research and extension systems (NARES) and IRRI, and to raise the profile of the IRRC in Asia and beyond. IRRC Coordinator Grant Singleton encourages contributions to the newsletter from anyone working in the irrigated rice or favorable rainfed agricultural domain, particularly NARES partners and nongovernmental organizations. *Ripple* is available online at www.irri.org/irrc.

Postharvest management to reduce burning

EUGENE AQUINO (IRRI) and Budi Raharjo (Assessment Institute of Agricultural Technology) show trainees in Mulya Sari village how to use hermetically sealed grain storage bags.

MARTIN GUMMERT

In Indonesia, the Irrigated Rice Research Consortium Postproduction workgroup has joined forces with the Assessment Institute for Agricultural Technology in South Sumatra and the South Sumatra Forest Fire Management Project in an effort to reduce postharvest losses, improve the quality of rice harvests, and increase farmers' income in the tidal and freshwater swamps of South Sumatra, around 2 million hectares of which are used to grow rice. Labor shortages during harvest lead to production and quality losses and often force farmers to use fire to clear uplands to grow more crops. A training workshop on 27-28 February led by IRRI's Agricultural Engineering Unit covered topics on understanding rice quality and improving seeds. The 35 participants also learned how to set up and operate hermetic sealed storage systems for safe seed storage. Such improvements help overall production and reduce the pressure to extend rice production to the uplands.

BRIEFLY

Institute research team, led by Flordeliza Bordey, found that hybrid rice production was one of the best options for increasing farm productivity by 8% to 14%.

Hybrid rice lessons

The Manila Times reported in January that European countries Boznia-Herzegovina, Bulgaria, Croatia, Hungary, Romania, Slovak Republic, and Yugoslavia have adopted the Hybrid Rice Commercialization Program of Tarlac Province, Philippines. Agriculturists from the Western Corn Rootworm Project in central and northern Europe inspected the Tarlac rice program in 2002, with support from the Food and Agriculture Organization of the United Nations.

Best organic rice

"Ta ti organic rice," grown in Chihshang Township of Taidong County, was named winner of Taiwan's first national organic rice-judging contest because of its luster and pleasant eating qualities. "The contest was aimed at rice producers who are able to package organic polished white rice into small amounts that can be sold at retail outlets," the *Liberty Times* reported on 7 December 2005.

Rice bran for healthier rats

Eating rice bran—part of the outer layer of rice removed in the milling process—helps lower rats' blood pressure, according to a study by researchers from Tohoku University and the National Research Institute of Brewing, Japan. The findings were published in the March 8 issue of the *Journal of Agricultural and Food Chemistry*. Adding rice bran to the diet of hypertensive, stroke-prone rats lowered the animals' systolic blood pressure by about 20%. More research is needed to determine whether humans experience similar health benefits, or whether eating more brown rice, which retains some of its bran, will have any effect.

Seeking salt-tolerant rice

Scientists at the Louisiana State University Agricultural Center's Rice Research Station are seeking salt-tolerant rice as a result of hurricane Rita, which ravaged Louisiana in August 2005. An Associated Press report said that researchers have started collecting soil samples from 180 sites across southwest Louisiana, where an estimated 200 thousand acres of rice land were affected by Rita's surge.

Careless offerings?

Chandigarh Newsline reported on 3 January that rats much bigger than usual are causing nightmares for Manimajra housing complex residents in Chandigarh, India. The rats are fed with rice and wheat at a nearby temple, which is visited by thousands of devotees every Saturday. Bhushan Makkar, head of the local area committee, blames devotees' "careless offerings to God."

Achievements

Shaobing Peng has received the honor of Fellow of the Crop Science Society of America (CSSA) for 2005, during the 6-10 November 2005 CSSA annual meetings in Salt Lake City, Utah. Dr. Peng (*pictured with CSSA President James Coors*) received the award with nine other scientists selected by the CSSA based on their professional achievements and meritorious service. His research focuses on rice physiology with emphasis on improving resource-use efficiency of high-yielding varieties and identifying the physiological and biochemical processes that limit the advance of rice yield potential in the irrigated ecosystem.

Also at the CSSA meetings, **J.K. Ladha,** IRRI senior scientist and coordinator of the Rice-Wheat Consortium, received the Outstanding Agricultural Scientist Award for 2005 in recognition of his research contribution to sustainable management of agriculture and natural resources.

At the concurrent American Society of Agronomy meeting in Salt Lake City, retired IRRI principal scientist **Sant Virmani** received the 2005 Monsanto Crop Science Distinguished Career Award. He also received a plaque of appreciation from IRRI for his 25-year contribution to hybrid rice research and development in the tropics during the 5th International Rice Genetics Symposium in Manila, on 23 November.

Dr. Peng was also a member of the IRRI team that won the 2005 CGIAR Science Award for Outstanding Scientific Article, *Rice yields decline with higher night temperature from global warming,* during the December 2005 annual general meeting of the Consultative Group on International Agricultural Research in Marrakech, Morocco. Along with Dr. Peng, IRRI scientists **John Sheehy**, **Rebecca C. Laza**, **Romeo M. Visperas**, **Grace S. Centeno**, and World Food Prize laureate and former IRRI principal scientist **Gurdev Khush** comprised the team. **Jianliang Huang** (Huazhong Agricultural University, China), **Xuhua Zhong** (Guangdong Academy of Agricultural Sciences, China), and **Ken Cassman** (University of Nebraska) were co-authors. The *Proceedings of the National Academy of Science of the United States of America* published the paper on 6 July 2004.

Dr. Khush also received an *honoris causa* (honorary degree) from the Ohio State University on 19 March.

IRRI senior scientist **Darshan Brar** was named Fellow of the National Academy of Agricultural Sciences and Honorary Fellow of the Punjab Academy of Sciences.

The Philippine Association of Academic and Research Librarians named IRRI chief librarian **Mila Ramos** as 2005 Outstanding Academic/Research Librarian of the Year for her "remarkable contribution to the advancement of agricultural research librarianship as trainer, paper presenter, and facilitator in both local and international conferences."

Surapong Sarkarung, former IRRI plant breeder for the Rainfed Lowland Program and one of Thailand's most renowned rice breeders, was named Outstanding Graduate for 2005 of the University of Arkansas.

Mario Movillon, former manager of the then Visitors, Exhibitions, and Conference Services, was named 2005 Most Outstanding Branch Manager of the Philippine Rice Research Institute—which he joined in 2002 after 19 years at IRRI—on 8 November 2005.

On 2 December 2005, IRRI awarded Wageningen University visiting consultant **Hendrika Hillegonda van Laar** a plaque of appreciation for service to the institute over the last 20 years. Dr. van Laar worked on various collaborative projects, including Simulation and Systems Analysis for Rice Production, Systems Research Network for Ecoregional Land Use Planning in Tropical Asia, and Potential of Water-saving Technologies in Rice Production.

Keeping up with IRRI staff

Mangala Rai, secretary of the government of India's Department of Agricultural Research and Education and director general of the Indian Council for Agricultural Research, has joined IRRI's Board of Trustees to complete the final two years (2006-07) of the unfinished second term of **Kay Beese** of Germany, who resigned effective 8 November 2005.

Robert Hijmans recently joined the Social Sciences Division (SSD) as geographic information systems specialist. **Zenaida Huelgas** joined SSD as associate scientist after a 7-year work stint in New York City, USA. She was a former IRRI scholar (1988-89) and senior research assistant (1994-97) at SSD.

Ian Wallace, former director for administration and human resources, left IRRI recently after 13 years of service. His initiatives as head of the IRRI Library (1993-99) made the facility the world's premiere documentation center on rice.

International Research Fellow **David Shires** is the new acting head of the IRRI Training Center, while senior manager **Elisa Panes** is acting head of Human Resources Services.

Plant breeder **Glenn Gregorio** left for Ibadan, Nigeria, on 22 January as IRRI's rice breeder for Africa, to work in collaboration with the West Africa Rice Development Association (WARDA, the Africa Rice Center) and the International Institute for Tropical Agriculture Substation.

Gone ahead

A. Syarifuddin Karama, former secretary general of the Indonesian Ministry of Agriculture, passed away on 19 February. Dr. Karama, who did his Ph.D. research at IRRI, was a widely respected scientist and admired advocate for rice research. His past posts include head of the Center for Soil and Agroclimate Research in Bogor and director of the Sukarami Rice Research Station in West Sumatra. His passing has been described as a great loss not only to his family but also to Indonesia.

Orlando Santos, who retired as the head of the IRRI Central Research Farm in 1994, passed away on 26 January at age 76. Lao-IRRI project employee, **Samien Luanglath**, 46, passed away on 28 January.

The direct approach

A return to the ways of their forefathers has seen Indian and Bangladeshi rice farmers reduce their need for water and address the growing problem of labor shortages

Story and photos by Adam Barclay

To understand the importance of rice farming to Bangladesh, look at the numbers. This densely populated country—more crowded than any other on Earth bar city-states such as Singapore—has 146 million people. Around 80 million of them rely on agriculture for their livelihood. Agriculture alone employs around two-thirds of the labor force of almost 70 million and rice is the country's most significant agricultural product, accounting for more than three-quarters of total cropped area. Add to this the fact that the average Bangladeshi receives around three-quarters of his or her calories from rice and you begin to understand the grain's significance. Further, in India and Bangladesh, the poorest people spend up to half their income on rice. While India doesn't rely on rice in the same way as its northeastern neighbor, rice remains India's single most important agricultural product. Given India's sheer numbers—its 1.1 billion people constitute almost one-fifth of the world's population—merely maintaining rice productivity is not enough; as the population rises, India must produce more rice on less land.

The Indo-Gangetic Plains, running east from northwestern India across to the Barind area of western Bangladesh, are some of the most agriculturally important tracts of land on the planet. Home to India's rice-wheat cropping system, the plains are the most productive area in the country and vital to the food security of India. Infrastructure, such as irrigation, is relatively well developed and many farmers have access to mechanical equipment including tractors and machine seeders. Despite these advances, farmers here face problems, such as deteriorating soil health, rising costs, and declining productivity and labor availability. Without workable solutions, things are likely to get worse.

As you move east along the plains into eastern India and then northwestern Bangladesh and the High Barind Tract, the farm sizes and level of development

tend to diminish. In the Barind, farms average less than 1 hectare in size, on which farmers do their best to simply grow enough food for themselves and their families. Rice farming here relies more heavily on manual labor and simple tillage equipment.

Despite dramatic differences between farms at either end of the Indo-Gangetic Plains, farmers along their length share several problems—two of which have grave implications for rice production and, by extension, for the welfare and food security of many millions of people.

First, as people who traditionally made their living working on farms are uprooting and moving to the cities to find work in the developing urban and industrial sectors, the availability of farm labor is decreasing—particularly during the peak periods of farm operations—and, consequently, becoming more and more expensive.

Second, and perhaps even more pressing, are the issues of water availability and cost. Farmers the world over are, of course, dependent on water. In Bangladesh, and on the least developed farms of the Indo-Gangetic Plains, farmers rely on monsoon rains. If the rains are too late or too little, farmers may not be able to establish the crop and, even where they do, yields can be decimated. At the other end of the plains, many farms pump groundwater when and as needed but unless something changes soon, this cannot continue. Water tables are falling and, as global fuel prices continue their steep climb of the last few years, the cost of irrigation is becoming prohibitive to the point where farmers are

BABUL, a farmer from Rashantapur village in Rajshahi, Bangladesh, describes his experiences with direct-seeded rice. Two girls (*above right*) take a break after harvesting rice in the Indian state of Uttar Pradesh.

