Rice Today

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Trade troubles in Thailand

Less water, more rice, happy farmers

Preparing for doomsday

After the storm

Bangladeshi farmers pick themselves up

Are high prices here to stay?

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IRRN International Rice Research Notes

goes open access this year

The *International Rice Research Notes* (*IRRN*), IRRI's longest-running serial publication, is ceasing print production and going open access in 2008 using Open Journal Systems (OJS).

OJS is a journal management and publishing system that was developed by the Public Knowledge Project (PKP) to expand and improve access to research and the quality of refereed research (http://pkp.sfu.ca/?q=ojs).

This open access initiative will improve the scholarly excellence of *IRRN*.

OJS is open-source software freely available to journals worldwide, which can speed up information delivery to end-users, allow real-time exchange of information between and among scientists, and improve the indexing and search capacities of the journal.

Watch for the launch of *IRRN* OJS in 2008!

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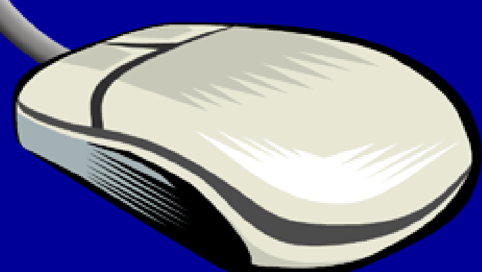
For more information about *IRRN* OJS, email t.rola@cgiar.org, d.martinez@cgiar.org, and k.s.lopez@cgiar.org.



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A rice market in Los Baños, Philippines, displays prices that are continuing to rise, stirring up turmoil around the world.

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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 13 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).

Weathering the perfect storm

> *"The food crisis is the result of specific failures in specific locations, for specific causes—usually weather or technology."*

These words were uttered more than 30 years ago by James Moomaw, the first agronomist at the International Rice Research Institute (IRRI). It was 1976 and Dr. Moomaw, then director general of the Asian Vegetable Research and Development Center, was discussing the world food crisis of the late 1970s (see page 41). Worryingly, his words are ringing true once again. Take, for example, comments by United Nations Secretary-General Ban Ki-moon in a 12 March 2008 article in the *Washington Post*:

> *"…we are also facing a perfect storm of new challenges.... The prices of basic staples—wheat, corn, rice—are at record highs, up 50% or more in the past six months. Global food stocks are at historic lows.... Food riots have erupted from West Africa to South Asia.... Fragile democracies are feeling the pressure of food insecurity.... In the here and now, we must help the hungry people hit by rising food prices. That means, for starters, recognizing the urgency of the crisis—and acting."*

We are not yet at the level of urgency of the 1970s, but the signs—the perfect storm, as Mr. Ban described it—are ominous. Declining rice stocks tell us that, for the first time in decades, the world is eating more than it is producing. Thailand and Vietnam—the world's two largest rice exporters—have capped exports at lower levels than previously to ensure domestic supplies. India has limited exports to high-grade basmati varieties only. China is taxing grain exports to encourage traders to keep food in the country. Steeply rising energy costs are hitting farmers. Increasing demand for meat from Asia's growing urban population is diverting production from food grains to animal feed. The rising thirst for biofuel is also starting to affect food production. Climate change threatens to further hamper production, especially in the developing world.

In the early 1970s, food prices spiked but then went on a steady 20-year decline. So we can relax, right? Higher food prices will encourage production and the price will come back down. Maybe, to a point. But the current situation is different from that of the 1970s in several ways.

In the late 1970s, we were in the midst of a decade or more of strong investment in technologies to improve food production. Technologies produced by IRRI and the International Maize and Wheat Improvement Center (CIMMYT), including high-yielding crop varieties, were just coming on line and countries were investing in irrigation that would enable these technologies to express their full potential.

And now? There has been a steady decline in investment in agricultural research over the last 15 years. Consequently, the pipeline that pumped out new products and technologies has been seriously depleted.

Nevertheless, new solutions are emerging. As people in first-world offices murmur about the new food crisis, IRRI and its national partners are introducing new flood-tolerant rice to farmers in Bangladesh, where millions are struggling to feed themselves after major floods and a cyclone demolished crops last year. At the same time, CIMMYT is developing and deploying drought-tolerant maize in Africa.

These are not overnight solutions: they take time and money. They also show what can be done when the support is there. Yet, precisely when all signs are pointing to mass hunger not seen for decades, many traditional donors are withdrawing investment in agricultural research.

If the current trends continue, it will not be the developing world's poor farmers and consumers who are to blame.

Adam Barclay
Editor

Rice prices spiral upward; no end in sight

As global rice stocks dwindle and prices rise to levels not seen since the 1970s food crisis, governments of rice-dependent countries are becoming increasingly anxious. Amid growing signs of civil unrest due to rising food prices in general, national leaders are hustling to ensure rice supplies for their populations.

To guarantee domestic supplies and keep local prices down, the world's two largest rice exporters, Thailand and Vietnam, have capped exports below previous years' levels. India has set a $1,000-per-ton minimum export price—effectively limiting exports to premium basmati varieties—and China is taxing grain exports in an effort to keep staple foods in the country.

In February, Philippine President Gloria Macapagal Arroyo took the unprecedented step of asking Vietnam to ensure rice supplies. In March, Thailand and Vietnam agreed to let the Philippines draw from their stocks in the Association of Southeast Asian Nations' emergency reserve. Thailand announced in late March that it would reserve some of its stockpile to be sold to consumers at cost price. The Philippine government has even asked fast-food restaurants to offer half portions of rice to prevent wastage.

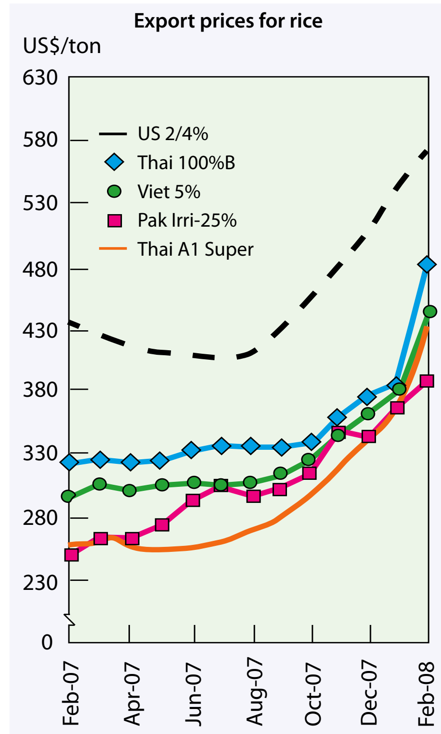
Several factors are conspiring to amplify the rise in prices. As rice land and irrigation water continue to be lost to industrialization and urbanization, Asia's burgeoning urban middle class, especially in India and China, is demanding more meat and dairy, which is diverting production from food grains to animal feed. Growing demand from Africa, where rice is an increasingly important staple—Nigeria alone now imports more than 2 million tons of rice annually—is pushing up prices; many African countries face difficulties in securing adequate supplies.

Weather- and pest-related problems have also helped force prices up. Insect and disease outbreaks in Vietnam, flooding and a major cyclone in Bangladesh, flooding in Indonesia, drought in the Philippines and Australia, and record-breaking cold weather in Vietnam and China—events that are expected to increase in frequency and severity with climate change—have all affected global production. Higher oil prices are both increasing the cost of food production and prompting many farmers to switch to biofuel crops, further reducing the area planted to food crops.

"The [rice] price will have to rise to the point where rice can compete, financially, with fuel crops," said Vichai Sriprasert, former president of the Thai Rice Exporters' Association. "I believe the domestic price of rice will triple, and will reach $1,000 per ton on the export market, just to catch up with oil prices."

The price increase is also hitting aid agencies, such as the United Nations World Food Program (WFP), which are being forced to scale down their operations at a time when—because of the high prices—the people they help are most in need of support. WFP officials warned in February that climbing food prices were pushing up the agency's budget requirements by several million dollars a week.

Although hoarding by traders may have contributed to the problem, "this is not all about speculation," said Sushil Pandey, agricultural economist at the International Rice Research Institute (IRRI). "Longer term demand-supply imbalance is clearly indicated by depletion of stock that has been going on for several years—we have been consuming more than we have been producing."



Source: FAO Rice Price Update March 2008

The current price rise is set against a background of ever-increasing population sizes and stagnating yield growth, compounded by a long-term withdrawal of government and donor support for public-sector agricultural research.

"Ultimately, however, achieving a supply-demand balance at a reasonable rice price will require a steady investment in development and dissemination of new technologies and improved management practices to raise rice yields and lower the unit cost of production," said Randy Barker, head of IRRI's Social Sciences Division.

IRRI Director General Robert Zeigler noted that, when the food crisis of the 1970s struck, new high-yielding rice varieties—products of the Institute's research after it was created in the 1960s—were already being distributed. "That success may have made governments complacent," said Dr. Zeigler. "Now, we're paying the price for decades of neglect of agricultural research."


RISING PRICES at a market in Los Baños, Philippines.

JOSE RAYMOND PANALIGAN

Quiet genes for better rice

A new tool that allows scientists to inactivate individual genes could help researchers develop improved rice varieties with favorable characteristics such as increased nutritional value and pest resistance.

With IRRI colleagues, scientists at the Max Planck Institute for Developmental Biology in in Tübingen, Germany, published their findings in March 2008 in the online journal *PLoS ONE* (www.plosone.org/doi/pone.0001829).

For crop breeders, "gene silencing," as the technique is known, is a key tool in the development of new varieties. The approach enables breeders to rapidly investigate the role of individual genes without having to perform lengthy cross-breeding experiments.

The new technique uses so-called microRNAs (miRNAs), short RNA molecules involved in regulating gene activity in both animals and plants (RNA is a form of nucleic acid, like DNA). The scientists constructed artificial miRNAs with sequences that correspond to a particular gene. The miRNAs degrade the rice plant's own messenger RNAs—molecules that correspond to genes and are involved in the synthesis of enzymes, regulatory factors, or other proteins. By degrading the messenger RNA, miRNAs prevent the expression of the gene in question. This is also a natural process in plants; the new technique allows researchers to easily target genes of interest.

As well as helping breeders to determine the function of genes, silencing can in itself also produce desirable traits. For example, it took the IRRI team just a few weeks to generate rice with a deactivated *Eui1* gene. Such plants have a taller top section, which facilitates the fertilization of neighboring plants and thus helps in hybrid rice production. Introducing the trait into other varieties using conventional breeding techniques originally took several years.

According to the researchers, the technique will allow breeders to inactivate genes of interest with unprecedented specificity. The team also anticipates that the method can be applied to other crops.

Rats wreak havoc


IRRI

Around 1 million people in Mizoram, in northeastern India, are facing famine following a rat plague that destroyed much of the state's rice crop. The rat population boomed after the flowering of a native species of bamboo—an event that occurs once each 50 years or so (for more, see *Preparing for the rat race* on pages 34-35 of *Rice Today* Vol. 6, No. 3). After exhausting the feast of bamboo seeds, the rats turned to the rice crop. Aid agencies have reported that many people have been forced onto a diet of wild roots, yam, and sweet potatoes. Only one-fifth of the state's monthly rice requirement is currently available. Worse, in early 2008, the rat plague moved into bordering areas of Bangladesh and Myanmar, increasing fears of widespread food shortages.

Funding paradox for IRRI

Several major donors have recently pledged support to IRRI at the same time that some traditional donors are withdrawing funding. The cuts will hit hard at a time when steeply rising prices and major production challenges are threatening food security for many of the world's poorest people.

Significant grants have recently come from the government of Japan ($5 million for flood tolerance in Southeast Asia), Germany's Federal Ministry for Economic Cooperation and Development in combination with the Eiselen Foundation ($1.6 million for salinity tolerance), the International Fund for Agricultural Development ($1.5 million for sub-Saharan Africa, in partnership with the Africa Rice Center), and the Biotechnology and Biological Sciences Research Council and UK Department for International Development ($1.5 million to develop rice resistant to climatic stresses, in partnership with the National Institute of Agricultural Botany.

In March, however, the U.S. Agency for International Development warned that it may cut funding to the network of Consultative Group of International Agricultural Research centers, including IRRI. Despite the new funding, support for public agricultural research has steadily declined over the past few decades—perhaps due to complacency after research investment in the 1960s and 1970s underpinned lower prices throughout the 1980s and 1990s.

BRIEFLY

High-protein rice

By crossing cultivated rice, *Oryza sativa*, with a wild species, scientists in the U.S. and India have developed high-protein rice, according to a study reported in the 23 January issue of the American Chemical Society's *Journal of Agricultural and Food Chemistry*. Crossing IR64, a popular cultivated variety, with wild *O. nivara* resulted in rice with a protein content of 12.4%. This is 18% and 24% more protein, respectively, than the parents. Protein enrichment in rice could help millions of poor and malnourished people in developing countries who depend on staple food for most of their nutrition.

Rodent ringtones

Former IRRI information technology head Paul O'Nolan has alerted *Rice Today* to an article in the 2 February issue of *The Economist*. The story, about the Internet in China, discusses the prevalence of mobile phones and the profits being made by selling ring tones and jokes for a few cents each to millions of people. A recent hit, generating more than US$10 million in sales, was "Mice love rice." Unfortunately, IRRI rodent experts confirm that this is all too true.