LEADING the direct seeding charge (*four photos from left to right*): Dr. M.A. Mazid observes direct-seeded rice fields in Rajshahi, Bangladesh, with field technician Md. Nazmul Hossain; Pantnagar farmer M.S. Grewal (*at left*), who describes direct seeding as "very beneficial," and G.B. Pant University agronomist Dr. V.P. Singh discuss Mr. Grewal's experiences; G.B. Pant agronomist Dr. K.S. Shekhar describes how researchers are getting information to farmers; and Dr. Y. Singh, also from G.B. Pant, has played a key role in developing direct-seeding in northern India.

foregoing the use of their irrigation systems and, like their Bangladeshi counterparts, waiting for the rains.

So, what are the alternatives? One approach, which has emerged as a promising part of the solution across the Indo-Gangetic Plains, is deceptively simple: rather than transplanting rice seedlings into flooded fields, sow rice seeds directly into an unflooded field. Such direct seeding can offer relief in terms of both the water and labor problems and, since 1999, has been investigated as part of two projects—*Promotion of cost-effective weed practices for lowland rice in Bangladesh* and *Promotion of integrated weed management for direct-seeded rice in the Gangetic Plains of India*—with collaboration among the International Rice Research Institute (IRRI), the U.K.-based Natural Resources Institute (NRI), and the University of Liverpool, with additional funding from the Crop Protection Programme of the U.K. Department for International Development. Through IRRI, the work is linked with the Irrigated Rice Research Consortium and the Consortium for Unfavorable Rice Environments.

With their in-country collaborators—the Bangladesh Rice Research Institute (BRRI) and, in India, G.B. Pant University of Agriculture and Technology in Pantnagar, Narendra Deva University of Agriculture and Technology in Faizabad, C.S. Azad Agriculture University in Kanpur, and Rajendra Agriculture University in Patna—the projects have examined the advantages, challenges, opportunities, and constraints of direct seeding across the Indo-Gangetic Plains and the Barind.

Although the idea of a rice farm often evokes images of flooded paddies and bunded terraces, direct seeding is not a new approach. Until the early 1960s, most Indian and Bangladeshi farmers direct-seeded their crops. At that time, the introduction of a more productive model of rice production, which exploited high-yielding varieties and increased fertilizer use, triggered a move to transplanting. In an ever-changing production environment, and despite its advantages, there is growing recognition that the transplanting model isn't ideal for every location and circumstance.

There are a number of options for direct seeding, though the principles remain the same. Rice can be sown with either dry or wet (pregerminated) seed, which is either placed in rows or broadcast.

EXPERIMENTAL plots at G.B. Pant University show the devastating effect of no weeding (*foreground*) versus good weed management (*background*).

DIRECT-SEEDED rice (*right*) matures 3–4 weeks earlier than transplanted rice (*left*), and so is more likely to avoid damaging early-season drought and increase farmers' chances of successfully growing a subsequent nonrice crop.

Bangladeshi farmers have tested dry-seeding rice in furrows made by a *lithao*, a simple, low-cost metal plow drawn by two people (see photo in *A tale of two farmers*, right). In both Bangladesh and India, if soil moisture is adequate, pregerminated rice seed may be either broadcast by hand or sown in rows with an inexpensive plastic drum seeder, pulled by a single user (see *Drumming up success* in *Rice Today* Vol. 4 No. 2, pages 22-27). Meanwhile, on many northeastern Indian farms, farmers use tractor-mounted mechanical seeders that sow seeds at chosen rates and simultaneously apply fertilizer.

The specific advantages of direct seeding vary with farmers' circumstances. David Johnson, an IRRI weed scientist and one of the project's investigators, explains the situation at the eastern end of the Plains, in Bangladesh.

"It takes about 500 mm of cumulative rainfall for a farmer to be able to establish a rice crop through transplanting," says Dr. Johnson. "If farmers direct-seed, they can establish the crop from about one-quarter of that."

By direct seeding, therefore, farmers can avoid the hardships of 2003, 2004, and 2005, when the monsoon rains arrived so late that many growers were unable to establish a rice crop at all. Further, even if there is sufficient rain for farmers to transplant on time, they are still at the mercy of the weather. Drought during the rice plants' flowering stage can devastate the crop, causing yield losses of 50% or more.

M.A. Mazid, principal scientific officer and head of the BRRI regional station in Rangpur, explains the situation in the Barind.

"Generally," he says, "farmers are supposed to transplant by mid-July. But if there's no rain, they can't transplant and the seedlings get older—40, 50, even 60 days, while seedlings should be no older than around 30 days to get the best yields."

The need for high levels of rainfall before transplanting means that direct-seeded rice can be established around 1 month ahead of transplanted rice. In addition, direct-seeded crops are not affected by "transplanting shock," a period of a few days immediately after transplanting when the plants don't grow, and so are further advanced than those transplanted. When *Rice Today* visited rice farms in Rajshahi, Bangladesh, in early October 2005, the direct-seeded crops had already flowered and thus escaped the worst effects of any subsequent drought, which would have ravaged the later-flowering, transplanted crops.

"Earlier establishment has an additional advantage," adds Dr. Johnson, "because it means earlier harvest, which increases the chances of growing a dry-season crop like chickpea, a cash crop that helps increase income and so improves the livelihood of farmers and their families."

Traditionally, Barind farmers transplant a single crop of rice each year, growing a second crop like chickpea only if sufficient moisture

A TALE OF TWO FARMERS

Abdul Basir and Shadat Hossain, rice farmers from Rajabari village in the Bangladeshi district of Rajshahi, tried direct seeding for the first time in 2005, preparing their fields by furrowing the soil with a locally produced *lithao*, which they demonstrate with Dr. M.A. Mazid, below (*Shadat at left*).

"Previously," says Shadat, "I needed a seedbed that required extra management like uprooting seedlings and transplanting. If there was enough rain, I could transplant but, if there was no rain, the seedlings became older and I had to wait—in some years, two months or more. If I transplanted older seedlings, the yield was very poor. In 2003, there was so little rain that we couldn't transplant at all."

"With direct seeding by *lithao*, we can go ahead, even with little water," concurs the 45-year-old Abdul, who supports a family of seven. "With direct seeding I expect that, whatever happens, I'll harvest something. This gives me a good feeling. Before, we believed that if there was no more rain, there would be no crop. Now, we believe that even if there's only a small amount of rain, the seed will germinate and we'll get some rice."

Both farmers have also been struck by the labor advantages of direct seeding, noting that labor requirements are less and more labor is available when it is needed.

"During transplanting time," explains Abdul, "every farmer wants to transplant, so there's a labor shortage and labor prices go up. Direct-seeded rice requires 15 labor days per hectare; transplanting requires 30 labor days."

When they transplanted, Abdul and Shadat generally grew only a wet-season rice crop each year. If there was enough soil moisture following rice harvest, they would plant a chickpea crop too, but in the past five years, Abdul managed to grow chickpeas only once. In 2005, both farmers reaped good yields from their direct-seeded rice fields and consequently grew successful chickpea crops.

There has been keen interest from surrounding farmers not directly involved in the project. Both Abdul and Shadat invited their neighbors to see their crop. About 50 local farmers visited and, according to Abdul, were so impressed that they now plan to try direct seeding themselves.

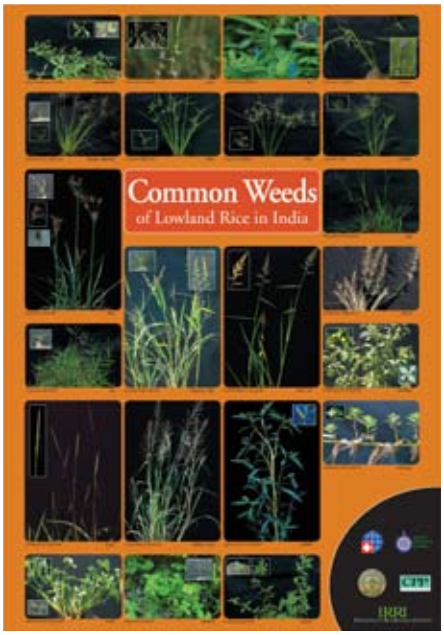
"We should follow this in the future," concludes Shadat. "We will continue to do this, even if the extension agents and the researchers have gone."

remains in the field following the rice harvest. Currently, in an average year, about 80% of the land remains fallow in the second season. The earlier harvest of direct-seeded rice increases the chances of there being sufficient residual soil moisture for a second crop.

"Chickpea is a high-value crop," says Dr. Mazid, adding that there is an excellent market for it in Bangladesh, where it fetches around two and a half times the price of rice per unit volume. "Generally, we import chickpea from Australia, India, or even Canada; there isn't sufficient production here."

The results of the 2005 harvest were encouraging. Yields were good and the early harvest and increased residual soil moisture allowed the direct-seeding farmers to establish chickpea crops, which also produced good yields. Direct seeding helped ensure that farmers and their families had enough food during *Monga*, the lean period in October and November before transplanted rice is harvested.

Back west in India's rice-wheat belt, some farmers, like their



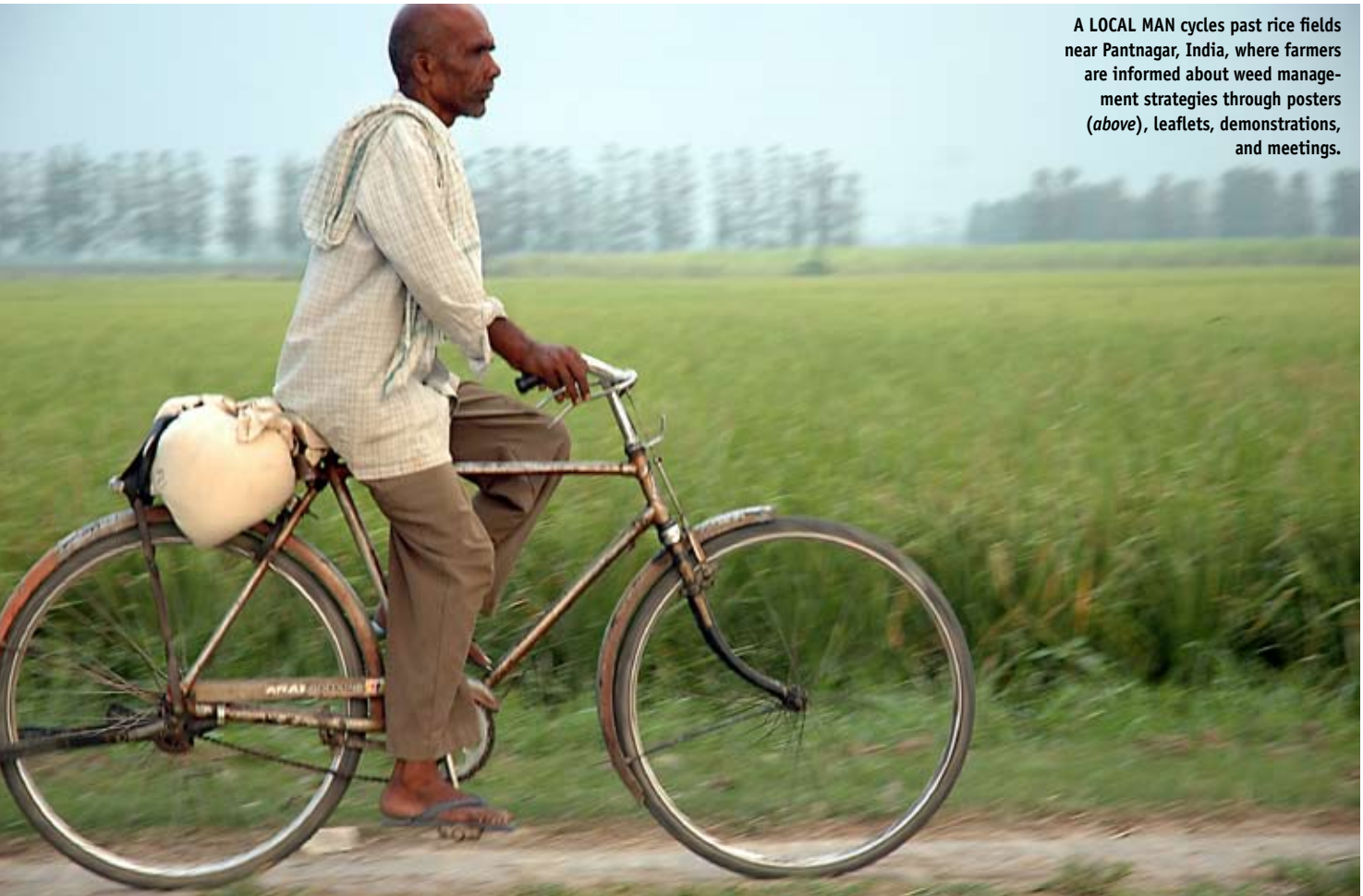
Bangladeshi counterparts, do not have access to irrigation. Many who do, however, are becoming increasingly reliant on rain due to the high costs of pumping while others face increased competition from the industrial and urban sectors that are making water a scarce resource. If rains arrive too late, the rice crop is compromised and the equally important wheat crop is jeopardized. Wheat needs to be well established before the weather becomes cold. For every week beyond 1 November that wheat planting is delayed, the crop suffers a yield loss of 10%, or around 400 kg, per hectare in the most productive areas.

Project team member Y. Singh, from G.B. Pant University, points out that the ideal time to transplant is in June but lack of rain can see farmers transplanting as late as September.

"Even if one good rain comes," says Dr. Singh, "a farmer doesn't have time to transplant his whole area—he'll need more good rain. With direct seeding, we can make sure that the entire rice area is sown and sown on time."

Timely harvests are not the only benefit, with direct-seeded crops needing less water overall. Dr. Singh explains that one of the reasons for this is the way that soil behaves under different planting systems.

"During a period of drought," he says, "when we don't get rains for many days, the soil in the



A LOCAL MAN cycles past rice fields near Pantnagar, India, where farmers are informed about weed management strategies through posters (*above*), leaflets, demonstrations, and meetings.

transplanted crop's field develops many cracks. Then, to irrigate it and take care of those cracks requires a lot of water. This doesn't happen for direct-seeded crops. When we work it out, the total quantity of water used for a direct-seeded crop is much less than that used for a transplanted crop."

The other major advantage of direct seeding over transplanting is that it requires less labor at a time when overall farm labor availability is dropping due to better opportunities outside agriculture in urban areas. Dr. Singh points out that as scarcity has increased, so have wages. "I would say agriculture is a last priority," he says. "It's low-paid, seasonal, and has a high degree of drudgery."

K.S. Shekhar, associate director of extension (agronomy) at G.B. Pant University, says that around his state of Uttaranchal, increased opportunities in nonagricultural sectors have caused labor wage rates to skyrocket.

"This area is in India's steel belt," says Dr. Shekhar. "There used to be a lot of labor, but now there are so many other industries established, so farmers want technologies that require less labor."

Even the farmers themselves understand why laborers are drawn off the land. Dr. Shekhar cites a national survey that showed most farmers would leave farming for a reasonable job in another industry. Farmers have a common lament, he says, that goes: "When I do a job, I have an 8-hour headache. Farming is a 24-hour headache."

There are other cost savings, too. Direct seeding is generally cheaper than transplanting, which incurs the expenses of nursery establishment and care, and the labor that goes along with that. And, on larger farms, running tractors and machine seeders is less expensive on a dry, unpuddled field than on a flooded one.

Dr. Mazid says that, in the Barind, average crop establishment costs per hectare are around US$120 for transplanted rice and $90 for direct-seeded rice—a reduction of 25%. And the results to date show no yield disadvantage. On the contrary, Dr. Mazid reports that in a 2004 study of seven on-farm sites planted to the popular variety Swarna, yields in transplanted plots were 4.7 tons per hectare while yields in plots that had been direct-seeded with a drum seeder were about one ton per hectare more.

If direct seeding offers these advantages, why transplant at all? The main answer is simple: weeds. First, the transplanted rice seedlings, grown in a nursery before being moved to the field, have a head

The widow farmer of Serapera

Alya, dressed in bright orange and purple, cuts a distinctive figure against the bright green backdrop of the rice field. A farmer from Serapera village, in Bangladesh's Rajshahi District, she is not your typical Bangladeshi rice farmer. Although women play a significant role in Bangladeshi rice production, the head farmers are usually men. Following the death of her husband, though, Alya (*pictured right*) was left with no choice but to take over the farm and single-handedly support her four daughters and two sons.

In the 2005 wet season, Alya used a drum seeder to direct-seed 1 bigha of land (just less than a seventh of a hectare). Through reduced water and labor requirements, she immediately saved around Tk500 (US$7.40) on the direct-seeded plot but, early on, it didn't look good.

"But now the direct-seeded crop looks better than the traditional crop," she says. "When other people first saw my field, they said, 'you'll lose everything!' Now, they say, 'your plot looks very good, one of the best in the area.' My neighbors are very happy about this."

Alya's 2005 direct-seeded rice, which was 3 weeks ahead her transplanted crop, achieved an impressive yield and she was subsequently able to grow successful wheat, sesame, and chickpea crops. In the previous season, when she only transplanted rice, Alya grew chickpea and linseed after rice, but the chickpea fared poorly because it was planted too late. Her sons, who help on the farm, are impressed.

"One of my sons is saying, 'Mum, we'll direct-seed,'" Alya explains. "We won't transplant any more."

THRESHING rice in Uttar Pradesh, India.

IRRI WEED scientist David Johnson examines a weed with field technician Emil Barcial.

JOSE RAYMOND PANALIGAN

start over any competing weeds. Second, the water in a flooded field effectively acts as a herbicide, suppressing weed growth. The flipside, of course, is that weeds are the major problem facing farmers who direct-seed, and who can lose most of their yield if they don't adopt adequate weed-control measures.

"It's likely that farmers who direct-seed will be more reliant on herbicides," says Dr. Johnson, "simply because they can't rely on flooding to suppress weeds during the crucial initial period of crop establishment."

Most Indian farmers already use herbicides. In Bangladesh, farmers are less familiar with herbicides but recent years have seen increased use. In the past, where farmers have changed from transplanting to direct seeding, a lack of good weed management has constrained the development of successful direct-seeding systems. Effective weed management is more than just spraying a field with herbicide. After 5 years of on-farm trials, the researchers are confident that direct seeding is a sustainable practice.

"However," says Dr. Johnson, "it is a knowledge-intensive system and we'll need to ensure that the farmers have the knowledge and information they need to make the right decisions at the right time."

The key to successful direct seeding on a large scale therefore lies in the way that farmers manage their crops.

"We have to change the farmer's mindset," says Dr. Singh. "If he wants to do better, he has to be a better manager. Only then will it be possible to benefit from new technologies. Productivity levels, by and large, could be improved and the gap is partly due to management. If a farmer improves management and input levels, certainly his productivity will go up."

Sure enough, when weeds are managed appropriately, direct seeding is showing promising results. Like their Bangladeshi counterparts, the Indian farmers who direct-seeded in 2005 had yields as good as or better than for their transplanted fields.

Direct seeding won't eliminate labor issues. As more farmers adopt the technique, there is likely to be an increased demand for hand labor for supplementary weeding. Even when herbicide is used, crops generally need at least one follow-up hand weeding. But this shift in labor use will be spread over a longer period than the labor bottleneck for transplanting.

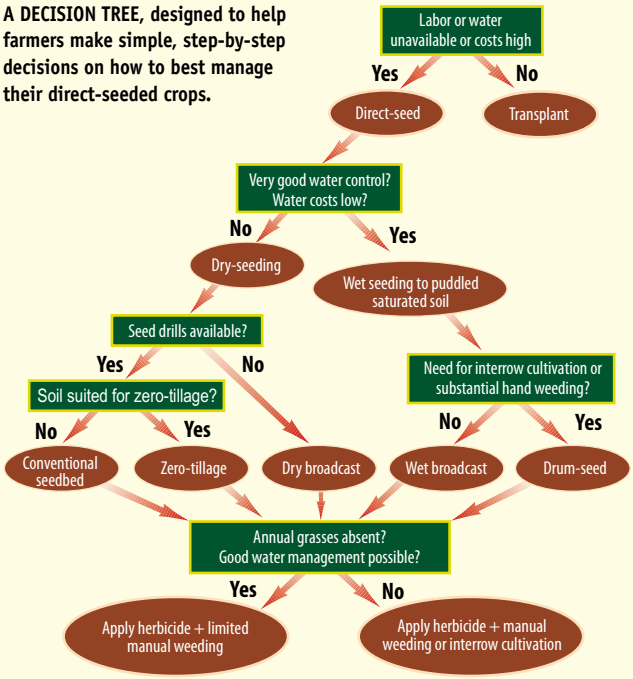
The challenge, then, is greater than training farmers to choose the most appropriate herbicides and use them safely and effectively at the correct time. Every field has its own weed issues, which reflect past crop management systems. If a farmer moves to a new system, different weeds will emerge as problems. Farmers therefore need decision-making tools that allow them to anticipate changes and adopt the most effective strategy for combating weeds (see *Work needed to weed out farmers' problems* on page 38).

"Ultimately," says Dr. Johnson, "we want a series of simple rules in question-and-answer form. For example, 'What direct seeding method should I use?' or 'If species A develops as a serious weed in the field, what should I do?'. This is the next step—to bring together the research results and develop a format that allows farmers to access the information." (See figure at *left*)

The real success of these projects will be seen when farmers over a wide area feel confident enough to adopt direct seeding. The research projects in Bangladesh and India have shown that successful weed management strategies that enable direct seeding can be put in place in both rainfed and irrigated rice-cropping systems.

"It might not be something that happens on a wide scale until the circumstances to encourage such a change are in place," says Dr. Johnson. "But with declining availability of irrigation water and of labor at peak periods, it's likely that, over the long term, we'll see a continued shift towards direct seeding in South Asia."

A DECISION TREE, designed to help farmers make simple, step-by-step decisions on how to best manage their direct-seeded crops.



Claiming rice fields from WILD RIVERS

by Gene Hettel

In the overleaf that follows, the breathtaking bird's-eye view of the winding Alimit River in remote northeastern Ifugao Province on Luzon Island in the Philippines shows how the landscape can be fashioned by nature—and humans. Indeed, the Alimit has carved its way through the mountains for centuries and, as can be seen in the lower right quarter of the centerfold, the Ifugao people have been doing some carving of their own.