Euro import regulation eased

The European Union (EU) no longer requires member states to test upon arrival all imports of U.S. long-grain rice for the presence of the genetically modified Liberty Link (LL) Rice601 trait. The new regulation requires only that the rice be tested prior to shipment from the U.S. Only rice that tests

Gates Foundation steps up to support rice research

The Bill & Melinda Gates Foundation has awarded US$19.8 million to IRRI to develop technologies that can reach 18 million households with improved rice varieties and increase yields by 50% within 10 years.

The funding, to be granted over 3 years, aims to harness major scientific advances and address some of the biggest unsolved problems in agriculture. The project, *Stress-tolerant rice for poor farmers in Africa and South Asia*, will help develop and distribute improved varieties of rice that can be grown in rainfed ecosystems—where farmers have little or no access to irrigation—and withstand environmental stresses such as drought, flooding, and salinity.

Within 3 years, the project aims to have 300,000 farmers in South Asia and 100,000 farmers in sub-Saharan Africa adopt the initial set of improved varieties. The grant was part of a $306 million package of agricultural development grants announced on 25 January 2008 by Bill Gates, co-chair of the foundation, at the World Economic Forum in Davos.

IRRI/WARDA

PARTICIPANTS at the launch of the Africa component of the Gates Foundation project.

IRRI will work closely with other national and international agricultural research centers, including the Africa Rice Center (WARDA), which will be IRRI's main partner in implementing the project's African component. The project will also build the capacity of researchers and seed producers in poor rice-dependent countries. The new funding comes at a vital time for rice farmers, who are now facing major production pressures and rising prices that threaten Asia's continued economic growth.

"If we are serious about ending extreme hunger and poverty around the world, we must be serious about transforming agriculture for small farmers," said Mr. Gates.

IRRI's project will target the poorest rice farmers in Africa and South Asia, who have little or no access to irrigation and who are totally reliant on sufficient, timely rains. These farmers are regularly exposed to drought, flooding, or salinity—conditions that reduce yields, harm livelihoods, and foster hunger and malnutrition. With minimal access to irrigation and fertilizer, these farmers, who own small plots on marginal land, are inevitably most exposed—and most vulnerable—to poor soils, too much or too little rain,

JOSE RAYMOND PANALIGAN

IRRI SENIOR SCIENTIST Edilberto Redoña (*right*) shows seed packets to David Bergvinson, Bill & Melinda Gates Foundation program officer for global development, during his visit to IRRI in December 2007.

and environmental disasters.

IRRI Director General Robert S. Zeigler emphasized that, with climate change threatening to worsen the frequency and severity of these problems, the need for insurance—in the form of stress-tolerant crops such as flood-tolerant rice recently developed at the Institute—is growing increasingly urgent.

"Scientists have been confounded by the challenges of stress tolerance for decades," said Dr. Zeigler. "But the rice-science community in general and IRRI in particular have recently taken significant steps forward through precision breeding to develop stress-tolerant varieties."

The project was officially launched in March at meetings at WARDA, in Cotonou, Benin, and at the National Agricultural Science Center in New Delhi, India.

negative at the 0.01% level of detection is permitted to be shipped. U.S. rice exporters hope that the change will help them re-establish the EU market.

Chinese honor for IRRI

IRRI has been named as a recipient of the Chinese International Award for Science and Technology. The award, recommended jointly by the Chinese Ministry of Agriculture and hybrid rice expert Yuan Longping, recognizes the Institute's efforts in scientific research and training for Chinese agriculture.

New journal

Japan's National Institute of Agrobiological Sciences (NIAS), in collaboration with Springer Publishing Co., recently announced a new international scientific journal, *RICE*, which aims to fill a glaring void in basic and applied plant science publishing. The journal, due to be launched in mid-2008, will be the world's only high-quality serial publication for reporting advances in rice genetics, structural and functional genomics, comparative genomics, molecular biology and physiology, molecular breeding, and comparative biology.

Aroma boost patented

Researchers who identified a compound responsible for aroma in rice have been awarded a U.S. patent for a method they subsequently developed for increasing fragrance. The team, from Thailand's Kasetsart University, was granted the patent—also filed in Australia, China, Philippines, Thailand, Japan, Vietnam, India, France, and the European Patent Office—in November 2007.

New research director at IRRI

Achim Dobermann, an internationally recognized agricultural research scientist with many years' experience working with rice in Asia and Europe, has been appointed as IRRI's new deputy director general for research. Already at IRRI as leader of the Institute's program on *Sustaining productivity in intensive rice-based systems: rice and the environment*, Dr. Dobermann began his new role on 1 April 2008.

After beginning his career as a soil scientist, Dr. Dobermann expanded his research interests to cover a rich array of crop and social sciences. He is a Fellow of the American Society of Agronomy and Soil Science Society of America, and recipient of numerous national and international awards.

Dr. Dobermann received his Ph.D. from the Institute of Tropical Agriculture, University of Leipzig, Germany. After working at IRRI from 1992 to 2000, he moved to the University of Nebraska (Lincoln) in the U.S. and rapidly rose to the rank of full professor. During his time in Nebraska, he maintained strong research linkages with East, Southeast, and South Asian colleagues.

T.P. Tuong, who served as interim deputy director general for research following the departure of previous deputy director general for research **Ren Wang**, returns to a senior research role in IRRI's Crop and Environmental Sciences Division.

Achievements

Former IRRI principal scientist **Sant Virmani** has won a Padma Award, given to Indian citizens to recognize distinguished public contributions. Dr. Virmani, recognized in the science and engineering category, was among 71 eminent Indians who received Padma Awards on 25 January 2008.

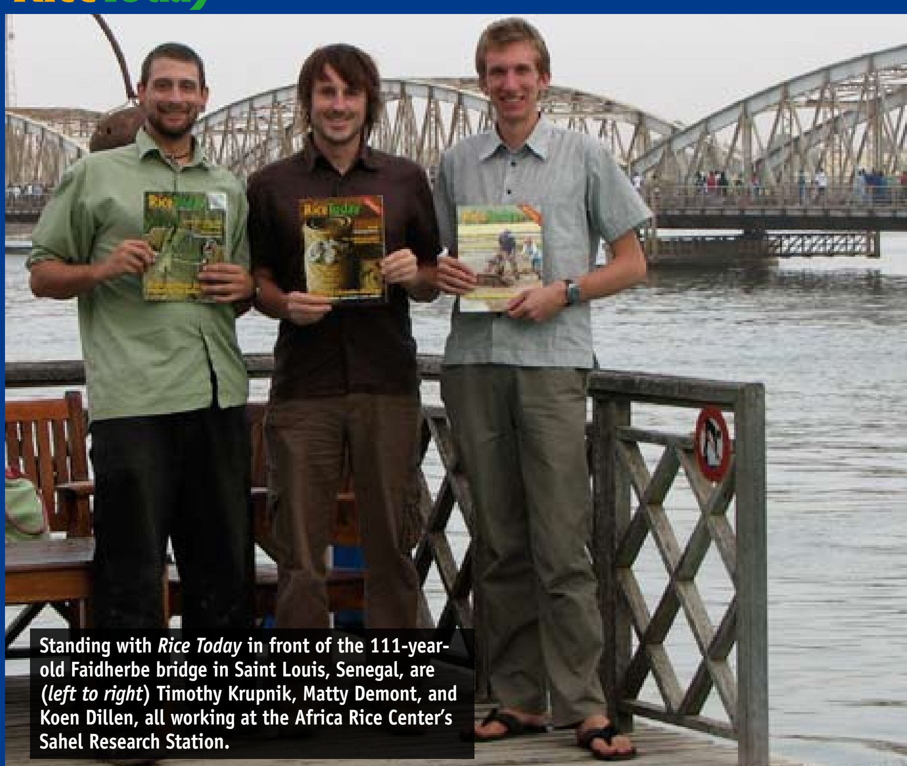
Niranjan Baisakh, former IRRI Ph.D. scholar and postdoctoral fellow in PBGB, has won a Tipton Team Research Award from the Louisiana State University Agricultural Center, along with his colleagues from the Center's School of Plant, Environmental, and Soil Sciences. The team was recognized in December 2007 for its work in developing coastal plants to aid in coastal reclamation projects.

Moving on

Ray Wu, professor at Cornell University in New York and one of the fathers of genetic engineering, passed away in Ithaca, New York, at the age of 79. A professor of molecular biology and genetics, Prof. Wu used biotechnology to develop high-yielding rice varieties resistant to pests and tolerant of drought, salinity, and temperature stresses. Born in Beijing, Prof. Wu moved to the United States in 1948.

L. Dale Haws, a former crop production specialist at IRRI (1974-85), died on 4 January at the age of 81 in Logan, Utah. **Rosendo Palis**, who served as IRRI's agronomist and liaison scientist to Burma (now Myanmar) from 1980 to 1993, died on 21 February in Sacramento, California, at age 73.

Rice Today around the world

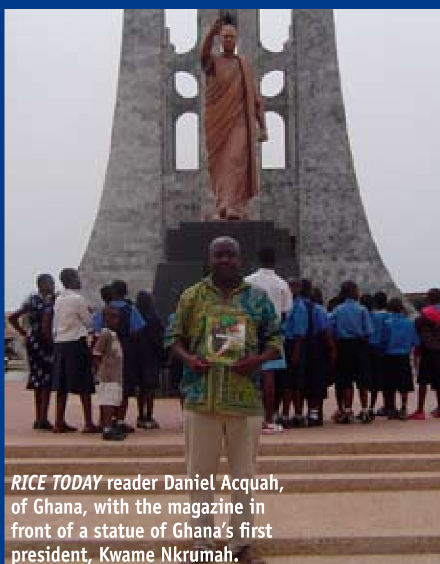


Standing with *Rice Today* in front of the 111-year-old Faidherbe bridge in Saint Louis, Senegal, are (*left to right*) Timothy Krupnik, Matty Demont, and Koen Dillen, all working at the Africa Rice Center's Sahel Research Station.

MIKE JACKSON, IRRI director for program planning and communications, with his submergence-tolerant *Rice Today* T-shirt at Anilao, Philippines.

GLENN GREGORIO, IRRI rice breeder for Africa, takes *Rice Today* up Mt. Cameroon, the highest mountain in West Africa at about 4,000 meters.

MICHAEL BOSCH, senior advisor for Germany's Advisory Service on Agricultural Research for Development, with *Rice Today* in front of Swayambhunath stupa, one of the most ancient and holiest Buddhist sites of the Kathmandu Valley in Nepal.



RICE TODAY reader Daniel Acquah, of Ghana, with the magazine in front of a statue of Ghana's first president, Kwame Nkrumah.

MARIA HETTEL, seen here in front of Tower Bridge, takes *Rice Today* to London, England.

Keeping up with IRRI staff

Samarendu (Sam) Mohanty has been appointed head of IRRI's Social Sciences Division (SSD), effective 1 June 2008. Dr. Mohanty, an agricultural economist, moves from his position as associate professor in the Department of Agricultural and Applied Economics at Texas Tech University in the U.S. Before moving to Texas, he worked for 5 years at the Center for Agricultural and Rural Development at Iowa State University.

Elizabeth Woods, Australia, became chair of the IRRI Board of Trustees (BOT) on 1 January 2008, replacing outgoing Chair **Keijiro Otsuka**, Japan, who had served on the Board since 2002. Also joining the BOT on 1 January were new members **Mutsuo Iwamoto** (Japan), **Seong-Hee Lee** (Korea), and **Achmad Suryana** (Indonesia).

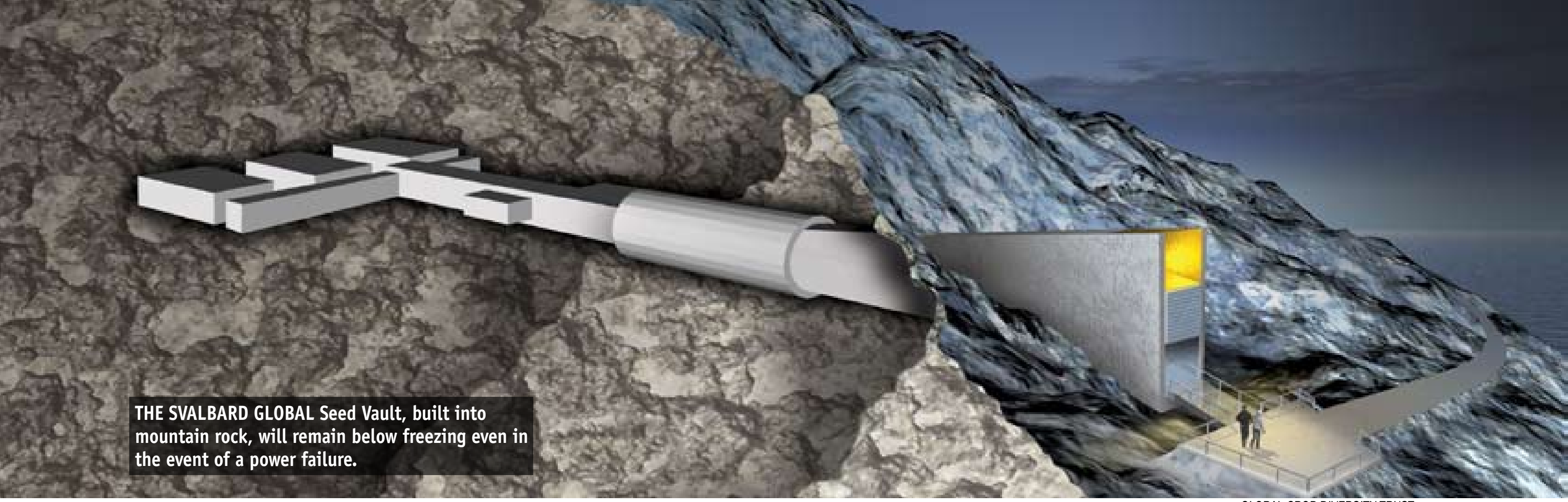
In March 2008, IRRI bade farewell to **Philippe Hervé**, molecular biologist in the Plant Breeding, Genetics, and Biotechnology Division (2005-08). Dr. Hervé played a key role in upgrading the Institute's facilities for rice biotechnology and established collaborative ties with advanced research institutes.

Also departing in March was **Deborah Templeton**, impact assessment specialist in SSD (2005-08). Dr. Templeton helped IRRI scientists develop impact-focused research projects and undertook impact assessments of IRRI projects.

Senior molecular biologist **John Bennett** left IRRI in December 2007 (find out more about Dr. Bennett in *Where science meets art* on pages 17 to 19 of *Rice Today* Vol. 6, No. 4). Entomologist **Yolanda Chen**, who performed innovative research to integrate ecology and host-plant resistance in rice stem borer management, also left in December.

In February 2008, the Institute welcomed new staff members **Martin Senger**, who will work as bioinformatics software project manager in the Crop Research Informatics Laboratory, and postdoctoral fellow **Jacob van Etten**, who joins the geographic information systems unit of SSD. **Digna Manzanilla** joined SSD in January as a postdoctoral fellow under the Japan-IRRI Submergence Project.

Bas Bouman became the new division head of Crop and Environmental Sciences Division on 1 January 2008, with an initial appointment for 5 years. **Edwin Javier**, former coordinator of the International Network for Genetic Evaluation of Rice at IRRI (1999-2006), became international variety development coordinator at the Asian Vegetable Research and Development Center in March.



THE SVALBARD GLOBAL Seed Vault, built into mountain rock, will remain below freezing even in the event of a power failure.

GLOBAL CROP DIVERSITY TRUST

The ultimate backup

The Svalbard Global Seed Vault, designed as a last-resort backup for Earth's most important crops, has accepted its first samples, including more than 70,000 different types of rice

On Monday 21 January 2008, flight LH3134 left Manila, Philippines, for Oslo, Norway, counting more than 35 million grains of rice among its cargo. Headed not for Scandinavian dinner plates, these grains would continue on to the Norwegian island of Svalbard, north of the Arctic Circle, only 1,000 kilometers from the North Pole.

The seeds, from the International Rice Genebank of the International Rice Research Institute (IRRI), represented 70,180 samples of traditional and modern rice varieties and their wild relatives bound for the newly constructed Svalbard Global Seed Vault. In total, more than 200,000 crop varieties from Asia, Africa, Latin America, and the Middle East—drawn from seed collections maintained by centers of the Consultative Group on International Agricultural Research (CGIAR)—were shipped to Svalbard.

CIP

ATTENDING THE OPENING of the Svalbard vault were (*left to right*) Dr. Zeigler, International Potato Center Board Chair Jim Godfrey, and Global Crop Diversity Trust Executive Director Cary Fowler.

IRRI's contribution included the first box placed in storage by Norwegian Prime Minister Jens Stoltenberg and 2004 Nobel Peace Prize Laureate Wangari Maathai during the vault's opening ceremony on 26 February 2008. Prime Minister Stoltenberg described the vault, which cost around US$9 million to build, as "a Noah's Ark for our biological heritage."

The facility—dubbed the "doomsday vault" by the world's media—is owned and administered by the Ministry of Agriculture and Food on behalf of the Kingdom of Norway and was established as a service to the world community. The Nordic Gene Bank will operate the facility and maintain a public online database of samples.

Constructed in the permafrost of the Svalbard mountains, the vault is designed to store duplicates of seeds from seed collections around the globe. Ruaraidh Sackville Hamilton, head of the International Rice Genebank, said that the new vault provides the "ultimate safety backup, located where all risks—political, geological, climatic—are extremely low."

He added, "For long-term survival, seeds need to be stored at low temperature. This is most economical in a place like Svalbard, where the ambient temperature is low and the insulation is high."

Further, he said, the risks faced by IRRI and Svalbard are not just independent but almost mutually exclusive. It is almost inconceivable that any risk could simultaneously destroy the two copies of the collection.

Svalbard Global Seed Vault: the numbers

The vault is located 120 meters into the rock, ensuring that the vault rooms will remain naturally frozen even if the mechanical cooling system fails or if external air temperatures rise because of climate change.

The distance from the front door of the portal building to the back of the vault is 145.9 meters. The width of each vault is 9.5–10 meters and the height is 6 meters. Each vault is approximately 27 meters long.

The vault has the capacity to store 4.5 million seed samples. Each sample contains an average of 500 seeds, so a maximum of 2.25 billion seeds can be stored. The seeds will be stored at minus 18 degrees Celsius in specially-designed four-ply foil packages that will be placed in sealed boxes. The low temperature and low moisture level will ensure that the seeds stay viable for decades, centuries, or even thousands of years.

IRRI itself holds the world's largest and most diverse collection of rice: nearly 110,000 accessions from 123 countries—around 20% of the total holdings of rice conserved in all genebanks around the world.

Rice agriculture depends on the vast diversity seen in the rice genebank. If a new rice disease appears, researchers can search the genebank for resistant varieties. The genes required to make rice more tolerant of drought, for example, exist within the varieties contained in the collection. The genebank contains the genetic diversity we need to respond to changes in climate, consumer expectations, agricultural technologies, and government priorities.

"Any new rice research project or rice breeding program typically starts with a scientist asking the seed bank to supply the types of rice required for their research," said Dr. Sackville Hamilton.

The immeasurable value of seed banks has been seen many times in the past. One notable example is the use of Cambodian rice varieties stored in IRRI's genebank to re-establish Cambodia's rice industry after it was devastated during years of civil strife in the 1970s, when a starving population ate the nation's seed stocks.

"The CGIAR collections are the 'crown jewels' of international agriculture," said Cary Fowler, executive director of the Global Crop Diversity Trust, which covered the costs of preparing, packaging, and transporting CGIAR seeds to the Arctic and will provide support for ongoing operations. "They include the world's largest and most diverse collections of rice, wheat, maize, and beans. Many traditional landraces of these crops would have been lost had they not been collected and stored in the genebanks."

DR. SACKVILLE HAMILTON helps load IRRI seeds in preparation for the flight to Svalbard.

JOSE RAYMOND PANALIGAN

IRRI Director General Robert Zeigler, who attended the vault opening, pointed out that Svalbard was neither built to make up for low standards nor an excuse to lower existing standards.

"If we assemble all the world's crop diversity in Svalbard and use that as an excuse to stop conserving it elsewhere, we'd be in an even worse situation, since then all available diversity could be destroyed by a single event," said Dr. Zeigler. "Moreover, the seeds in Svalbard are not accessible to anyone except the depositor. To realize the potential benefits of crop diversity, our farmers, scientists, and breeders must be able to use the seed easily. Seed banks such as IRRI's must therefore be maintained at locations around the world where they are most needed."

IRRI's collection is itself protected to the highest possible standards. The facility is raised above flood levels and is designed to withstand an earthquake of up to 7 on the Richter scale or a nuclear accident in a warship in Manila harbor 60 km away. IRRI has two levels of electricity backup—one set of generators for the whole Institute and one specifically for the genebank. To address the risk of equipment failure, the Institute maintains backup systems, for example, using two compressors for cooling, so that, if one fails, the second takes over. Spare parts of all key operational components are kept on-site.

"The high standard of construction and protection was confirmed during the devastating Typhoon Milenyo of October 2006, which caused severe damage to the Philippine national seed bank situated a few kilometers away but left our facility unscathed," said Dr. Sackville Hamilton.

Despite this, Dr. Sackville Hamilton cautioned that it is impossible to protect against all threats, which is why Svalbard is one—but only one—of the essential elements of a global system for the efficient and effective conservation and use of crop diversity.

"For such an important collection, we have to take all risks, no matter how remote, into account," he said. "For example, news of political unrest is common in the capital city Manila, and in the southern island group Mindanao. Might this political activity one day escalate to threaten IRRI? It is unlikely but who knows? We are close to an inactive volcano, Makiling. Might this volcano one day erupt again? Might we suffer a force-10 earthquake one day? The evidence suggests not in the near future, but even expert volcanologists and seismologists cannot guarantee zero risk, and they cannot make long-term predictions."

Among the VIPs and dignitaries at the vault's opening, Eulogio "Tay Gipo" Sasi Jr., a 64-year-old Filipino rice farmer, represented the people without whom all the seeds in the world would be of little use. "I hope that the knowledge that goes with the seeds will not just be stored in ice," said Tay Gipo, addressing the international audience, "but further enriched by giving support to the work of farmers."

Making it happen

Preparing for the Svalbard opening involved an enormous amount of hard work by many people for many months. IRRI staff who made the shipment possible are listed below.

Flora de Guzman	Melencio Lalap
Lydia Angeles	Alicia Lapis
Imelda Boncajes	Juan Lazaro IV
Nerissa Boonggaling	Wilma Lumaybay
Priscila Cabral	Yolanda Malatag
Jane Carandang	Gilbert Mamiit
Isabelita De Mesa	Veronica Mangubat
Minerva Eloria	Violeta Manila
Aurelio Gamba	Bernardo Mercado
Evangeline Gonzales	Bogs Panaligan
Patria Gonzales	Roniella Prantilla
Minerva Gulde	Jacqueline Ragudo
Emerlinda Hernandez	Renato Reaño
Carlos Huelma	Digna Salisi
Jose Ibabao	Teresita Santos
Ariel Javellana	Anthony Telosa
Nora Kuroda	Liza Yonzon

Rice forum examines key policy issues

JOSE RAYMOND PANALIGAN

THE RISE of rice prices was a key item on the agenda of the rice policy forum at IRRI

Increasing rice productivity is the only long-term solution that can provide high returns to farmers while keeping the price of rice low for poor consumers. This was the consensus of participants at the *Forum on rice policy research: key issues from national perspectives*, held at the International Rice Research Institute (IRRI) in Los Baños, Philippines, on 18-19 February 2008.

The forum, held in the midst of rice-price rises not seen since the 1970s, aimed to identify key policy issues relevant to the rice industry from the perspective of national systems, prioritize the identified policy issues for research, establish a network of rice policy researchers, and develop a collaborative arrangement for conducting policy research on high-priority issues.

Senior policy researchers from Asia (Bangladesh, China, India, Indonesia, Nepal, Philippines, Thailand, and Vietnam) and Africa (Mozambique and Tanzania) attended the forum along with representatives of the Africa Rice Center (WARDA), the Food and Agriculture Organization of the United Nations, and the private sector. Sixteen papers were presented on various aspects of rice policy, and a panel discussion on the implications of rising rice prices was held.

The participants largely agreed that rice is seen by most governments as a "political" commodity although the national perspectives on rice policy issues varied among countries depending on national incomes and the performance of the rice industry. Most countries viewed the world market as "thin and unstable," meaning that a relatively small percentage of total rice produced is bought and sold internationally, and that export prices are prone to large swings. Thus, governments mostly seek a high degree of self-sufficiency.

Given this broad scenario, policy tools to promote the rice industry in different countries were discussed. The policy research agenda identified during the forum included assessment of allocation of resources for research and development, analysis of comparative advantage in rice production in different countries and rice-growing environments, policies to provide adequate returns to farmers while keeping the rice price low for consumers, provision of safety nets for the poor, and reorganization of agriculture for greater efficiency.

Although the current rising rice price was seen as beneficial for farmers who grow a reasonable surplus that they can sell on the market, poor farmers with small or no surplus and poor urban consumers will continue to lose out if the price continues to rise.

Mahabub Hossain, executive director of the Bangladesh Rural Advancement Committee, pointed out that marginal farmers—who are net buyers of rice—are also hurt by increasing fertilizer and pesticide costs, which are climbing in line with rising energy costs.

According to forum organizer Sushil Pandey, who leads IRRI's Rice Policy and Impact Program, prices are likely to continue to rise for some time.

"Longer term demand-supply imbalance is clearly indicated by depletion of stock that has been going on for several years," said Dr. Pandey. "We have been consuming more than what we have been producing and research to increase rice productivity is needed to address this imbalance."

The importance of research into technologies that boost productivity was underscored by Randy Barker, head of IRRI's Social Sciences Division. "Even before the spike of prices in the 1970s, high-yield variety technology was well under way to widespread adoption," said Dr. Barker, who emphasized that effective research and development requires long-term planning.

One implication of this, according to Leo Sebastian, executive director of the Philippine Rice Research Institute, is the need for increased investment in agricultural research.

"Impact of technologies is a driver of increased rice production, whether a country exports or imports," said Dr. Sebastian. "But everybody is saying that investment in agricultural research is small or limited—and something needs to be done about this."

Dr. Pandey said that the Institute has identified technological and policy opportunities and challenges for addressing the rising rice prices. "We are tackling the issue head-on by developing and promoting interventions to increase the productivity of the rice industry," he said.

The forum participants agreed to establish a network of rice policy researchers to facilitate rapid exchange of ideas and information. The network will develop linkages with the existing agricultural policy networks in Asia and Africa. Proceedings of the forum are expected to be published by the end of 2008.