Their decades-long, methodical chiseling of the riverbank will eventually help isolate the oxbow from the river's flow, providing these ingenious engineer-farmers a new fertile niche on which to grow their famed Ifugao rice. The photo at right shows the end result of a successful centuries-earlier claiming of the river's territory for rice growing.

These photos are just two of nearly 1,000 shots made from a small airplane during an early March 2006 expedition by *Rice Today* photographer Ariel Javellana under the guidance of eminent Yale anthropologist (retired) Harold Conklin. With the fickle weather of Luzon's Cordillera Mountain Range being unusually cooperative, the adventuresome duo spent many hours flying above the province's rice terraces, fields, river valleys, mountains, and forests. They documented some 40 years of both change and stability across approximately 80% of the province's 2,500 square kilometers of rugged topography.

"The Ifugao people do not consider anything immovable," said Dr. Conklin in admiration of these indigenous people, whom he has studied for more than 4 decades, as he reviewed with Javellana the treasure trove of images they brought back with them to IRRI for study. Dr. Conklin plans to include an analysis of some of the photos in a book he is planning about rice and the Ifugao. Watch for more spectacular photography from this collection in a future issue of *Rice Today*.

The Alimit River winds through remote northeastern Ifugao Province, Philippines.

SAMJHANA SHRESTHA

LAO farmers tend vegetable terraces on the Nam Khan River near Luang Prabang. Improved rice production allows farmers to diversify their crops, and therefore their diet and income—but life throughout Lao PDR, seen in the surrounding photos, continues to depend on rice.

PETER FREDENBURG (7)

DANIELE MARECHAL

GENUINELY LAO

THE STORY OF THE PROJECT THAT REVOLUTIONIZED RICE PRODUCTION IN LAO PDR

BY ADAM BARCLAY AND SAMJHANA SHRESTHA

In 1990, the Lao People's Democratic Republic (Lao PDR) needed more food. The rice industry in particular and agriculture in general were ready for change. It had been a long time since the country had produced enough rice—from which the average Lao person receives around two-thirds of his or her calories—to feed everybody. Something needed to happen, and soon.

History tells us that change did arrive that year, along with the Swiss Agency for Development and Cooperation (SDC) and the International Rice Research Institute (IRRI). The Lao-IRRI Rice Research and Training Project aimed to completely revitalize the Lao rice industry. The next 15 years would see an enormous surge in Lao PDR's research and training capacity as well as the long, hard journey to rice self-sufficiency.

DANIELE MARECHAL

John Schiller, the former IRRI scientist who led the project from its start in 1990 until 2001, recalls the situation when the project began.

"In 1990," he explains, "there was almost no research aimed at developing technologies for improving rice production, almost no commercial fertilizer use, and limited rice research expertise."

After Dr. Schiller left, Karl Goeppert took over project management in 2001-04, followed by IRRI agronomist Bruce Linquist, who arrived in Lao PDR in 1997 and led the project in 2004-05. Dr. Linquist points out that the country's problems were compounded by a dearth of international aid before the project began. "We were the only ones doing rice research and we basically started from scratch," he says.

IRRI entomologist Gary Jahn, who took over management of the project in July 2005, will oversee the transition from a bilateral project to a fully fledged national research program, completely managed and coordinated by the Lao government's National Rice Research Program (NRRP) under NRRP director Kouang Douangsila.

How did the Lao-IRRI Project improve rice production and build a national research program? For a start, the timing was good and, as the project began, several key factors converged.

"The government introduced favorable agricultural policies," explains

THE LAO-IRRI Project contributed substantially to the development of a functional national rice research system and the establishment of a network of research stations across the country in all provinces.

A LOWLAND rice farmer from Savannakhet Province threshes his rice after the 2005 harvest.

DANIELE MARECHAL

Ty Phommasack, the vice minister for agriculture and forestry. "At the same time, IRRI arrived with technologies and know-how and SDC came in with long-term financial support. The government's support has been a big factor from the very start, and the impact it has had on the Lao rice industry really is unprecedented."

Dr. Schiller adds that the minister for agriculture and forestry, Siene Saphangthong, who spent time at IRRI as a research scholar and served on the institute's board of trustees in 1996-2001, strongly supported the project in its early stages, when he was vice minister. "As a result," he says, "we didn't suffer a lot of the work-related frustrations that other agencies faced."

It would be impossible to point to a single measure of success in a project as broad as Lao-IRRI. Statistics, such as the amount of land planted to Lao modern rice varieties—high-yielding varieties developed specifically for Lao conditions from the Lao-IRRI research programs—tell part of the story (see *Growing impact* on page 27).

"At the field level, one of the most obvious impacts has been the release of the improved Lao rice varieties," says Dr. Schiller. "In the Mekong River Valley in 1990, only 5% of the lowland rice area was under improved varieties. By 2004, many provinces had up to 80% of their lowland area planted to improved varieties."

The impact of these modern varieties has been profound, playing a huge part in Lao PDR increasing rice production between 1990 and 2004 from 1.5 million to 2.5 million tons. From 1996 to 2004—the period during which technologies were disseminated—the country saw a 79% increase in rice production with a corresponding increase in land area planted to rice of only 39%—and most of this increase was due to double cropping of rice, not clearance of new land. The average annual growth rate in production for the 15-year duration of the project is just above 5% and this increases to more than 7% since 1996. According to Sengpaseuth Rasabandith, head of the Food Crops Department at the Lao National Agricultural Research Center, "Without the Lao-IRRI Project, there would not have been national modern varieties to release. The project has created a 'rice revolution' in the country."

At the same time, Lao farmers' traditional rice varieties are not being sacrificed. The project has aimed for a well-balanced development of the country's rice industry and, currently, around one-third of Lao PDR's rice-growing area is planted to Lao modern varieties, one-third to other modern varieties (developed in other countries and at IRRI), and one-third to traditional varieties.

While the impact of improved production is unquestionable, Drs. Schiller and Linquist agree that the most significant success has been the growth of Lao PDR's agricultural research capacity. "You can't go anywhere in Lao PDR and not bump into somebody who's benefited from Lao-IRRI," says Dr. Linquist. "If you're in the agricultural sector, there have just been hundreds of people who have been trained through Lao-IRRI. Training has been huge.

"Sometimes that's worked against us—restructuring has moved a lot of people from our program to higher positions because they've been well trained. In the long term, though, that's beneficial because as well as having trainees in the rice area, it filters through to all areas of government."

Another area where Lao-IRRI has made great progress is that of gender equity. Improved technologies developed by the project are gender-neutral, meaning that male- and female-headed households benefit equally. For example, average rates of adoption of modern rice varieties and subsequent yields are the same regardless of whether households are headed by males or females. Monthathip Chanpengsay, deputy director of research at the National Agricultural and Forestry Research Institute and herself a beneficiary of many of the Lao-IRRI training programs, points out that the project also ensured that women had the same opportunities for training as men.

"Qualified women have had an equal chance of being selected in any of the Lao-IRRI Project's training programs," she says. "There is no evidence at any level of discrimination in training programs based on gender."

PETER FREDENBURG (2)

BRUCE LINQUIST talks to farmers at a taste test of candidate rice varieties. After tasting, the farmers vote their preferences for eating quality.

LAO upland farmers and traders manhandle bags of Job's tears outside warehouses on the banks of the Mekong at Luang Prabang. Most of the harvest is shipped down the Mekong to Thailand, where it is used to brew beer.

LAO farmer Mai Tamma of the village of Matahe, near Luang Prabang, tells farmers and extension workers at a December 2002 field day how hedgerows of stylo in his upland field control erosion and provide high-protein feed that his pigs love. Because Mai Tamma has paddies suitable for lowland rice, he need not plant his upland field to less productive upland rice.

PETER FREDENBURG (2)

The project has made a big contribution to the conservation of rice biodiversity in Lao PDR. Apart from being an indicator of overall environmental health, strong biodiversity can provide genetic materials for future agricultural use. Lao-IRRI has helped NRRP establish a collection of over 13,000 samples of traditional varieties, document indigenous knowledge regarding traditional varieties, and conserve wild rice varieties in their natural habitat. Lao PDR is also the second-largest contributor to the International Rice Genebank maintained at IRRI.

According to Rod Lefroy, representative of the International Center for Tropical Agriculture in Lao PDR, "The presence and documentation of rice genetic diversity is of enormous pride to Lao people and this is one aspect of the Lao-IRRI Project that is going to be remembered long after the project has been completed."

The past 15 years have seen numerous vivid illustrations of the impact that the project has had on people throughout Lao PDR. Samjhana Shrestha, a consultant agricultural economist at IRRI, recalls one of these.

"I visited Naoukhou village in 2002," says Shrestha, "and I remember the villagers talking in Lao. I couldn't understand, but I kept hearing this name—'Sulaphon'—over and over again. It turns out that he's a Lao-IRRI-trained agronomist. When he first visited Naoukhou in the late 1990s, it was a very poor village. Now, largely thanks to his efforts, they are self-sufficient in rice."

As it happens, the rise of Naoukhou happened almost by accident, but stands as an example of the project's many unanticipated benefits.

"Naoukhou wasn't a target village," explains Dr. Linquist. "We chose the area because it had gall midge problems and it was good for screening. But Sulaphon got to know the farmers, who looked at these trials and saw some good stuff. They asked for seed, Sulaphon gave it to them, and 'boom!'—it just spread."

Dr. Schiller is adamant that one of the factors in Lao-IRRI's success was nurturing a sense of Lao ownership.

"I didn't want it seen as just an 'IRRI Project in Lao PDR'," he says. "I often played on the 'IRRI' component of the project name. Expressed in the Lao language with the right tones, 'IRRI' means 'genuine.' You can appreciate the opportunity we had to emphasize that the project was genuinely Lao."

This ownership can be seen in the way farmers themselves take part in the research, and aren't merely told what to do by foreign researchers. According to Dr. Linquist, this practice extensively boosted the adoption of new farming technologies.

"We worked very closely with the farmers," he explains. "Involving farmers in all the steps of research, from analyzing their problems through to finding new technologies, has really been beneficial and has allowed us to get technologies into farmers' fields."

Lao-IRRI's emphasis on capacity building means that, as well as working closely with farmers themselves, project staff have taught Lao agricultural officers to work more effectively with the farmers.

"Traditionally, district advisers and extension agents have just told farmers what to do," explains Dr. Linquist. "After training district officers, we asked them what sort of benefits they found in working

New hope for upland farmers

IMPROVED rice production in the highlands leaves land available for diverse crops.

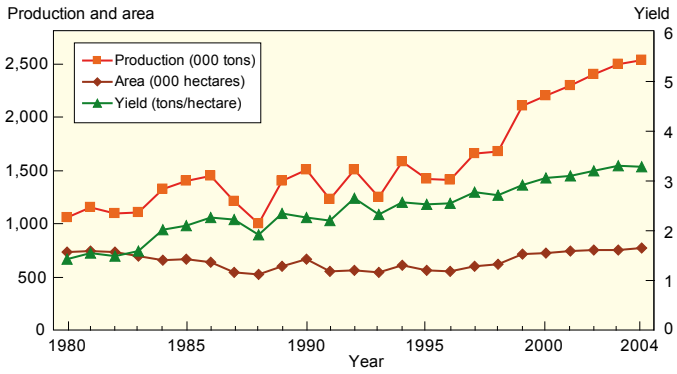
Rice farming in Lao PDR's uplands is a backbreaking way of life. The upland environment, where crops are at the mercy of unpredictable rains, is a poor one for growing rice. The farm families who live there tend to be income and resource poor and therefore unable or unwilling to invest adequately in inputs such as fertilizer. Upland rice yields are notoriously low, but most high-yielding modern varieties developed for irrigated systems tend to perform poorly under rainfed conditions.