Troubling trade

It would be easy to think that the escalating price of rice is a boon for exporters—but, in a Thailand exclusive, Rice Today *reports on the chaos that has Thai traders reeling*

Story and photos by Bob Hill

International rice trading is not a business for the faint-hearted.

Thailand's exporters knew that well. They also knew, when they prepared in November 2007 for what was supposed to be a boom year ahead, that prices were likely to rise. Little did they realize how steep that rise would be.

Poor weather and domestic supply concerns had severely restricted competition on the world's markets from Vietnam and India, Thailand's main export rivals. China, Egypt, and Australia had also restricted their rice exports. So, 2008 amounted to a one-horse race, and, as the 2007 harvest began to roll in from the fields, Thailand's exporters began their wheeling and dealing, with buyers clamoring at the door.

"You can only make money if you speculate properly," says veteran exporter and former president of the Thai Rice Exporters' Association Vichai Sriprasert. "At the time of the deal, we expect to make $5 a ton. Nobody has 100% of the stock in hand. We hope to buy the rest. If I end up making $1 per ton, then I'm happy with that."

It was their forward-orders practice that let them down, in a sellers' market the likes of which they had never experienced before. Local and export prices were soaring, even as they struck their deals to deliver in three or four months' time, when they still had to buy the rice they had just sold. In some cases, the small profit margins they were happy to accept disappeared within a few hours. Then, they could only watch in despair as the spiraling prices battered at their solvency. In order to honor their commitments, some were forced to buy milled rice at a ruinous US$200 per ton more than they had agreed to sell it.

PARBOILED RICE is loaded at a riverside dock in Bangkok. It will be hauled down the Chao Phraya River to the Gulf of Thailand, to be loaded aboard cargo ships bound for Africa.

THAI RICE Exporters' Association Secretary-General Korbsook Iamsuri (*right*), who is also chief executive of the Kamolkij Group of companies, oversees the sealing of bagged parboiled rice bound for Nigeria and Benin in Kamolkij's Bangkok plant.

In the few months from November to February, 30 to 40 exporters, many of them among the country's most experienced traders, lost an estimated $128 million.

Worse still, supplies of paddy (unmilled rice) all but dried up in late February, leading to claims that farmers and millers were hoarding it to speculate on even higher prices. The government ordered an official check of its own stocks after the discovery that 12,000 tons of paddy had "disappeared" while in the storage custody of millers, and exporters scoffed that 12,000 tons was the tip of a very large iceberg. The accusations rumbled back and forth through a shell-shocked industry, bleeding on the one hand and profiting on the other. At the same time that many exporters faced heavy losses, farmers, local paddy traders, and many millers profited like never before.

Unable to find supplies and badly scared, many of Thailand's smaller exporters withdrew from trading in March, to brood and wait for the second crop to come in, later that month and in April. Others cautiously accepted orders no more than one month in advance.

Had they kept an eye on world food prices, they might have been forewarned. The price of wheat has doubled since April 2007 and the food price index of the United Nations' Food and Agriculture Organization climbed by almost 40% in 2007. Demand is outpacing supply and the world's stocks of cereals like rice are dwindling to the point at which they can no longer provide an effective buffer in years of poor production.

Although population growth is the fundamental cause, the production and pricing problems are also partly due to weather problems linked to climate change as well as rising oil prices boosting demand for biofuels. Changing diets in fast-developing countries such as China are also a factor, with more land needed to raise livestock to meet increasing demands for meat.

"The force of the technology that created the Green Revolution has run out," says Mr. Vichai. "World stocks of rice have been falling for 4 or 5 years, and consumption of rice exceeds production. This is a very dangerous situation. We need a new level of technology in the rice fields of the world, so that we can meet the demand."

In 2007, Thailand exported about 9.5 million tons of rice. In the 4 months from November 2007 to February 2008, exports accelerated to 1 million tons per month—well above the expected monthly rate of 800,000 tons. Some of Thailand's biggest firms, such as CP Intertrade, part of the giant Charoen Pokphand conglomerate, say that rice exports will bring them a bonanza. Other big firms that bought rice at auction from the Thailand government's stocks and were still holding sizeable amounts also raked in big profits in the early months of the year. Smaller exporters simply didn't have the money to do that.

The Thailand government has set a target of 8.75 million tons for rice exports this year, and a senior government official close to the rice trade says he is "quite positive" the target will be reached.

The country has about 400 licensed rice exporters. Of these, 185 belong to the Thai Rice Exporters' Association, and, according to its secretary-general, Korbsook Iamsuri, this group accounts for more than 80% of the country's rice trade.

The association says that, in the 3 months from 6 December 2007 to 12 March 2008, the f.o.b. prices of major Thai export grades of rice rose way beyond expectations. The price of 5% white rice rose from $348 to $544 per ton; Hom Mali 100% B climbed from $606 to $771; parboiled 100% went from $380 to $604; and broken A1 super rose from $321 to $512. At last report, the pace of the escalation was undiminished. (f.o.b. stands for "free on board," which means the seller bears the cost of loading goods onto a ship or other form of transport, at a given port or point of departure.)

Making the trading position of Thai exporters much more difficult is the need to conduct all transactions in U.S. dollars. Not only is the dollar growing weaker, but their home currency, the Thai baht, is appreciating against the dollar and showing no signs of slowing down. In January 2006, one U.S. dollar bought 40.77 baht; in January 2007, 35.55 baht; and in mid-March 2008, just over 31 baht. As difficult as making a modest profit has become, it is often further eroded by a volatile exchange rate.

"The exporters are scared," admits the government official, who asked not to be named. "They must wait and see what happens. Meanwhile, there is speculation and hoarding. The exporters can't buy rice, so this is a difficult time for exporters and millers. The farmers think prices will continue to rise."

Normally, the annual crop totals 18 to 19 million tons of milled rice. Nine million tons are consumed domestically, eight or nine million tons are exported, and the rest is held in stock.

"We don't know where the 2007 harvest is," complains Ms. Korbsook. "At this time last year, I could buy 100,000 bags per day without any trouble. Today, I'm lucky if I can get 10,000 bags." She accuses farmers and millers of hoarding stocks to speculate on higher prices. "They should be selling it now, if they're going to sell it at all, because they're getting a 500% markup. But nothing is hitting the market. It's madness!"

Ms. Korbsook is also chief

PARBOILED RICE rolls out of the Bangkok plant of the Kamolkij Group of Companies, bound for Nigeria and Benin, in Africa.

MS. KORBSOOK is chief executive of the Kamolkij Group of companies, which claims to be the world's largest exporter of parboiled rice.

executive of the Kamolkij Group of Companies, having taken over the family firm from her father. It claims to be the world's largest exporter of parboiled rice (which is soaked and steamed before milling), shipping 400,000 tons per year to markets such as Nigeria and India.

In an effort to shift the paddy onto the market, the exporters' association has urged the government to set aside its controversial price intervention program, a move it says would save Thailand billions of baht per year. The association suggests that, without a price guarantee as a psychological backstop, farmers may opt to sell, easing pressure on domestic prices and dealing with the current supply shortage.

The price intervention program has existed for some years, but began to play a significant role in the country's rice production and marketing system as one of the early "populist" policies of the deposed Thaksin administration. Since the military takeover in September 2006, guaranteed prices have sunk far below market prices. But, since the election of the new government in December last year, populism is once more a driving force in Thai politics.

Under the scheme, farmers can opt to sell to the government at a guaranteed price or sell to traders or millers if they can make more money. In years of low market prices, the program has seen the government gather huge stocks of up to five million tons, spread around the country in countless warehouses, many of them privately owned. The stocks have then been sold from time to time by an electronic auction system. In March, the government's stocks were officially 2.1 million tons.

The exporters' association warns that, if the new government uses the program to once again set high guaranteed prices, it will affect both local and export markets.

The intervention scheme has encountered many problems, the least of which were claims that rice entering the program had been mixed, with lower-graded rice mixed with premium grades. This led not only to extensive accusations but also to widespread DNA testing to ensure that buyers were getting what they paid for.

There have also been repeated claims that quantities of government stocks being held in private storage have "gone missing."

Ms. Korbsook dismisses the program as riddled with corruption and losses, and says that quantities of rice have been sold, switched, or mixed. "Maybe the politicians have benefited," she says, "but it means that the farmers don't go for quality. They can sell anything at all at the guaranteed price. It discourages improvement. The farmers don't care when the market needs better quality."

"In theory," concedes the government official, "it is not good, because we should let supply and demand work. We shouldn't intervene in the market.

"But realistically, the program is suitable for the character and circumstances of Thailand. Developed countries subsidize their farmers directly, but we don't have that much money. We have 3.6 million farming families in rice alone, so we can't afford subsidies. We don't put a lot of money into this intervention. We absorb some surplus quantities."

"They keep the rice everywhere," says Mr. Vichai. "Private millers are holding a lot of it, and the millers sell the paddy belonging to the government first. When the government releases stocks, they scramble to replace it, and instead of the price going down, it goes up!"

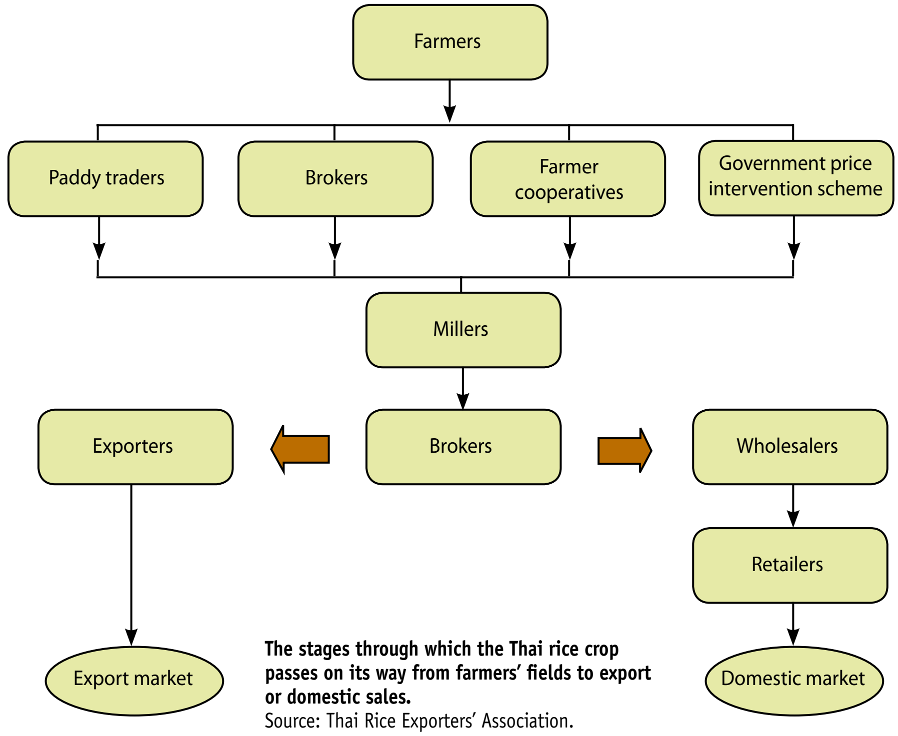
The exporters are also quick, in their current frustration, to refute the notion that middlemen have consistently squeezed farmers dry. Mr. Vichai, whose company, Riceland International, began in the tough times of the Great Depression of the early 1930s and who took over from his father after studying economics in the U.S., says that, even in the best of circumstances, the profit margins of rice exporters are figured in fractions of 1%. Thai farmers, on the other hand, often make 100% percent profits on their rice crops.

"The truth is, they will still be poor because they don't have enough land," he says. "They will not earn enough for a good life. We have too many people and too little land."

The exporters claim that producing paddy costs farmers about 5,500 baht per rai (0.16 hectares), which at a recent exchange rate is about $1,100 per hectare. Even if a farmer plants 2.5 hectares—around the national average farm size—and both his yield and selling price are optimum, his 100% profit will still be only about $172 per month.

The price rises also came too late for the poor rainfed farmers, whose harvest was in October and November. The main profiteers have been the irrigated farmers of Thailand's central region, who plant three crops a year.

In the midst of the turmoil, Thailand's rice industry has become intensely introspective. Government departments feel that development of the country's rice industry still



The stages through which the Thai rice crop passes on its way from farmers' fields to export or domestic sales.
Source: Thai Rice Exporters' Association.

has a long way to go, particularly in the effort to build yields and reduce water use. There has been talk of bringing the industry together to discuss its future, in the hope of achieving some kind of unity.

There's also a plan to implement a zoning system in which farmers will be compelled to grow varieties that perform well in their local farming conditions and that are in market demand. The senior government official said the plan needed another 4 or 5 years to set up, but, once operating, it would help overcome present problems and assist in the marketing of Thailand's crop. The exporters are skeptical, pointing out that there's not a farmer born who takes kindly to any kind of compulsion.

Whatever might happen, prices are still rising.

"It is purely a matter of supply and demand," Mr. Vichai says. "Higher oil prices mean that farmers are changing to fuel crops, and these crops will need more land and more water. Rice prices have to go up, or humanity will have nothing to eat. The price will have to rise to the point where rice can compete, financially, with fuel crops. I believe the domestic price of rice will triple, and will reach $1,000 per ton on the export market, just to catch up with oil prices.

"Maybe, at some point, the Thailand government will intervene to protect domestic consumers."

THAI RICE EXPORTER Vichai Sriprasert.

The senior government official disagrees with the expected move to fuel crops. "Shifting to fuel crops is not easy," he says. "You need suitable land and conditions. Our culture demands that we still must have rice as our staple food. It is our soul and our spirit. In the beginning, we grew rice for our own consumption, and we expanded to become world leaders in rice production. No matter what happens, we will still grow rice."

In one way, both Ms. Korbsook and Mr. Vichai are typical of long-standing rice exporters in Thailand: they come from family firms that have been operating for several generations. Their companies have diversified their businesses purely because of the huge risks and difficulties of rice trading on its own, and the businesses have been kept within the family.

Ms. Korbsook believes a complete overhaul of the rules and regulations surrounding Thailand's entire rice industry is long overdue, and she is scathing in her criticism of what she claims is the industry's lack of ordinary integrity. "Rice has so many steps to pass through and there's fraud, theft, and mismanagement all along the way."

Mr. Vichai sees what is happening as a "disruptive situation."

"Too few people acknowledge that it takes integrity—an integrity built up over generations of reliability—to survive in this kind of situation," he says. "This is a crucial time. It will tell the story of who will survive and who will not survive."

Bob Hill is a Thailand-based writer specializing in science and technology.

AFTER THE

NASIRUDDIN KHAN harvests what is left of his rice crop after it was devastated by Cyclone Sidr in November 2007.

STORM

Story and photos by Adam Barclay

MODIS RAPID RESPONSE PROJECT AT NASA/GSFC

CYCLONE SIDR on 14 November 2007, a day before it slammed into Bangladesh.

In the aftermath of Cyclone Sidr, the rice farmers of southern Bangladesh are struggling to get back on their feet. Immediate relief is needed, but science can provide technologies that help minimize the damage caused by the next disaster.

The winds started to pick up during the afternoon of what should have been a normal Thursday in southern Bangladesh. There had been warnings of a storm, somewhere out in the Bay of Bengal, heading toward the coast. But the people of Chornajir Village didn't think things would get too bad.

Besides, there was work to be done in the fields and the nearest shelter was a long walk away, especially for the young children. If it rains, so be it. Hopefully, the crops will be OK.

As evening approached, though, it became clear that 15 November 2007 would not be a normal Thursday. Chornajir, like most of the villages in Patuakhali District, is poor. People scrape by from season to season, trying to grow enough rice to feed themselves and maybe sell a little if they're lucky. It's a precipitous existence: one failed crop, one big flood, and it can send people spiraling into destitution. And, at this level of poverty, the channels of communication, which should bring news of floods and storms, don't always work like they should.

Cyclone Sidr, a category-4 brute with peak winds of 250 kilometers per hour, slammed into the southern Bangladesh coast in the evening. By the time the villagers of Chornajir, around 20 kilometers inland, realized this was more than a common storm, it was too late to get to the shelter safely.

MILLIONS OF SOUTHERN Bangladeshis were forced into makeshift huts after Cyclone Sidr destroyed their homes.

If you've never been to Bangladesh, you may not know how flat the country is. Apart from hills in the southeast and northeast, the land rarely gets more than a few meters above sea level. The country is effectively an enormous delta formed by the confluence of the Ganges, Brahmaputra, and Meghna rivers and their tributaries, which catch the Himalayan snowmelt and wend their way toward the Bay of Bengal.

Hundreds of rivers and streams crisscross their way out to sea, the end result being an entire country that floods like a bathtub if it rains too much. Add to that a cyclone-induced tidal surge and you start to understand how devastating a major storm can be here. In 1970, a cyclone killed up to half a million people—one of the largest single disasters in human history. In 1991, another cyclone killed more than 130,000. In terms of the cost to human life, Sidr was not as brutal, causing the deaths of around 4,000 people (though still a major disaster by any definition). Fortunately, it struck at low tide, so the surge was not as powerful as it might have been. And, despite the communication breakdowns that left Chornajir residents in grave danger, a great number of people made it to one of the many cyclone shelters that have

IRRI'S ZAINUL ABEDIN talks about Sidr's impact with Mosammat Khadija Begum (*far right*) from Mushiliabad Village in southern Bangladesh.

been built in the past three decades.

As the wind strengthened and the rain hammered, the floodwaters grew. First, the rice crops went under, then the lower houses and huts. Some people, such as Hasina and her husband, tried to make it to the nearest shelter. Soon after they set off, the water had risen above the level of the road. Hasina's husband carried their 7-year-old daughter. Just staying on the now-invisible road was almost impossible; holding onto a child at the same time proved too much. Amid the chaos, deafened by the screaming wind, Hasina's daughter was swept away. Like thousands of others, she wasn't found until it was too late.

It was a sickening blow to a family already doing it tough. There was precious little time to grieve, though—in the wake of tragedy, Hasina and her husband were forced to turn their thoughts to finding food and caring for their remaining family.

Nazma Begum was luckier. Her husband and son made it through unscathed. But her livelihood was swept away in the muddy water. The small hut in which she and her family lived was ruined. Her 0.8-hectare rice field, from which she and her husband expected to harvest the food that would prevent them from going hungry, was destroyed. The seeds she had stored to use the following season were gone as well, along with the family's few chickens, their vegetable crop, and almost all of their personal belongings.

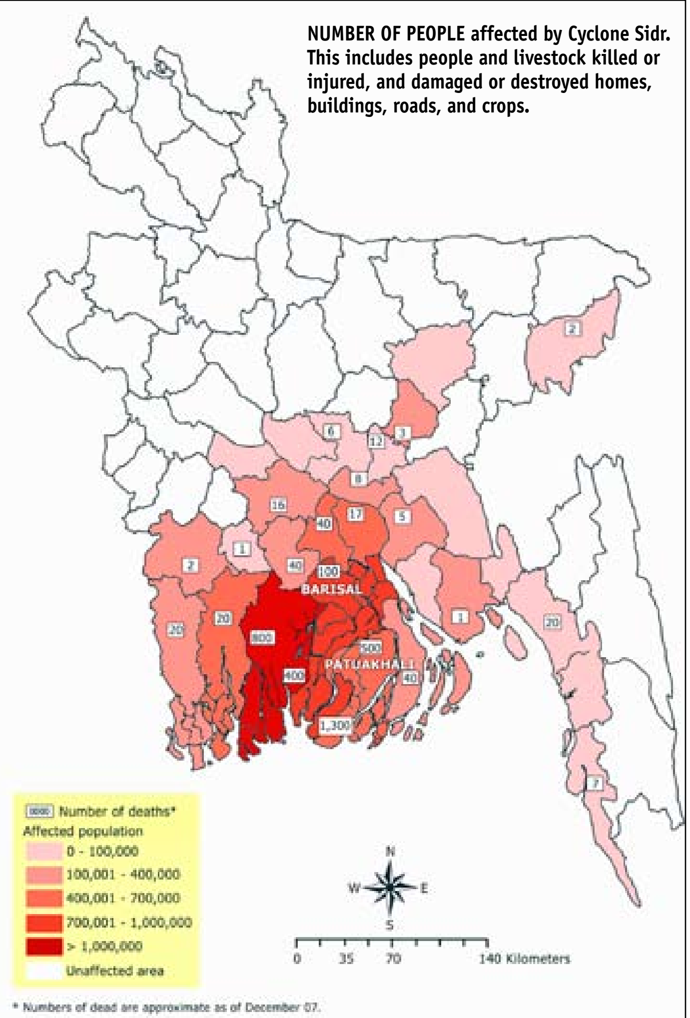
In all, Sidr affected around 2 million families comprising around 9 million people. More than 1.5 million homes were destroyed. Just as distressing, around 1 million hectares of crops—predominantly wet-season (known as transplanted *aman*) rice—were damaged or ruined. Across the whole affected area (see map, *below*), average crop loss was 50%. Close to rivers and the coast, though, farmers suffered complete loss of their crops.

International Rice Research Institute (IRRI) weed scientist David Johnson, who visited the Sidr-affected area in December 2007, points out that another critical issue was the stage of plant growth when the floods hit, which happened to be around the flowering period. The effects on the rice crop appeared to be quite different, depending on whether it was at, before, or after flowering, which lasts about a week. Farmers recovered at least some rice if the crop was hit before or after flowering. If the floods and winds hit a flowering crop, though, the plants became completely sterile and did not produce grain.

"Farmers' chances of recovering some of the crop depended on a few days, really, in terms of crop development," says Dr. Johnson.

Sidr prompted millions of Bangladeshis to wonder how they would feed themselves until the next harvest and, perhaps worse, with so many farmers losing their seed, they were unable to sow their *boro* crops, the seedling nurseries for which should have been planted in November and December for transplanting in January. Compounding the problem was the destruction of *boro* seedbeds—in Patuakhali, around 60% were affected—and damage to irrigation canals, which allowed highly saline water into the fresh water being stored for the dry season. Barring

NUMBER OF PEOPLE affected by Cyclone Sidr. This includes people and livestock killed or injured, and damaged or destroyed homes, buildings, roads, and crops.



Source: Disaster Management Information Centre, Disaster Management Bureau, Bangladesh Ministry of Food and Disaster Management

THE CYCLONE DESTROYED roads throughout southern Bangladesh. In many cases, people attempting to make their way to safety drowned when the embankments collapsed.

further disasters, many farmers are looking at a November-December 2008 *aman* harvest or, at best, an *aus* crop (grown by some farmers between the wet and dry seasons), to be harvested in mid-2008.

But that's only half the problem. Each wet season, the farmers here save their crop's best seeds, with which they plant the next wet season's crop. Following Sidr, even though some farmers managed to salvage some rice, it was of such poor quality as to be useless for seed.

"Urgent short-term measures are needed to ensure sufficient seed supplies for these farmers, particularly for 2008," explained IRRI scientist Abdelbagi Ismail during his visit to Patuakhali in December 2007. "This is because most farmers lost their rice crop and the grain yield of the remaining crop is expected to be very low, and will mostly be consumed within a few months. Besides, harvested grain is likely to be unsuitable for seed for the next transplanted *aman* season because of low quality."

Condemned to as much as a year's reliance on food aid, families are left wondering how they'll manage. Moreover, most of the crops grown in these areas are local varieties adapted to saline and waterlogged conditions. Seeds of these varieties are hard to replace.

"It looks like I'll get less than half a ton from my 6 acres [2.4 hectares]," lamented Nasiruddin Khan, a rice farmer from Purbohajipur Village, Patuakhali. "Last year, I got 5 tons. I don't know how we'll get enough food in the coming months."

When *Rice Today* visited Purbohajipur in December 2007, Nasiruddin was harvesting what muddy, flattened rice remained in his field. He said he would use the straw for animal feed but that much of the recoverable grain had begun to rot and tasted bitter.

Nasiruddin's neighbor, Ali Akbar, harvested 10 tons from his 4 hectares in 2006. In 2007, he was expecting around 1 ton. It was a story repeated over and over across southern Bangladesh.

A recent report issued by the Centre for Policy Dialogue and Bangladesh Rural Advancement Committee (BRAC) warns that, following the cyclone and two major floods earlier in 2007, the country is now facing a shortage of at least 3 million tons of rice.

"We usually have a rice shortage of 1–1.5 million tons a year, but, because of recurrent natural disasters, there will be an additional shortage of 1.9 million tons," Mahabub Hossain, BRAC executive director, said in January 2008.

Adding to the burden for the millions afflicted, the shortages have come at a time of high and rising global rice prices, resulting in higher prices for consumers, many of whom have already lost everything. The country's dire situation was recognized by the Food and Agriculture Organization (FAO) of the United Nations, which in December 2007 added Bangladesh to a list of 37 countries facing a food crisis and requiring external assistance.

To see what role IRRI might play both in response to this disaster and to mitigate the effects of future cyclones—predicted to occur with

A GIRL FROM Mushiliabad Village, which was hard hit by Sidr.

How can rice research help?

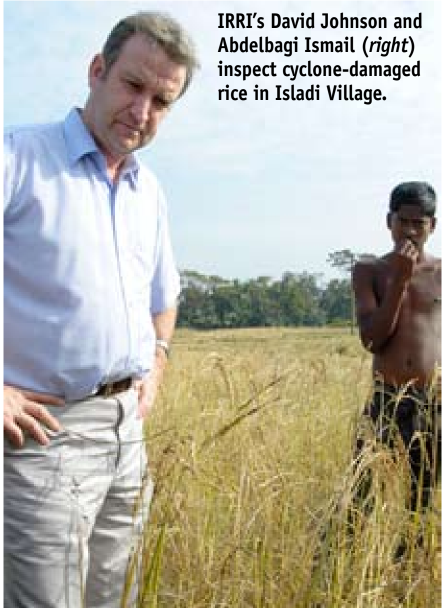
Following their visit to southern Bangladesh in December 2007 to assess the situation in areas hit by Cyclone Sidr, IRRI scientists Abdelbagi Ismail, Zainul Abedin, David Johnson, and M.A. Hamid Miah, along with their BRRI counterparts, developed preliminary plans for research focused on mitigating this sort of disaster.

The researchers discussed their observations at a series of meetings with the Secretary of the Ministry of Agriculture Md. Abdul Aziz, the Bangladesh Agricultural Research Council (including Executive Director Nurul Alam), and the Bangladesh Rural Advancement Committee (including Executive Director Mahabub Hossain).