Following the success of an upland farming program in China's Yunnan Province (see *A mountainous success* in *Rice Today* Vol. 5 No. 1, pages 30-35), however, things are looking up in the uplands. Now, Lao PDR's National Agricultural and Forestry Research Institute and the provincial governments of Oudomxay and Sayabouly will work together with IRRI and the International Fund for Agricultural Development (IFAD) to boost Lao upland rice farming in a new three-year project.

Farmers from remote upland villages in Oudomxay and Sayabouly will test aerobic rice production technologies, including high-yielding varieties of upland and aerobic rice—which grow well in dry conditions—from the Lao genebank, China's Yunnan Academy of Agricultural Sciences, and IRRI.

According to Ren Wang, IRRI deputy director general for research, "We expect a relatively quick impact in increasing rice yields for upland farmers. Not only will this help alleviate poverty, it will also help stop the environmentally damaging slash-and-burn farming practiced in many upland areas."

As well as introducing higher yielding modern varieties, the project will develop traditional Lao varieties that are resistant to soil-borne pests. Over the next three years, researchers hope to see average rice yields increase from the current 1 ton per hectare to around 3 tons per hectare. Such progress would significantly improve the livelihoods of upland farm families and their communities.



RICE PRODUCTION, area, and yield in Lao PDR, 1980-2004.

with farmers this way compared with past methods. They told us, 'We used to have to look for farmers. Now farmers are coming to us and asking to work with us.'"

The true success of the Lao-IRRI Project—which is set to end in September 2006—will only be known years from now. But the impact so far has been impressive, with much of the country now self-sufficient in rice. Work remains to be done, though, with the less favorable areas of eastern Lao PDR still suffering from a rice deficit.

But the building blocks are in place. According to Dr. Monthathip, the country now has the ability to continue improving on its own. There is, she says, a confidence that simply didn't exist 15 years ago.

"The National Rice Research Program is now sustainable," says Dr. Monthathip. "Even if IRRI went home tomorrow, the rice industry would be OK. But having IRRI involved has many benefits. It helps us network with neighboring countries and international agencies, and it gives us a broad overview that keeps things moving along smoothly."

"The capacity is there for the future," agrees Dr. Linquist. "There are strong links established between IRRI and the Lao national partners. The big issue now is thinking of innovative ways to continue the research. But the capacity is there."

A fully functional rice research system is now a reality in Lao PDR. This includes the establishment of a network of research stations and a well-trained cadre of research scientists and managers. These people are now providing scientific and management leadership to the country's agricultural research system, which has developed to a stage where it can fully participate in regional research initiatives and networks. IRRI's faith in Lao research capacity can be seen in the institute's request to base its Greater Mekong Regional Office in Lao PDR. Dr. Jahn anticipates that Lao PDR will play a pivotal role in regional agricultural challenges.

"In just 15 years, Lao PDR has progressed from subsistence rice farming to more intensive production farming," he says. "With sufficient support, the country will move to the next level of development—commercial farming and rice export. This stepwise approach to the development of rice-based economies has worked well for Vietnam and Thailand.

"The Lao-IRRI Project has effectively nurtured Lao PDR's research system through its infancy. The system, which now has a critical mass of well-trained scientists and research managers, has reached the point where it can operate effectively on its own."

This is a tremendous and lasting contribution to national and institutional development that will continue to pay handsome dividends well into the future.

PANY VANMANIVONG (*right*), who works for the Lao Agricultural Research Organization, interviews a farmer from northern Lao PDR for a survey on the impact of the Lao-IRRI Project.

SAMJHANA SHRESTHA

Growing impact

Farm impact

- Farmers who grow Lao modern varieties have approximately US$42 per hectare—or 20%—higher net returns than those who grow traditional varieties and other modern varieties. Yield improvement is the main reason for increased returns.
- Among surveyed households, 77% were self-sufficient in rice. Self-sufficiency is higher among modern variety adopters (82%) relative to nonadopters (58%).
- Overall, cash income from rice is 77% higher for adopters of modern varieties than for nonadopters.
- Around 80% of surveyed households planted modern varieties on 69% of rice area.

National impact

- Between 1990 and 2004, rice production increased from 1.5 million tons to 2.5 million tons.
- The total investment of the Swiss Agency for Development and Cooperation in the Lao-IRRI Project was approximately $15 million. The benefit-cost ratio is 7:1—for every dollar invested in the project, the Lao economy is reaping a benefit of $7.
- The estimated gain in production for 2004 directly attributable to the Lao-IRRI Project is 226,000 to 282,000 tons, corresponding to a value of $26–32.4 million at the farm-gate price of $115 per ton.

Institutional impact

- During the early phases of the Lao-IRRI Project, in 1990-95, infrastructure such as access roads, buildings, and laboratories, was constructed and research farms were established. Research and training facilities were constructed in the Lao capital of Vientiane and in other regions.
- Lao-IRRI has established a network of research stations in all 17 provinces, forming part of a functional national rice research system.
- Lao PDR's rice research and training capacity has been increased through more than 4,600 training opportunities, including higher degree training, on-the-job training, and participation in international conferences.
- The project has fostered collaboration between the national research system and a range of national and international organizations. Project alumni are now the main personnel collaborating with development agencies.

BACK TO THE FUT

Smallholders who integrate rice farming with livestock are the mainstay of traditional agriculture in the Greater Mekong Subregion—and a model for sustainable development

by Peter Fredenburg and Bob Hill

The Farming Systems Research Group at Khon Kaen University, in Thailand's hardscrabble northeast, studies the evolution of local farming systems. In collaboration with the International Rice Research Institute (IRRI), it has focused particularly on those that integrate rice farming with animal husbandry. Suchint Simaraks, head of the research group, recreates life on the farm in northeastern Thailand as it was in the middle of the 20th century.

Most farmers, he says, grew their traditional varieties of glutinous rice. It was eaten by hand or scrunched into a pocket, to be eaten during a moment's shady rest in the oppressive heat of the day. Rice was their major crop, planted with the first rains in May or June and nurtured through the rainy season, which was equally prone to flood or drought. If the weather was kind, farmers had just enough rice to last through the year. But the years without drought or flood were the occasional ones, so farmers' arts of survival were finely honed.

Always wary of theft, they kept cattle and buffalo under their houses at night. The animals were their "money in the bank." If an urgent need for cash arose, a beast was sold. Meanwhile, land preparation depended almost entirely on buffalo power. Chemical fertilizer was unknown, so the manure shoveled off the corral was the universal fertilizer. It nourished the mulberry trees that fed the silkworms that produced silk for the family to weave. It was used to fertilize tobacco crops, was saved for the rice nursery before the rain, and was available for vegetable plots around the house.

In the dry season, the animals roamed freely in the paddies, widely distributing their manure. Farmers also threw manure into natural ponds to feed the fish, crabs, and aquatic insects that would later feed humans. Nothing was wasted. Sometimes farmers found personal nourishment in the manure itself: dung beetles for deep-frying, or the seeds of certain wild fruits to be shelled and eaten like nuts.

URE

THE MEKONG River, pictured here at Luang Prabang, Lao PDR, is central to the lives of hundreds of millions of people. A boy carries rice straw (*opposite*) in the ethnic Khmer village of Letri in An Giang Province, Vietnam.

PHOTOGRAPHY BY PETER FREDENBURG (8)

Times have changed in Thailand, even in the relatively traditional and disadvantaged northeast. According to Dr. Suchint, integrated crop-animal systems started getting squeezed in the 1970s as large tracts of forests disappeared, leaving farmers short of grazing areas for their cattle and buffalo.

"Around 1961, more than half of the land in this area was covered with forest," he says. "When the government introduced timber concessions, the forested area declined sharply. The cleared forests were replaced by cash crops such as [fiber-producing] kenaf and cassava. This, in turn, stimulated more forest-clearing. At the same time, the human population swelled, causing further acceleration of forest-clearing for settlements and more cash crops. The beasts could no longer be allowed to wander free, and the prices the livestock brought were not high enough for farmers to continue raising them on their farms."

Government policy accelerated the trend. "During the past few decades, policy reforms were instituted in Thailand that gave emphasis to strengthening exports, in particular agricultural exports," Dr. Suchint says. "These policies transformed smallholdings from near subsistence level to more commercialized and specialized systems."

Today, recovering prices for meat and growing demand for milk have made livestock once again an attractive option for farmers. Meanwhile, the Thai government actively encourages the revival of integrated crop-animal systems,

granting a million baht ($24,000) to every village in the country for investing in small community-based ventures. "Farmers have been borrowing this money to buy more cattle," Dr. Suchint reports. "So, the traditional farming system is recovering."

Although large specialized farms enjoy many commercial advantages over more traditional smallholdings, Thailand's experience shows the danger of plunging headlong into specialized agriculture without regard to its environmental, economic, and social sustainability. As Thai farmers rediscover the half-forgotten virtues of many of their traditional integrated farm practices, less-developed countries in the Greater Mekong Subregion can benefit from the Thai lesson—and from research that aims to guide the evolution of integrated systems for the benefit of farmers and consumers alike.

"Integrated crop-animal systems are popular because they maximize the use of farm resources," explains Mercedita Sombilla, a former agricultural trade and development specialist in IRRI's Social Sciences Division. "They employ idle rural manpower, generate supplementary income for farm families, and reduce financial risk and rural poverty. And they are—or at least can be—environmentally sustainable.

"Intensified development of these systems is appealing as the major actors and beneficiaries are small farmers and landless families," she adds. "However, sustaining the complementarities between crop and animal activities is a big challenge, especially in the rice areas of Southeast Asia."

Dr. Sombilla coordinated studies on integrated crop-animal systems in the Greater Mekong countries of Thailand, Cambodia, and Vietnam (considering the Mekong and Red River deltas separately), as well as in the Philippines and Indonesia. The studies, published in the book *Integrated Crop-Animal Systems in Southeast Asia: Current Status and Prospects* (available free at www.irri.org/livestock), describe these systems and track their evolution; investigate their potential for poverty alleviation, food security, and livelihood improvement in rice-farming communities; and advise on how best to address the problems that constrain their sustainable, market-oriented development.

"Livestock production in most parts of Cambodia is so intimately related to rice production that neither can be studied nor understood in isolation from the other," comments El Sotheary, Dr. Sombilla's collaborator at the

NGUYEN DUY CAN (*second from right*), shown with diversified rice farmer Le Thanh Dang, observes that too few Vietnamese farmers fertilize their crops with manure, and that pesticide overuse limits rice straw's use as livestock feed.

CAMBODIAN rice farmer Ing Chea (*left*) examines his poorly filled rice grains (*inset*) with Cambodian Agricultural Research and Development Instutute agronomist Chea Chanthan.

Cambodian Agricultural Research and Development Institute. "The great majority of the livestock are raised in integrated farming systems, most of which have rice as their major component."

The recent difficulties faced by Ing Chea, a rice farmer in Don Keo District of Takeo Province, 80 kilometers south of Phnom Penh, demonstrates how critical the rice component is. Chea, who once owned a herd of more than 10 cattle but sold most of them in 1997 to pay for house construction and his daughter's wedding, now has four cows, a couple of pigs, and a dozen chickens. He has been unable to afford to rebuild his herd. He uses manure as fertilizer for his two annual rice crops, and rice straw to feed his cows. In a recent season, though, he complained that he lost 90% of his grain to rice bugs, whose odor discouraged the cows from eating the leaves and straw.

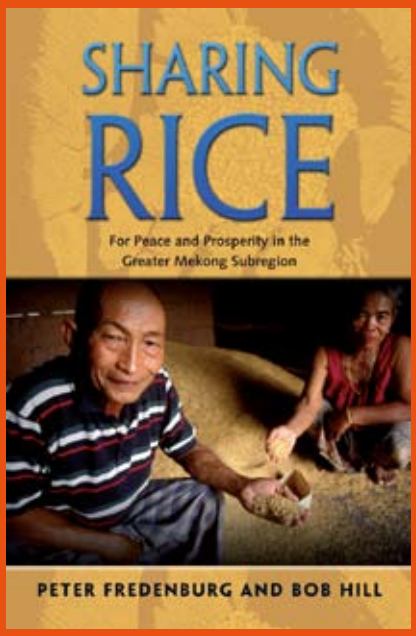
Sotheary points out that straw alone offers incomplete nutrition for cattle. Cambodian farmers rarely add dietary supplements, though recently some have started treating the straw with urea. Pigs fare somewhat better on a diet that is about half rice bran. "Rice bran is in itself a reasonable feed for pigs," she says. "In fact, raising pigs can be viewed as a means of adding value to rice bran."

Farmers buy the bran from rice millers, who collect it as the milling

Sharing Rice

for peace and prosperity in the Greater Mekong Subregion

A book by Peter Fredenburg and Bob Hill



The Mekong is a river of contrast and transition. Springing clear and icy from the rugged plateau of Tibet, it is most familiar worldwide as a maze of muddy channels threading across the flat, steamy delta of southern Vietnam. In a journey of more than 4,000 kilometers, the river traverses the southwestern Chinese province of Yunnan, slips along the easternmost tip of Myanmar, and drains almost all of Laos, Cambodia, and northeastern Thailand.

Unlike many of the world's major rivers, the Mekong has never been a unifier. In 1866-68, the French explorers Doudart de Lagrée and Francis Garnier journeyed from colonial Saigon up the "great river," as it was called in Vietnamese and Khmer, to demonstrate that it was a "river road" to China. They were wrong. Broken by rapids above the Khmer town of Kratie, and subject to extreme variations in seasonal flow, the Mekong has historically divided the peoples who live along its shores and tributaries—a mélange of more than 70 distinct ethnic and linguistic groups. Astonishingly, the first bridge across the Lower Mekong, the Thai-Lao Friendship Bridge near Vientiane, did not open until April 1994.

Two years earlier, the Asian Development Bank had encouraged Cambodia, Laos, Myanmar, Thailand, Vietnam, and Yunnan to join hands in a program of economic cooperation called the Greater Mekong Subregion. The concept has facilitated infrastructure development and fostered international recognition of a new growth area, with the river serving as a symbol of this newborn spirit of cooperation. The subregion's 2.3 million square kilometers are home to a combined population of 250 million, a total nearly equal to that of the United States.

With the arrival of durable peace in the 1990s, Greater Mekong living standards have improved. Yet per capita gross domestic product in most of the region hovers at the poverty line of a dollar a day. Persistent poverty drives unsustainable agricultural practices that erode the public health and natural resources upon which hope for a better future depends.

Rice pervades the Greater Mekong not just at mealtime. Agriculture employs two-thirds to three-quarters of all workers in most areas of the subregion—accounting, in Cambodia, Laos, and Myanmar, for more than half of all economic activity by value. In the Greater Mekong Subregion, agriculture means, first and foremost, growing rice , largely at a subsistence level. Rice occupies 60% or more of all farmland in the poorest areas.

That rice and its cultivation are central to the issues of poverty in the Greater Mekong Subregion holds true from all key perspectives: livelihood, nutrition, health, protecting the environment and biological diversity, and promoting equal opportunity. Rice is therefore the indispensable entry point by which agricultural scientists and extensionists can work with farmers to improve their lives and those of the poor urban residents who depend upon them for affordable supplies of their daily rice.

Sharing Rice—which offers snapshots of rice research collaboration between the International Rice Research Institute and its local partners—is dedicated "to the millions of rice farmers in the Greater Mekong Subregion who continue to strive for better lives for their families and to help feed a hungry world."

Adapted from the introduction of Sharing Rice, *published in 2006 by Sid Harta Publishers.*

LE THANH DANG (*right*) shows Dr. Can one of his pigs. Dang has raised pigs for two decades, started raising cattle half a decade ago, and continues to grow just enough rice to feed his family of five.

fee. "The quantity, quality, and cost of rice bran available at local mills are the major determinants of the number of pigs that are raised in a village, how well they grow, and how profitable the activity is," Sotheary explains. She adds that taking bran as payment is a disincentive for Cambodian millers to improve the quality of their milling, from a rice-recovery rate that averages a dismal 57%.

Cattle and buffalo contribute somewhat more than a quarter of the 12.4 kilograms of meat annually eaten per capita in Cambodia. Farmers themselves consume relatively few livestock products, except, on special occasions, chicken (which they raise as free-range scavengers with perhaps a scattering of white rice, paddy, or kitchen waste) and, even more occasionally, chicken eggs. "Cattle, buffalo, and pigs are sold to slaughterhouses, but their meat is rarely purchased by the farmers," Sotheary reports. "However, animals that die in an accident or from disease are commonly consumed by villagers."

A survey conducted by IRRI in the mid-1990s found that animal raising brings in 29% of the total income, including off-farm activities, of Cambodian farm households and fully three-quarters of their income from agricultural activities (80% for farm households considered poor). "At times, livestock may be the only way farmers can benefit from community resources, such as grazing lands or forests," comments Sotheary.

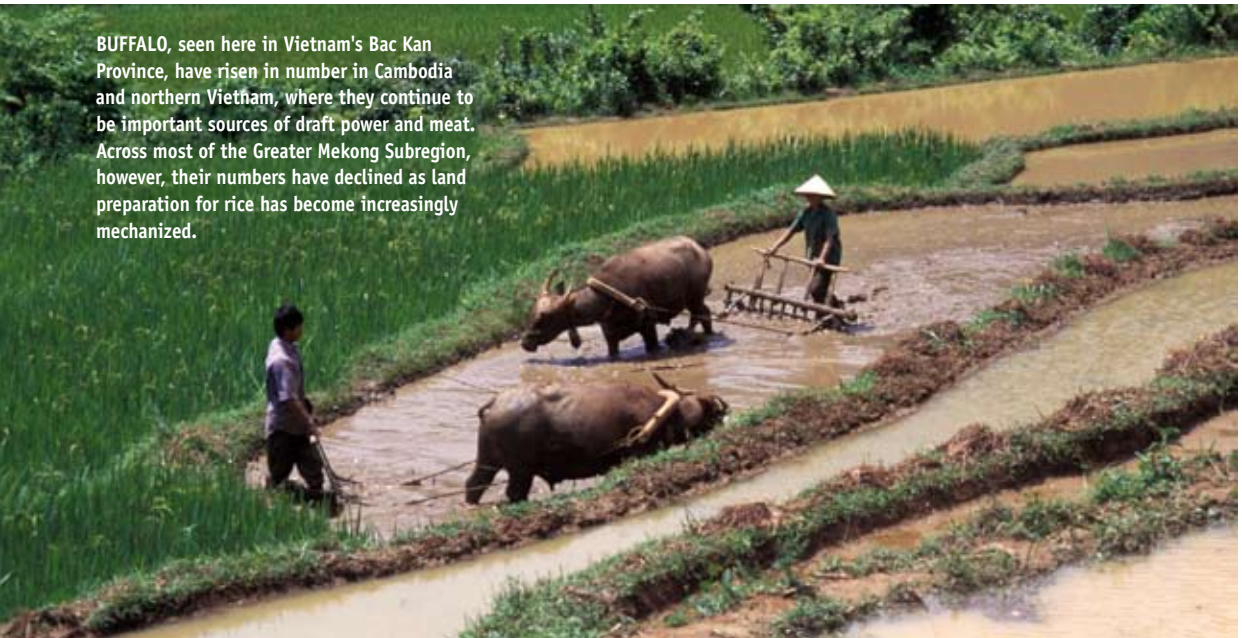
Because cattle and buffalo provide 90% of draft power in Cambodia, and because the country is still recovering from war, it is the only one in the Greater Mekong Subregion to see a nationwide rise in the number of buffalo in recent years. Buffalo numbers also rose in the northern mountains of Vietnam, where buffalo production—accounting for 60% of the national total—provides both draft power and meat. However, like Thailand, Vietnam as a whole has seen a significant decline in the number of buffalo and draft cattle as land preparation for rice has become increasingly mechanized.

Raising large ruminants has never been widespread in the Mekong Delta of southern Vietnam, except among ethnic Khmer, many of whom cluster along the Cambodian border and engage in cross-border livestock trade. Few mainstream Vietnamese farmers in the delta even use manure to fertilize their rice fields. Cao Van Phuc, a diversified rice farmer in Chau Thanh A District of Cantho Province who recently acquired 14 head of cattle, prefers to use chemical fertilizers in his paddies.

"Not many better-off farmers like him apply manure to rice," explains Nguyen Duy Can, deputy head of the Sustainable Resources Management Department of Cantho University's Mekong Delta Farming Systems Research and Development Institute. "Farmers here aren't familiar with its use on rice. And handling manure is difficult, time-consuming, labor-intensive, and smelly."

Phuc finds plenty of other uses for the stuff. Biogas piped from the manure pit into a large polyurethane bag hanging from the roof of a shed provides all the cooking gas his family needs. He cultures earthworms in manure to feed to his catfish and sells manure to neighbors who do the same. And he uses manure to fertilize his durian and pomelo trees.

Dr. Can views farmers' reluctance to fertilize paddy with manure as a weakness in the system. "The greater the interactions between various components of the system, the more sustainable the system is," he points out, calling for further work on how farmers can most efficiently make and use compost. He adds that widespread overuse of pesticides on rice limits



BUFFALO, seen here in Vietnam's Bac Kan Province, have risen in number in Cambodia and northern Vietnam, where they continue to be important sources of draft power and meat. Across most of the Greater Mekong Subregion, however, their numbers have declined as land preparation for rice has become increasingly mechanized.

the straw's use as livestock feed, especially for dairy cows.

Le Thanh Dang, of Hau Nghia village in Duc Hoa District of Long An Province, just 25 kilometers or so from downtown Ho Chi Minh City, is another better-off farmer who is milking the growing Vietnamese market for dairy products—some 90% of which is met with imports (mostly milk powder). A pig and rice farmer for more than 20 years, Dang started raising dairy cows 5 years ago and now has 10 head. He makes a good living selling milk and female calves, which are worth 10 times as much as their male siblings. He devotes most of his meager half-hectare plot to growing grass for the cattle, reserving only 0.15 hectares, which he says is "not suitable for growing grass," for a crop of groundnuts and two crops of rice that add up to 1.2-plus tons of grain, or just enough to feed his family of five.