Suggested intermediate-term plans to protect and enhance farm productivity included

1. New varieties with sufficient tolerance of submergence, salinity, and stagnant flooding, but with higher yields than the current local varieties need to be tested and out-scaled in cyclone- and flood-prone areas. These include flood-tolerant varieties already developed by IRRI and BRRI, and salt-tolerant varieties that are currently being developed. Breeding lines with tolerance of submergence, stagnant flooding, and salinity should also be tested with farmers to select suitable lines for further evaluation and release.
2. Crop management and crop intensification strategies could help raise productivity to ensure higher and more stable income and food security. Increasing the options for dry-season (*boro* and *aus*) rice as well as other upland crops (such as potato, sweet potato, maize, and watermelon) would help reduce reliance on the vulnerable *aman*-season rice, whose yields are often low and susceptible to harsh conditions. Diversification will help ensure sufficient food and income for farmers if they lose most or some of their *aman* rice produce.


BRRI's Abu Saleque.


IRRI's David Johnson and Abdelbagi Ismail (*right*) inspect cyclone-damaged rice in Isladi Village.

greater frequency because of climate change—Institute scientists Dr. Ismail, Dr. Johnson, Zainul Abedin, and M.A. Hamid Miah traveled to southern Bangladesh on 14-16 December 2007. They were joined by representatives from the Bangladesh Rice Research Institute (BRRI), the Department of Agricultural Extension, and two nongovernmental organizations—Action Aid and SPEED Trust—working on the IRRI-coordinated Food Security for Sustainable Household Livelihoods (FoSHoL) project.

All groups, along with several others, including BRAC, are helping affected families get back on their feet. It is an enormous task. BRRI and BRAC both jumped in immediately to distribute seeds, but getting hold of enough was proving difficult, with around 20,000 tons required to meet the expected shortfall. Abu Saleque, principal scientific officer and head of the BRRI Research Station in Barisal District just north of Patuakhali, says that, to cover losses due to Sidr, BRRI is helping farmers to grow transplanted *aus* rice.

"BRRI is supplying *boro* seeds to farmers and is also encouraging more farmers to grow *boro* rice," explains Dr. Saleque. "In Barisal District, only 40% of the rice area (107,000 hectares) is planted to *boro* rice."

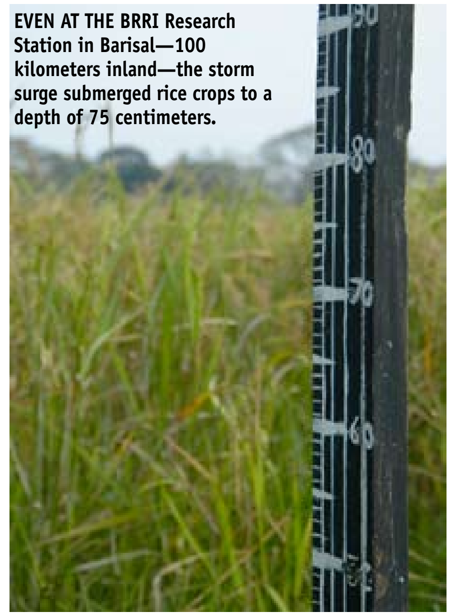
One major constraint, says Dr. Saleque, is that farmers must be organized. For example, water allocation is a problem, as is the practice of allowing livestock to graze on *aman* crop residue—farmers would need to coordinate to ensure that animals don't eat newly planted *boro* rice.

If the coming rice seasons are to be successful, the bare minimum needed by farmers is seeds, fertilizer,


LOCAL RESIDENTS reported that the storm surge produced by Sidr reached halfway up this palm tree on the southern Bangladesh coast.


SOME THINGS even a cyclone cannot stop—local boys play cricket in front of large river barges that were washed hundreds of meters inland by the cyclone's storm surge.

ONE MONTH after the cyclone, reconstruction efforts were well under way.



EVEN AT THE BRRI Research Station in Barisal—100 kilometers inland—the storm surge submerged rice crops to a depth of 75 centimeters.

and help with land preparation. If draft animals weren't killed in the cyclone, their feed was most likely lost. As a result, many farmers have either lost or ceased to keep animals.

Although any rice crop hit directly by a full-force cyclone is sure to be damaged, new varieties with sufficient tolerance of submergence, salinity, and flooding—but with higher yields than currently grown local varieties—need to be developed, tested, and out-scaled in southern Bangladesh and other cyclone-prone areas. Subsequent increased production, combined with storage facilities that can withstand flooding, can buffer Bangladeshi farmers against future catastrophe.

"For this kind of disaster, it's very difficult to design varieties that can withstand this kind of devastation—even human beings are not able to do that," says Dr. Ismail. "But you can develop certain traits that can mitigate the effects. We can also see what varieties are available that can be used immediately after the flood, because we expect to see residual salinity, high iron, and other changes in surface soil due to debris brought by seawater. Tolerant varieties will at least give a good start to the next season."

According to Dr. Johnson, an important role in IRRI's research is to reduce the vulnerability of rice production systems and, through that, the vulnerability of people's livelihoods.

"We saw a gradient from those areas that were seriously affected to areas that were less so," he says. "One hope is, if improved materials are available with greater tolerance of some of the stresses caused by an event like this, the proportion of the area that is seriously affected will be smaller."

Dr. Hossain points out, however, that the Sidr aftermath also offers an opportunity to improve livelihoods in the long run. "At times of crisis, that's the time to suggest new ideas to farmers," he says.

During the IRRI scientists' visit in December 2007, discussions were predominantly about *action*—seed distribution, next season's crop preparation, research to develop technologies to minimize losses after the next cyclone, and so on. Importantly, says Dr. Abedin, these are not the types of action that will create dependence: they are ways to not only get people back on their feet, but also keep them there.

"Cash relief," he says, "is something people will use today. But they need something for tomorrow."

RICE EXPOSED to Sidr's winds and flooding was heavily damaged, like this example belonging to a farmer (*left*) from Isladi Village.

Ariel Javellana

Unloading rice at Manila Harbor: for the Philippines—the world's largest rice importer—high prices spell clouds on the horizon.

As well as improving farmers' incomes and productivity, water-saving technologies can also help to ease social tensions—but not without local experts who champion the cause

The big SQUEEZE

*Story by **Adam Barclay**,*
*photos by **Raymond Jose Panaligan***

In 1998, the farming community of Canarem, 120 kilometers north of Manila in the Philippine province of Tarlac, had reason to celebrate. The Philippine National Irrigation Administration (NIA) funded the construction of a deep-well pump, designated P-38, that would allow the farmers to irrigate their rice fields. Previously dependent on rain or shallow tubewell pumps, which often run dry, P-38 promised to help Canarem's several dozen farmers produce higher-yielding, more reliable crops.

Sure enough, P-38 did improve things. Farmers had access to more water and started growing an additional dry-season rice crop each year. But the celebration was muted.

NIA paid in advance for the diesel that fueled the pump, with farmers repaying with a portion of their harvest at the end of the season. With a steady source of irrigation water and no need to pay up-front fuel costs, farmers adopted a "too much is better than not enough" policy.

As new members joined the cooperative, enticed by P-38's promise, each farmer's wait between irrigations—which should have been 7 days—grew to almost 2 weeks. In the dry season, the interval became so long that fields dried out and the soil began to crack. Some of the increasingly anxious farmers would sneak out at night and divert water into their own fields by placing holes underneath their paddy dikes. Others turned to alcohol. Village officials were called in to resolve conflicts.

THE MAIN CANAL from Pantabangan Reservoir irrigates around 90,000 hectares in the Philippines' Central Luzon region.

IRRI'S RUBEN LAMPAYAN points at dry, fallow fields—a common sight in Central Luzon, where water-saving technologies can help farmers grow dry-season crops.

For 3 years after the construction of P-38, tensions and distrust grew among the families of Canarem.

Then, in 2002, two events conspired to turn things around. First, with the rising cost of fuel, NIA announced it would no longer pay for diesel, which had more than quadrupled in price since P-38 began operating. Second, a team of researchers arrived, hoping to introduce a water-saving technology known as alternate wetting and drying, or AWD (also called controlled irrigation).

Scientists at the International Rice Research Institute (IRRI) and the Philippine Rice Research Institute (PhilRice) had established that rice need not be continuously flooded. It can be flooded to a lesser extent than usual (to a depth of 3–5 centimeters instead of up to 10 centimeters), allowed to dry to a degree, then re-flooded, with this cycle repeated throughout the season if the soil remains flooded throughout the all-important flowering period. Up to a quarter less water is needed and there is no drop in yield. Importantly, farmers don't need to make any other major changes to the way they manage their crop (see also *The benefits of a hole in the ground*, on page 29).

The practice, confirmed in experimental fields, needed to be extended to real farms. So, IRRI and PhilRice initially teamed up with NIA staff to introduce AWD to farmers. Canarem seemed the ideal place to start but, according to Vic Vicmudo, manager of NIA's Tarlac Groundwater Irrigation Systems Reactivation Project, this was easier said than done.

"For centuries, farming in the Philippines has been based on the idea that, the more water, the higher the yield," says Dr. Vicmudo. "It's not easy to reverse that belief."

But the plain fact is that, in many areas, rice farmers simply don't have enough water. Bas Bouman, water scientist and head of IRRI's Crop and Environmental Sciences Division, says that it was this understanding that drove not only the initial collaboration but also the participation of other organizations such as state colleges and universities.

"It started in 2000 with NIA and PhilRice on a very small scale," recalls Dr. Bouman. "Step by step, more and more partners came on board—now, we can barely count the number of partners involved. Many of these attended a training

STANDING IN FRONT of the P-38 deep-well pump are (*left to right*) Ramon Ganiban, Dario Antalan, and Manuel Apolonio—president, treasurer, and secretary, respectively, of the P-38 Irrigation Service Cooperative.

NIA's Armilito Lactaoen.

course we ran in 2004, and took it from there on their own."

Dr. Bouman says the urgency stems from farmers' lack of choice. "We often get asked, 'How can you convince farmers to save water?' My standard reply is that we don't need to convince them to save what they don't have. These technologies are really about helping farmers who are unable to keep fields flooded to get the best out of the limited water they have," he explains.

Jump forward to the present, and Canarem is a different place, says Manuel Apolonio, secretary of the P-38 Irrigation Service Cooperative and owner of a 2-hectare farm.

"There used to be so many conflicts between cooperative members and managers," Mr. Apolonio recalls. "Now, the farmers know how to manage water. Before, if the soil started to crack, people thought the crops would die. Now, they know that small cracks are OK."

In a way, farmers were practicing AWD before it was formally introduced. But it was an uncontrolled AWD, forced onto farmers by insufficient and poorly managed irrigation. With the knowledge of how to use water more efficiently, the yields obtained by Canarem's farmers using AWD, at 5–6 tons per hectare, are the same as when they tried to maintain continuously flooded fields.

Ramon Ganiban, P-38 cooperative president and owner of a 4-hectare farm, says that when the researchers and NIA staff introduced them to AWD, many of the cooperative's 61 farmers were skeptical. Now, the cooperative's success has inspired neighboring communities.

Ironically, having farmers pay for their own fuel was a key to the technology's success, as it provided a financial incentive to use less water. Before they learned about AWD, farmers ran the pump for 10–12 hours to irrigate a single hectare. That has been reduced by more than half, to 4–5 hours.

AWD rice crops also require less labor and are 20–25% cheaper to manage than continuously flooded crops, meaning higher profit for farmers. In fact, under AWD, some Canarem farmers have gone from barely breaking even from rice farming to making a modest income.

"There's really been a big change in the farmers' mind-set and culture," says Mr. Ganiban. "Now, people know that, if they're short of money for fuel, they can just flash-flood the crop and it will be OK. We don't need to prove AWD anymore: we've done it for 6 years and we know it works. AWD has really strengthened the cooperative. There are no more conflicts and farmers understand each other's needs much better."

VIC VICMUDO, manager of NIA's Tarlac Groundwater Irrigation Systems Reactivation Project.

CHILDREN PLAY in the outlet channel of deep-well pump P-38.

Armilito Lactaoen, one of NIA's senior technical staff, works with farmers in the nearby GP-125 Irrigation Service Cooperative. He cautions that, although AWD can "solve the problem of greed in irrigating," it needs good people management. Some cooperatives have failed to adopt AWD, he says, because of "human resource problems, such as a lack of strong co-op leadership or management problems within the co-op."

NIA is working with farmer groups at 72 irrigation systems across Tarlac. Around 20% of the farmers have adopted controlled AWD (as opposed to uncontrolled AWD, which has been forced onto Tarlac's farmers through a lack of water), but some systems have seen 100% adoption. Dissemination is now the main challenge. Dr. Vicmudo is optimistic, pointing out that, once farmers are convinced, they themselves become key disseminators.

"NIA, PhilRice, and IRRI have held several harvest festivals," he says. "Yields from farms using traditional irrigation and AWD were directly compared,

MALAYA IRRIGATORS' Association President Victorino Erese.

so farmers could see that there's nothing hocus-pocus, no magic."

Just north of Tarlac in Nueva Ecija Province, IRRI, PhilRice, and NIA are working with farmer groups that get their irrigation water from subcanals running off the main canal of the Upper Pampanga River Integrated Irrigation System (UPRIIS). Fed by Pantabangan Reservoir in the foothills of northern Nueva Ecija, UPRIIS irrigates an area of around 90,000 hectares in Central Luzon, the region north of Manila (the area will soon undergo a 35,000-hectare expansion), and is the country's largest irrigation system.

One of the biggest challenges of managing UPRIIS is ensuring that the farms farthest from the reservoir and the main canal receive their share of water, especially given that those closest to the source tend to use more than they need. Evangeline Sibayan, agricultural engineering division head at PhilRice, likens the problem to 50 people sharing a 10-liter bottle of water. "The people who drink first need to take into account those who will drink later," she says.

Ms. Sibayan says that finding farmers to try AWD in 2007 was extremely difficult. It took a demonstration trial at PhilRice and, ultimately, a promise to compensate farmers for any yield loss compared with 2006 production to convince a farmer group serviced by a subcanal named Lateral F.

The result? Perhaps the best evidence is the fact that PhilRice barely paid out any compensation. Not only were yields as high as they had been under continuous flooding, but 2007 was also the first year for many during which downstream farmers—those farthest from Lateral F—didn't complain about a lack of water.

The Malaya Irrigators' Association (MIA), a group of 264 farmers covering 265 hectares in the municipality of Santo Domingo, also adopted AWD in 2007. The farmers here also agree that the practice has reduced tensions and improved social harmony.

"With AWD, there's better unity among MIA members," says MIA President Victorino Erese. "Before, people looked out only for themselves."

Prior to AWD's introduction, 60% of MIA farmers grew dry-season rice. Despite initial doubts, that figure has increased to 80% after only one year. An unanticipated bonus is that lenders now have more confidence in the MIA members' ability to repay loans and thus are happier to offer credit.

One major difference between implementing AWD in an area serviced by a gravity-fed irrigation system like UPRIIS versus a deep-well system like P-38 is direct economic incentive. In Canarem, where farmers pay for their own fuel, the less water they use, the higher their income. In Santo Domingo, farmers pay a flat fee, regardless of how much water they use. So, if you're an upstream farmer with good access to water, why conserve it?

The benefits of a hole in the ground

To help farmers move to alternate wetting and drying, IRRI devised a simple way to check when a crop needs water. A pipe with holes drilled into it is pushed part way into the rice-field soil. Farmers can then observe the water level, irrigating when it reaches a certain distance—usually around 15 centimeters—below the surface. Anywhere above that level, the plants' roots will reach the water and the crop will be fine. The tool is simple enough for farmers to easily construct it from cheap local materials such as PVC or bamboo. After one or two seasons, farmers no longer need the tube and are able to judge when to irrigate simply by looking at the crop. If a new technology relies on complex, difficult-to-make, or expensive methods, it is bound to fail. Simple, adaptable tools—like a hole in the ground—are crucial.

Ms. Sibayan argues that farmers recognize and value the social benefits. "If downstream farmers didn't get water," she

DANILO ESTEBAN, vice president of the Malaya Irrigators' Association, checks the water level in his AWD rice field.

PhilRice's Evangeline Sibayan.

says, "at night they would walk upstream, armed with their *bolos* [traditional Philippine knives], and reposition the flow."

In this light, Ms. Sibayan describes AWD as a "peace-making technology." And, as well as fostering camaraderie among farmers, AWD is allowing downstream farmers to grow two rice crops per year and thus improve their income. Previously, many downstream farmers could grow rice only in the wet season.

"We need to make AWD part of the farmers' culture," says Jovino De Dios, supervising science research specialist at PhilRice.

Mr. De Dios is confident that, with wise water management, the entire UPRIIS can be successfully irrigated, but he stresses the need to educate the farmers in the UPRIIS expansion area *before* the system becomes operational. "If they farm without water-saving knowledge, without good technology, farmers tend to irrigate wastefully," he says.

PhilRice and NIA aim to convert the 50,000 or so rice farmers in the UPRIIS area to AWD by 2010. There are also plans to spread the technology through the neighboring Magat River Integrated Irrigation System service area. It's an ambitious goal, but, if it can be achieved, a quarter of the entire Philippine irrigated rice system will be under AWD. "Then," says Ms. Sibayan, "hopefully, it will trickle down to smaller systems too."

Ruben Lampayan, IRRI postdoctoral fellow and leader of the IRRC Water-Saving Work Group, has been involved with the research and dissemination of AWD for the past 7 years. He says that AWD has enormous potential not only in the Philippines but also across Asia.

"In many Asian countries, we see the same problems, same mind-set, same challenges," explains Dr. Lampayan. "People are aware of the problems but they are astonished when told of their true extent. If we are successful, UPRIIS can be a model that can be replicated throughout Asia."

To help AWD's impact reach its full potential, IRRI anthropologists Flor Palis and Rica Flor are looking at how and why (or why not) AWD is being adopted. Dr. Palis says

PhilRice's Jovino De Dios.

that adoption of new technologies is almost always a challenge. "We need to understand what enables adoption," she says. "What are the social and cultural factors as well as economic factors, and what allows faster diffusion of the technology?"

The point is, even if a technology works in experimental trials, it still may not succeed. For example, there are areas where AWD has failed because of "free riders"—farmers who managed to obtain the water without paying their share of the cost. In this case, strong leadership from cooperative managers is the key to success. The decision by the P-38 leaders to make farmers pay for their own fuel not only provided incentive to use less water but also eliminated the free-rider problem.

What happens, though, if farmers have access to neither gravity-fed nor pump irrigation? Such is the case in many areas of Bulacan Province, immediately north of Manila. At Bulacan Agricultural State College (BASC), researchers believe the answer is "aerobic rice"—growing rice in unflooded fields, much like wheat or maize, instead of transplanting seedlings into a flooded field (for more on aerobic rice, see *High and dry* on pages 28-33 of *Rice Today* Vol. 6, No. 4).

Junel Soriano, director for research, extension, training, and production at BASC, has led the college's aerobic rice project since it began in 2004. He says that farming life can be extremely difficult in an area such as Bulacan, where farmers are almost entirely reliant on rain.

"The benefit of aerobic rice," says

FOR THE CHILDREN of Canarem, Tarlac, irrigation water means fun as much as it means rice.

A YOUNG BOY crosses an irrigation canal near Ramos, Tarlac.

Dr. Soriano, "is that you can establish wet-season rice in early May, up to one-and-a-half months earlier—and therefore harvest earlier—than transplanted rice, which needs much more water before it can be planted. Then, following harvest in August or September, there's still enough rainfall to establish another crop."

Dr. Soriano says the ultimate goal of the project is to increase cropping intensity. Without aerobic rice, Bulacan farmers manage a single rice crop per year. The project results so far suggest that as many as three-quarters of those farmers who adopt aerobic rice, which needs irrigation only once a week or so, will be able to plant a second rice crop.

So far, farmers' yields have been around 4.5 tons per hectare, which is similar to what they achieved with transplanted rice. One constraint is seed availability, but two 1-million-peso (US$25,000) projects, funded by Japan through the Philippine National Economic Development Authority and by the Philippine Commission on Higher Education, have enabled BASC to set up a seed production business that will also help raise revenue. Local governments in the Norzagaray, Doña Remedios Trinidad, and San Rafael municipalities have also stepped in and are currently subsidizing seeds for farmers by 50%.

In the Philippines, local government is responsible for agricultural technology dissemination and training, so administrative or financial support from mayors and local extension officials is crucial if a new technology is to succeed.

BASC has also recruited partners from other provinces. Bataan Polytechnic State College and Palawan State University have already begun aerobic rice projects and, in 2008, organizations from Mindanao, in the southern Philippines, and northern Luzon, in the north, are set to join in. "We want to be the research-and-development center for aerobic rice in the Philippines," says BASC president Josie Valdez.

BULACAN AGRICULTURAL State College's Junel Soriano.

In many ways, the burgeoning success of AWD and aerobic rice is not a story about technologies. It's a story about people, about the local champions without whom the best technologies in the world would languish on shelves and in academic journals.

"We need these people who go beyond the limits of their institution and, really, beyond their own limits," says Dr. Lampayan. "IRRI did not assume that its partners would champion the technology in the way they have. It was quite spontaneous."

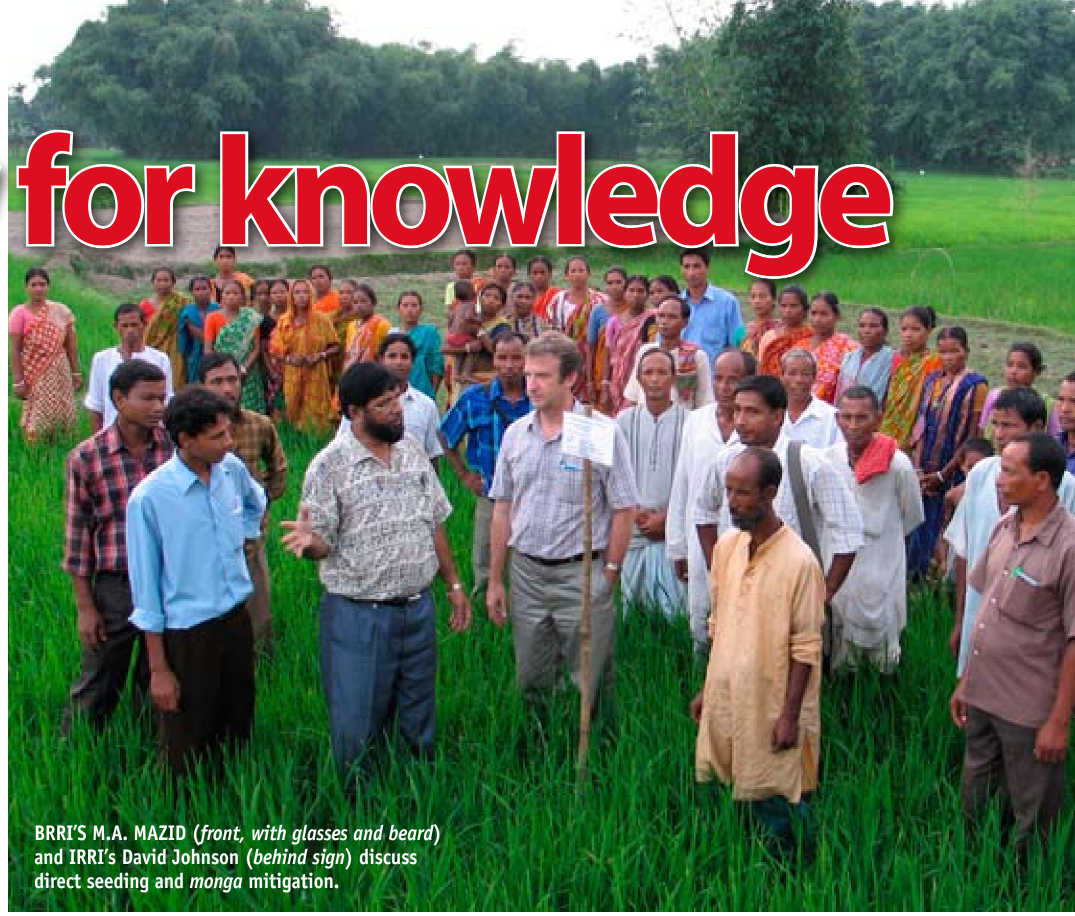
Without people like Vic Vicmudo, Evangeline Sibayan, and Junel Soriano to provide the sparks, promising technologies too often fail to ignite.

The development and dissemination of water-saving technologies for rice as reported here are carried out through the Water-Saving Work Group of the Irrigated Rice Research Consortium and the Consultative Group on International Agricultural Research Challenge Program on Water and Food.

Hungry for knowledge

by Trina Leah Mendoza
and David Johnson

Every year in Bangladesh, millions of rural families suffer the privations of monga*, the period after the previous season's food has run out and before the next season's harvest. Now, several technologies are helping to close the window of hardship.*



BRRI'S M.A. MAZID (*front, with glasses and beard*) and IRRI's David Johnson (*behind sign*) discuss direct seeding and *monga* mitigation.

Travel from the Bangladeshi capital of Dhaka to the district of Rangpur in the country's northwest takes about 7 hours by an increasingly rough road. In the course of that long journey, you get a feel for this largely flat, waterlogged nation, teeming with around 150 million people. Departing the crowded urban streets of Dhaka, you leave behind images of makeshift tents crammed between trees along the highway. Nearing Rangpur, you can see communities of tin houses. And in villages in neighboring Nilphamari and Kurigram districts, families live in thatch huts, most of them without electricity or plumbing. These simple dwellings represent home for millions of Bangladesh's poor. About one-fifth of the nation's population—around 30 million people—suffer from severe hunger each year.

Life for the rural poor, hard enough at any time, gets harder in northern Bangladesh from late September to mid-November. It is at this time that the annual famine known as *monga* bares its teeth. During these months, many cannot afford three meals a day, often struggling to piece together a single decent meal. At this time of the year, most of the people who rely on farmwork—around 70% of the adult population—in the greater Rangpur District are jobless, waiting for the harvest of transplanted rice in December. By the time the *monga* season comes, they have consumed all of their stored food and opportunities for work have dried up.

Most of the men migrate to cities to find work pulling rickshaws, transporting bananas and logs, or similar. But these prospects are few and poorly paid. Often, families buy livestock and poultry before *monga* and sell them during these trying months. Even 8- to 12-year-old children are sent to work for landowners. Boys receive about US$28 and food for a year in exchange for hard labor in the fields. The girls, restricted to household chores, receive only food.

DR. JOHNSON with local residents in Rangpur.

It does not help that northwest Bangladesh is transected by 21 rivers that regularly overflow, leaving thousands of families homeless. Floods usually arrive in August and September, bringing with them water-borne illnesses and hardship that are only intensified by the *monga*, which follows close behind.