Cau Le Huu, in nearby Xa Tan My village, has taken advantage of low-interest credit offered in recent years by the Vietnamese government for buying piglets and beef and dairy cattle. His excellent relationship with local agricultural extension staff has also ensured ample supplies of certified rice seed, advice on how to profitably grow high-quality seed for sale to neighboring farmers, help in choosing cattle breeds, and timely veterinary services to keep his herd healthy.

Successful enough to have appeared on local television as a model farmer, Huu feeds his eight cattle and five pigs rice straw and stems of groundnut and maize from his own crops, supplementing the feed with waste cassava he buys from others. He fertilizes his crops with both manure and chemicals, calculating that manure saves him more than $65 per crop per hectare and believing that it is better for his land than relying solely on chemical fertilizer. He recently replaced his wooden cattle stalls with concrete ones and is looking to buy more land.

Most mixed farmers are not so fortunate in enjoying strong support from agricultural extensionists and ready access to markets. Women in particular are underserved despite the demands placed on them. A 1999 survey of three villages in Cantho Province found that women provide 95% of the labor in animal raising, but only a third of them have special knowledge of animal care or diseases. The situation is similar in Cambodia.

VIETNAMESE rice farmer Cao Van Phuc and his wife stand beneath a polyurethane bag used to store manure-generated biogas, which provides enough cooking fuel for Phuc's entire family.

Other common constraints to small-scale integration of animals and crops are farmers' poverty and lack of credit, the variable quality and high prices for improved animal breeds, spotty availability of affordable feed, and markets that offer unstable prices and a lack of processing for animal products.

IRRI researcher Dr. Sombilla points out that, despite the global trend toward specialized agriculture, as recently as 1995, the Food and Agriculture Organization of the United Nations reported that half of all farm animals and their by-products came from integrated crop-animal systems. And smallholders still constitute the bulk of Asian agriculture, even in relatively prosperous Thailand. A factor driving the reemergence of integrated crop-animal systems in northern Thailand, in addition to rising demand, is a lifestyle trend that emphasizes back-to-basics organic agriculture and self-sufficiency.

"Farmers are changing their lives to stop unnecessary expenditure," says Dr. Suchint. "They're buying livestock to provide fertilizer for their crops, and they're using home-made gadgetry as working tools. They believe in self-sufficiency and sustainability, and they're gathering a lot of support. Some say that, within 10 years, such farmers will be a million strong. If they achieve that number, it will represent 20% of the farmers in northeastern Thailand. It remains to be seen whether 20% is a critical mass, capable of bringing about a general change in farming systems and lifestyles."

Yet, few agricultural scientists believe that updating traditional practices appropriate for smallholdings will fully meet the needs of urban consumers increasingly able to afford a rich, diversified diet.

"Commercial farms should be encouraged to fill most of the increasing market demand for meat and other animal products," urges Dr. Can. "At the same time, however, integrated crop-animal systems should be developed further as an effective way of sustaining food production among small farm households and improving rural living standards.

Adapted from Sharing Rice*, published by Sid Harta Publishers. See www.sidharta.com for purchasing information.*

MATTHIAS WISSUWA

TRADITIONAL rice varieties, like the one grown by this farmer in the Hindu Kush, may harbor useful genes for making hardier modern rice varieties that achieve higher yields under stressed conditions.

Opposites attract ... attention

Researchers zero in on two genes at opposite ends of the rice genome that provide tolerance for a dreaded duo of widespread stresses, high salinity and phosphorus deficiency

by Peter Fredenburg

Crop breeders have enjoyed remarkable success in breeding plant varieties that resist pests and diseases. As resistance is typically a qualitative trait—meaning that it arises from the effect of just one or a few genes—it is a much more straightforward breeding target than tolerance of such abiotic stresses as drought, salinity, acidity, aluminum toxicity, nutrient deficiency, extreme temperature, or submergence. Abiotic stress tolerance is almost always a quantitative trait, arising through the combined effects of several genes.

Yet, a few genes exist that, like resistance genes, individually confer a degree of abiotic stress tolerance, cracking open the door for researchers to breed these traits into popular cultivars. A collaboration led by the

International Rice Research Institute (IRRI) as part of the Generation Challenge Program—an initiative to use molecular biology to help boost agricultural production and, consequently, the quality of life in developing countries—is well along the way toward success with *Saltol*, a gene on rice chromosome 1 that confers salinity tolerance, and *Pup1*, a gene on chromosome 12 that improves the plant's uptake of the essential nutrient phosphorus. Although the two genes govern altogether different processes and occupy opposite ends of the rice genome (the sum total of the rice plant's genetic information, encoded in its DNA), they are closely linked in the fields where rice farmers struggle to make a living.

"Both salinity and phosphorus deficiency are widespread and often coexist, especially in the rainfed fields of the poorest farmers," explains Abdelbagi Ismail, the principal investigator of the project, whose avowed aim is to revitalize marginal rice lands. "Globally, more than 15 million hectares of rice lands are saline, and more than half of all rice lands are phosphorus-deficient. From the research perspective, we have a good understanding of the biology of tolerance of both stresses. And we are in the last stages of fine-mapping the location of the genes, both of which have clear-cut effects. We expect to have clones of both genes within a year or two."

Ismail explains that rice is particularly sensitive to salt stress during its seedling and reproductive stages. *Saltol* confers tolerance at the seedling stage, which is important for good crop establishment in coastal areas, where river water is brackish early in the growing season before seasonal rains weigh in.

"It's always safer to have salt-tolerant varieties in coastal areas," Ismail adds. "The Indian Ocean tsunami shocked us with its terrible destruction and loss of life. But the kind of damage that the tsunami caused to croplands is more routine than people realize. Saline flooding from relatively small storms destroys crops in the Indian state of Orissa every 2 or 3 years, most recently in September 2005. But such events rarely make the news."

The project's main aims are to isolate and clone *Saltol* and *Pup1*, validate their respective roles in salt tolerance and phosphorus uptake, facilitate their use in crop-breeding programs, and train national scientists in relevant molecular gene-discovery and breeding techniques.

The IRRI team mapped the location of *Saltol* by crossing Pokkali, a traditional cultivar from India that exhibits moderate salt tolerance, with the saline-sensitive variety IR29. Growing a population of eighth-generation inbred descendants with and without salt, the team was able to map the location of *Saltol* on the rice genome. Fine-mapping of the *Saltol* locus continues, using descendants of the hybridization that are almost genetically identical but differ by the presence or absence of *Saltol*.

The project's many participants, along with IRRI, include the University of California (Davis and Riverside), Australia's Commonwealth Scientific and Industrial Research Organization, Dhaka University in Bangladesh, the Indonesian Center for Agricultural Biotechnology and Genetic Resources and Research Development, Japan's National Institute of Agrobiological Sciences (NIAS), Iran's Agricultural Biotechnology Research Institute, and the Japan International Research Center for Agricultural Sciences—

ABDELBAGI ISMAIL (*holding rice*) describes to IRRI visitors how he screens rice plants for salinity tolerance.

LAURO ATIENZA

MATTHIAS WISSUWA (2)

IN PHOSPHORUS-DEFICIENT soil, the modern variety Nipponbare (*center*) fares poorly alongside the tall traditional variety Kasalath, the *Pup1* donor, and (*right*) an experimental line that received *Pup1* and is otherwise almost identical to Nipponbare. By transferring *Pup1* using the modern technique of marker-assisted selection, the researchers avoided carrying over unwanted genes that could have compromised Nipponbare attributes such as good grain quality. The corresponding grains from these varieties can be seen below.

where co-principal investigator Matthias Wissuwa, who left IRRI in 2005, continues his work on *Pup1*.

In fact, *Pup1* has been following Wissuwa around for years. Having started the project as a European Union science and technology fellow at NIAS in 1999, Wissuwa continued working on it when he arrived at IRRI in the Philippines as an international research fellow in 2002.

"It's good to be able to change jobs and keep working on the same thing," Wissuwa says. "What's exciting about *Pup1* is that it really does something positive in the field. We observed that plants with *Pup1* extract up to three times as much naturally occurring soil phosphorus. These plants can therefore fill a large portion of their phosphorus requirement without phosphorus fertilizers. This benefits the poorest rice farmers, who can't afford to buy enough fertilizer.

"And *Pup1* is one of the few cases where we're close to isolating the gene *and* have a clear picture of its phenotypic effects," Wissuwa adds. "Usually you have one or the other, not both."

As some traditional rice cultivars take up 20 times more phosphorus than other varieties, the project's mapping population descended from a cross of the tolerant traditional variety Kasalath with Nipponbare. *Pup1* is clearly associated with vigorous root growth, but the cause-and-effect question remains: Does strong phosphorus uptake spur root growth, or the other way around?

Either way, phosphorus uptake is closely linked to drought tolerance. As Wissuwa points out, a plant lacking phosphorus cannot grow long roots, but one with *Pup1* can. He is nevertheless careful not to oversell the gene he has been working for years to isolate.

"In an experimental background, *Pup1* triples the grain yield and dry weight," he says, referring to a standard measure of plant bulk. "But of course we test with susceptible varieties. We don't know how much *Pup1* will improve normal rice cultivars because we don't know if they already have it. If they don't, it should double their grain yield on severely phosphorus-deficient soils.

"In any case, phosphorus uptake is an important trait for rainfed fields and uplands," he continues. "The risk of phosphorus deficiency is higher there than in irrigated fields, and those farmers can rarely afford fertilizer. Another thing makes this research worthwhile — when you actually have the gene, you can use it in a very targeted way. You can even put it, for example, into maize."

After cloning, breeding a new gene into popular rice cultivars takes 2 years, with another year required to multiply enough seed to deliver the improved variety to farmers. Molecular breeding develops the product 4–6 years more quickly than conventional breeding, as well as providing greater understanding of the gene and, as Wissuwa points out, more options for its use. Finally, the clean and precise insertion of a single trait like those conferred by *Saltol* and *Pup1* saves additional time following delivery of the new variety to national programs.

"Adding only one trait to a familiar and popular variety accelerates its spread and adoption," Ismail explains. "In some cases, you may not need to go through the full release process, which normally takes an additional 3 years after delivery to national programs and multiplication of seed. When farm families are going hungry, or children can't go to school because their parents can't pay the fees, any time saved can make all the difference in the world to those individuals."

Adapted from Research Highlights 2005*, published by the Generation Challenge Program (www.generationcp.org).*

Drought perpetuates poverty

by Sushil Pandey and Humnath Bhandari

Drought is a major constraint to rice production in Asia, where at least 20% of the total rice area is drought prone. When rice is grown under rainfed conditions, both the area sown and the yield depend mainly on the available rainfall; any shortage in rains translates directly into production losses. Although most other natural disasters, such as floods and cyclones, result in visible and immediate loss of life and infrastructure, the effects of drought are creeping and long-lasting. It cripples the livelihoods of a large number of people, often trapping them in perpetual poverty. Even without the extremes of starvation and death, drought is a major economic and social burden that slows economic growth and makes escape from poverty enormously difficult.

A powerful example of drought's impact on rice production is seen in the zigzag trend in rice yields in Orissa, one of the major drought-prone states of eastern India (Figure 1). Almost every upward movement in rice yields is followed by major downswings, most of which are caused by drought. Orissa experiences drought once every three or four years and often in consecutive years. It is the severity and frequency of drought that largely account for the slow growth in rice production in Orissa over time, and similar patterns are seen in other drought-prone areas in eastern India.

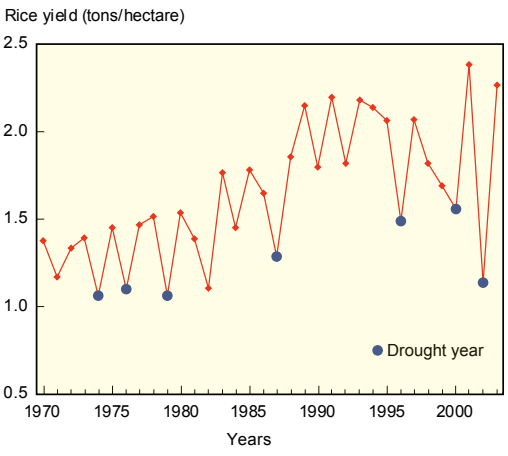


Figure 1. Trends in rice yield and major drought years, eastern India (Orissa), 1970-2003.

Drought results in production loss not only of rice and other crops grown with rice, but also of subsequent nonrice crops that require the rice fields' residual soil moisture. The value of production loss resulting from drought is indeed very large. In three states of eastern India—Chhattisgarh, Jharkhand, and Orissa—where rainfed rice is grown widely, the average production loss of rice during drought years is estimated to be 5.4 million tons—over 30% of the annual production in nondrought years (see *Dreams beyond drought* on pages 14-21 of *Rice Today* Vol. 4 No. 2). In severe drought years, the loss can rise to as high as 40–50% of normal production. When production losses of rice and nonrice crops are considered together with the costs farmers bear by adjusting their production system to try to cope with drought, the total annual economic loss in these three states alone is close to US$400 million.

And, as opportunities for farm employment dry up in the face of drought, so too do the incomes of farm laborers who rely on rice production for their wages. It is estimated that in Chhattisgarh, Jharkhand, and Orissa, almost 13 million people who sit perilously just above the poverty line fall back below it due to drought-induced income loss. Others already below the poverty line in nondrought years are pushed further down. Figure 2 illustrates this effect in Jharkhand. If drought occurs in consecutive years, the situation is even worse. As farmers go into debt and liquidate their productive assets—such as bullocks, farm implements, and even land—they are trapped even deeper within a poverty from which escape becomes more and more difficult.

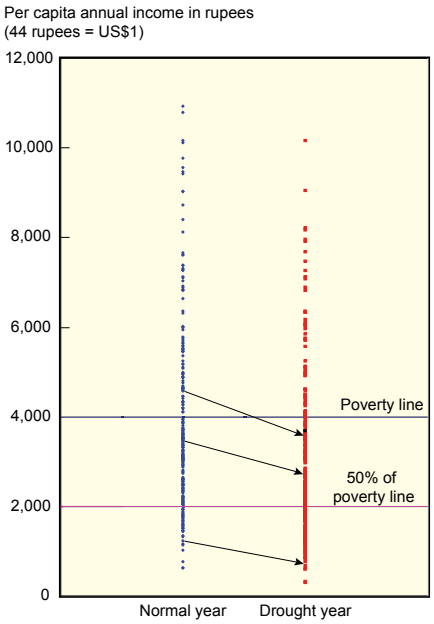


Figure 2. Effect of drought on poverty in eastern India (Jharkhand). Each point represents one person; the arrows show where individuals sit relative to the poverty line in a drought year compared with a nondrought year.

How can farmers avoid drought's worst effects? Improved technologies, such as drought-tolerant rice varieties, are important for reducing the grinding economic burden of drought. Such varieties are being developed, along with crop management options that improve plant recovery from drought and more efficiently use available water resources. Substantial scientific progress has been made on this front (see *Drought – what is IRRI doing?* on page 20 of *Rice Today* Vol. 4 No. 2). However, investment in agricultural research in almost every rice-growing country in Asia is too low given the benefits in poverty reduction that can be realized. Increased research investment, together with policy reforms that help raise and stabilize farm incomes, can substantially boost the prospects of eliminating the worst effects of this scourge of nature.

Sushil Pandey is deputy head, IRRI Social Sciences Division. Humnath Bhandari is a postdoctoral fellow at the Japan International Research Center for Agricultural Sciences. This article is based on a report by the authors prepared in collaboration with D Naik (Orissa University of Agriculture and Technology), R Sharan (Ranchi University), and SK Taunk and ASRAS Sastri (Indira Gandhi Agriculture University).

grain of truth

DAVID JOHNSON

WORK NEEDED TO WEED OUT FARMERS' PROBLEMS

Since land was first cultivated to create a favorable environment for crops, other less desirable plants have exploited the same land more effectively. Control of weeds has been described as humanity's biggest single occupation, and while herbicides have greatly reduced the effort needed to control weeds in some farming systems, in others, controlling them requires more labor than any other facet of crop production up to harvest. Weed control can also account for a significant portion of crop costs.

Many lowland rice systems—ranging from highly developed irrigated systems to hillside terraces—integrate several "cultural" weed control elements into crop management. Floodwater, on puddled fields, to suppress weed growth is the most widespread. Another, the transplanting of rice seedlings, gives the seedlings a size advantage over any germinating weeds and allows farmers to maintain floodwater and avoid draining the field, which stimulates weed germination. A third approach, thorough land preparation, involves repeated cultivation, which kills existing weeds and depletes the soil's "seed bank."

In many areas, however, water and labor shortages are forcing farmers into new approaches. Direct seeding of rice, for example, requires less labor than transplanting and water shortages lead to reduced periods of flooding. Further, reduced tillage systems allow farmers to save energy costs, which have risen steeply in recent years.

Any one field may be home to dozens of plant species other than the crop itself, though only a few of these are likely to be important weeds. Prevailing growing conditions will usually favor a small number of weeds, which may consequently cause serious problems. If a farmer changes the field conditions—by direct seeding or reducing flooding, for example—other species may become dominant. The composition of a field's weeds and soil seed bank reflect current and past crop management and farmers, particularly in traditional farming systems, often use certain species as indicators of the system's overall health.

In the modern systems of intensive rice cultivation and repetitive crop management, there may only be a very limited number of species occurring—often annual grasses that have similar growth habits to rice and are able to thrive under existing farming practices. Repeated use of a single set of crop and weed management components will commonly result in the "deflection" of the weed composition to a single weed species. Further, in some rice growing areas weeds have evolved resistance to regularly used herbicides, making them increasingly difficult to manage. To counter such problems, we need long-term weed management strategies that aim to prevent the buildup of problem weeds and to make the most of opportunities for cultural control.

In this light, knowledge of how the weed species react to different management practices over several seasons can be used to predict changes and avoid problems. Any change—such as a move from transplanting to direct seeding or from flooded to dryland conditions—will tend to favor a new set of weeds, while species that thrived in the previous conditions may decline in dominance. By anticipating changes in weed composition, farmers can alter their crop management in response to emerging problems and implement more effective weed management strategies. Further, by rotating through a series of management practices, farmers can limit the chance of species becoming dominant.

Farmers need knowledge-based crop and water management options to form the cornerstones of future weed control strategies

Crop management rotations have not yet played a role in many of the modern rice systems, but these may have a greater role in the future. Changing the timing and depth of flooding, altering soil tillage and crop establishment practices, direct seeding rather than transplanting, alternating rice with other crops, and varying herbicides are examples of management practices that can affect the composition of weeds and prevent the build-up of individual species.

Agronomists must better exploit knowledge of how different weeds respond to varying ways of managing a crop. Farmers need knowledge-based crop and water management rotations that can form the cornerstones of future weed control strategies. Weed management is an age-old problem but it remains as relevant and challenging today as ever, and it is one that we ignore at our peril.

David Johnson is a senior weed scientist in IRRI's Crop, Soil, and Water Sciences Division.

INTERNATIONAL RICE RESEARCH NOTES

BEST ARTICLE AWARDEES, INTERNATIONAL YEAR OF RICE 2004

M. Ashraf
W. Boonma
K. Coffey
B.N. Johri
Chunhai Li
R.A. Mann
S.B. Mishra
Tongmin Mou
C. Padoch
D. Panda
A. Pathak
M. Pinedo-Vasquez
Y.S. Ramakrishna
G. Nageswara Rao
A.V.R. Kesava Rao
G.G.S.N. Rao
D.N. Rao
A. Rashid
K. Rerkasem
D.L. Sanchez
R.K. Sarkar
A. Sharma
A.K. Sharma
S.G. Sharma
N.K. Singh
A.K. Singh
K.K. Singh
R.K. Singh
A. Sirabanchongkran
R. Thakur
S.S. Virmani
Junying Xu
M. Yasin
N. Yimyam

Thirty-four scientists from developing nations, working to feed the world's rice-eating population

IRRN @30 1976-2006

Now in its 30th year, International Rice Research Notes (IRRN)—the scholarly journal of the International Rice Research Institute (IRRI)—continues to offer scientists a wealth of information on the latest rice research

IRRN gives scientists from poor regions the chance to publish their findings and reach more than 4,000 readers from more than 100 countries worldwide

Join the 2006 winners' circle

The IRRN Best Article Award is now open for entries

Helping rice researchers advance and exchange rice-related knowledge and technology

- Open to all national agricultural research and extension systems rice researchers. Research must have been conducted in a developing country.
- There will be six winning papers from the six sections of IRRN: *plant breeding; genetic resources; pest science and management; soil, nutrient, and water management/environment; crop management and physiology;* and *socioeconomics/agricultural engineering.*
- The first author of each winning paper will receive a plaque and US$500 cash.
- The award ceremony will be held during the International Rice Congress in India in October 2006.

Deadline for submission: 30 June 2006

IRRN is published by IRRI twice each year and is available online at www.irri.org/irrn, where you can learn more about the IRRN Best Article Award and the mechanics of the competition. Winning entries will be announced in the October 2006 issue of Rice Today and published in the December 2006 issue of IRRN. For more information, email t.rola@cgiar.org.

To subscribe to IRRN, e-mail irripub@cgiar.org or fill out the enclosed order form and send by fax or post. Rice researchers can receive FREE subscriptions.

Science, technology, and trade for peace and prosperity

International Rice Congress 2006

Bringing together the international rice community to address emerging issues for the world's most important crop

9-13 October
26th International Rice Research Conference
Innovations for efficiency enhancement

10-11 October
2nd International Rice Commerce Conference
Product diversification, value addition, and business promotion

10-13 October
2nd International Rice Technology and Cultural Exhibition
Rice culture in agriculture

9-10 October
2nd International Ministerial Round Table Meeting
Fostering partnerships in rice research, development, and trade

Abstracts to be submitted by 30 June 2006

International Rice Congress 2006 is jointly organized by the Government of India (Ministry of Agriculture, Food Technology, and Cooperation through the Department of Agricultural Research and Education and Indian Council of Agricultural Research (ICAR)) and the International Rice Research Institute (IRRI).

For more information:
www.icar.org.in/irc2006
E-mail: rice2006@gmail.com

Pramod K. Aggarwal
Organizing Secretary of the IRC 2006
Fax: 91-11-2584-1866

Jagdish K. Ladha
IRRI-India office
Fax: 91-11-2584-1801

Duncan Macintosh
International Rice Research Institute
Fax: 63-2-845-0606
E-mail: d.macintosh@cgiar.org

IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

ICAR

The premier international event for the food that feeds almost half the planet