To help ease the suffering during *monga* and improve farm productivity, the International Rice Research Institute (IRRI)-led Irrigated Rice Research Consortium (IRRC), the Bangladesh Rice Research Institute (BRRI), and local nongovernment organizations (NGOs) have teamed up. Together, they are developing the means for earlier harvests through shorter-duration rice varieties combined with direct seeding of rice and weed control options.

IRRI weed scientist David Johnson, of the IRRC Labor Productivity Work Group, and M.A.

Mazid, head of the BRRI Rangpur station, have been working closely with farmers to test the potential of direct seeding as an alternative to transplanted rice in different cropping systems. Direct seeding allows the rice to be established earlier and raises the chances for farmers to grow an extra crop, such as potato, maize, mustard, wheat, chickpea, or vegetables.

The IRRC team traveled to Rangpur on 22-28 October 2007 to capture the impact of direct seeding on *monga* mitigation. IRRI socio-cultural anthropologist Florencia Palis interviewed farmers and landless men and women in Rangpur, Nilphamari, and Kurigram districts.

One grief-stricken widow in Nilphamari said that her "life was miserable and useless because she had no work and no land to work on." Left with two daughters to take care of, remarrying was, in Bangladeshi culture, not an option. Another woman had descended into a spiral of debt, borrowing successively from several NGOs to pay for each previous debt.

Despite this misery, such landless women refused to lie down. Some formed groups to develop incomes during the *monga* period. Others borrowed money from NGOs to hire a teacher for their young children. Some sold poultry and livestock and also took on lac production, supported by the NGO Grameen Artto Unnayan Sangstha (GAUS). Lac (*Laccifer lacca*) is a scale-insect that secretes a resinous product, which can be harvested and sold. Almost all the lac rearers in Bangladesh are women.

Direct seeding, too, is playing a key role. One Nilphamari rice farmer's direct-seeded crop yielded about a respectable 3 tons per hectare. Also able to grow ginger, he described his situation as "a miracle." With the introduction of direct seeding and the early-maturing rice variety BRRI dhan 33, farmers can harvest 25 to 40 days earlier, sell at a higher price, and earn extra income from cash crops or as laborers for other farmers.

IRRI agricultural economist Arelene Malabayabas trained interviewers and conducted household surveys designed to collect rice and other crop production data from 200 farmers. The preliminary results indicated that the most effective ways of informing farmers about direct seeding are through television (a village's few sets are often watched by many farmers), demonstrations and training, farmers' field schools, other farmers' influence, and extension technicians. These data, along with those of Dr. Palis's interviews, will give the IRRC a better understanding of how direct seeding and improved weed management can be spread effectively to help improve farmers' harvests.

The team also discussed with government and nongovernment agencies the potential of direct-seeding technology as a way to mitigate *monga*. They met with officials of the Department of Agriculture and Extension (DAE) and the district commissioner of Kurigram, who agree that planting early-maturing varieties is vital in mitigating *monga*, but also stressed a need for more seeds and training. DAE has been promoting early-maturing varieties since 2005, along with direct seeding by drum seeder, although their efforts were hampered by several floods in 2007.

The team also met with NGOs including Solidarity, Inter-Cooperation, GAUS, Rangpur Dinajpur Rural Service, and the Bangladesh Rural Advancement Committee (BRAC).

"These two technologies, early-maturing varieties and direct seeding, can stagger employment generation and, to some extent, combat *monga*," says Mahabub Hossain, BRAC chief executive officer.

For GAUS members, this project was a "dream come true" according to Matiur Rahman, GAUS executive director. "Before using direct seeding, the farmers were harvesting only 2.1 tons per hectare," he says. "Upon using direct seeding with BRRI dhan 33 variety, and with good management and training, they were able to harvest about 4.7 tons per hectare."

There is still much work to be done to relieve the problem of *monga* by enabling farmers to harvest rice earlier. Further farmer training will be undertaken this year so that farmers themselves can become trainers in the community. The IRRC team will travel the road to Rangpur again, and the tents and thatch huts will probably still be there. But, by helping farmers make more of their natural resources, simple, well-managed technologies can go a long way to easing the misery of *monga*.

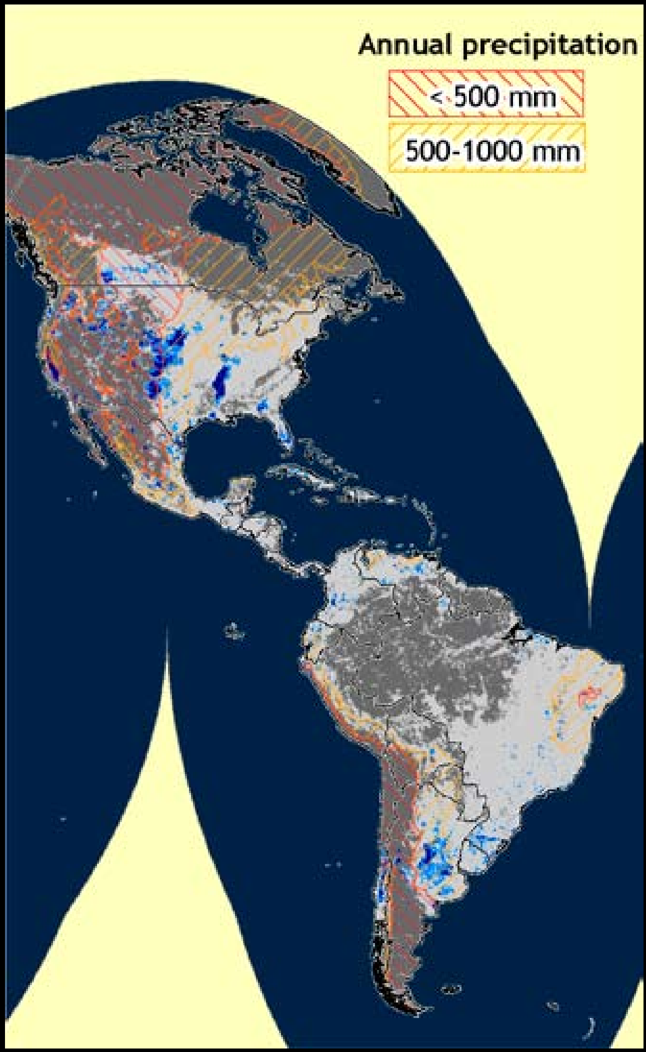
Ms. Mendoza is a communication specialist with the IRRC. Dr. Johnson is a senior weed scientist in IRRI's Crop and Environmental Sciences Division.

IN RANGPUR, Bangladesh, direct-seeded rice can help people avoid the hungry *monga* months.

TRINA MENDOZA (3)

The Asian exception: irrigation

by Robert Hijmans
Geographer, IRRI Social Sciences Division



The availability of water is a fundamental requirement for crop growth. In many places, rainfall is scant or erratic and this can diminish crop yield and strongly affect the livelihoods of farming households. To cope with this problem, farmers can use irrigation, the artificial supply of water to increase crop production. Because irrigation takes away some of farming's climate risk, farmers who irrigate are more likely to further invest in their agricultural production—by using more fertilizer, for example. It is therefore particularly in irrigated areas where we find the intensive agriculture associated with the Green Revolution.

There are striking regional differences in the use of irrigation (map). According to the data sources used for this map,[1] India and China each have about 20% of the world's irrigated lands, and about 68% of the world's irrigated area is in Asia. Although determining exact figures on this scale is impossible, there is agreement about Asia's large share of global irrigation. For example, the recent *Comprehensive Assessment of Water Management in Agriculture*[2] states that "over 60%" of the world's irrigated land is in Asia, and that about half of this land is used for rice.

According to the *Comprehensive Assessment*, there are currently about 300 million hectares of irrigated land worldwide—double the area in 1960. About 80 million hectares (27%) of this irrigated land is used for rice production. Because rice receives more water than other crops, it uses some 39% of the world's irrigation water.

Asia also has a large share—about 48%—of the world's crop land. But this alone does not explain the difference in the extent of irrigated areas: about 28% of Asia's crop land is irrigated, versus 9% for the rest of the world. Only 5% of the crop land in Africa is irrigated. Much of this is in very dry areas such as the lower Nile Valley; unlike in Asia, there is very little irrigation in zones with 500 to 1,000 mm annual irrigation.

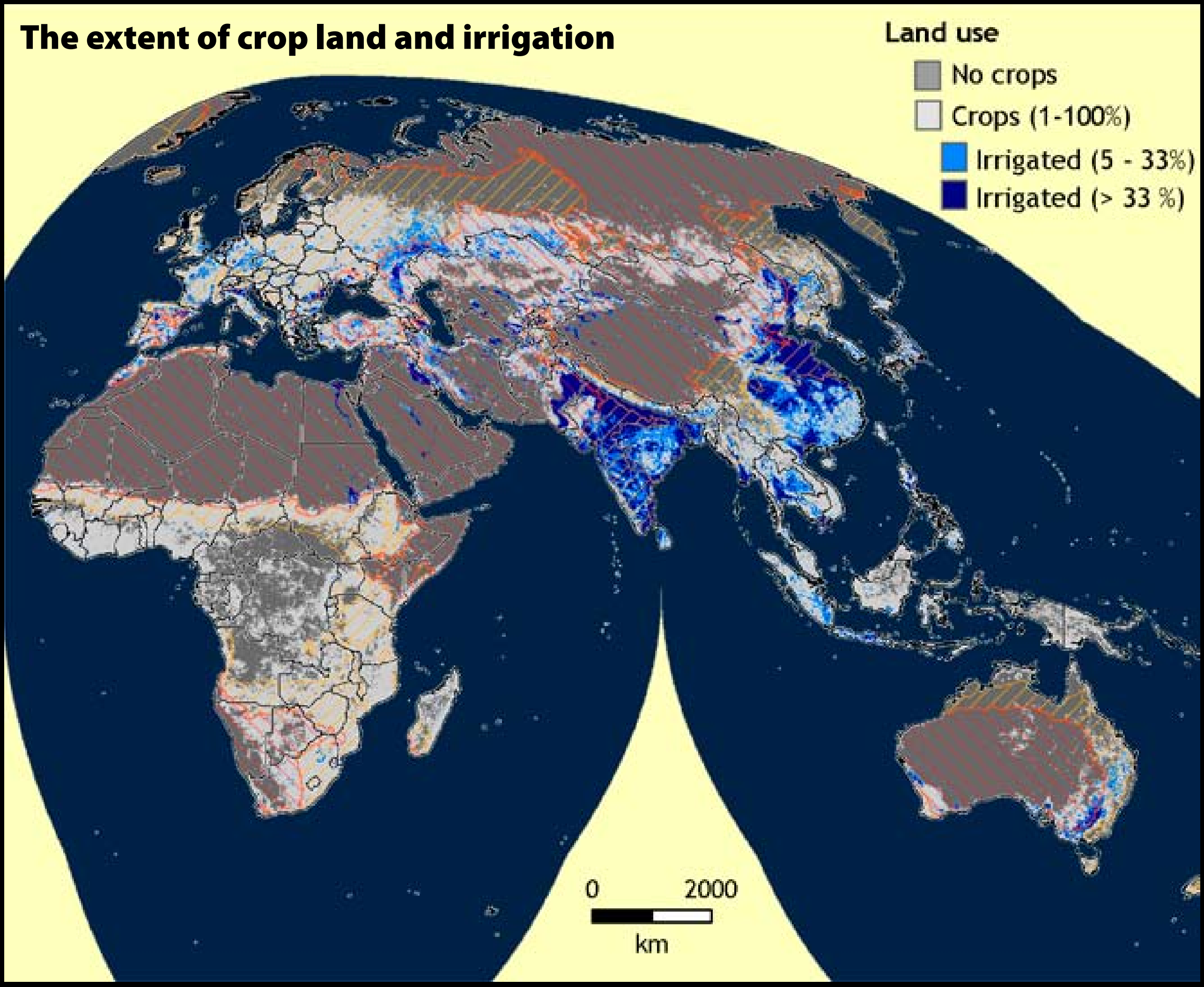
The low level of irrigation in Africa raises the questions of whether there should be more investment in irrigating the crop lands of that continent, and whether Green-Revolution-type intensification could take place there without it.

There are many very dry areas in the world (less than 250 mm of annual precipitation), but only a small proportion of this land is used for crop production. Where it is used to grow crops, it tends to be irrigated. For example, in Egypt, more than 90% of agricultural land is irrigated. However, only 30% of the world's irrigated area is in areas with less than 500 mm of rain per year (Figure 1). Another 30% is in areas with between 500 and 1,000 mm per year. The remainder is in areas with higher rainfall. The majority of irrigated rice land in Asia receives more than 750 mm of rain per year. In these areas, irrigation provides either additional water during the rainy season and the opportunity for dry-season crops.

Detailed geographic data on the extent of crop land and irrigation are an important source of information for studies of agriculture and development. Here, we

[1]Sources: *Crop land*: GLC2000 (www-gvm.jrc.it/glc2000/); Wood et al, IFPRI Agricultural extent v2, IFPRI. *Irrigation*: Siebert et al 2005. Global map of irrigated areas version 3. University of Frankfurt and FAO; Thenkabail et al 2006. An Irrigated Area Map of the World (1999) derived from Remote Sensing. Research Report 105. IWMI. *Precipitation*: Hijmans et al 2005. International Journal of Climatology 25:1965-1978; www.worldclim.org.

[2]Comprehensive Assessment of Water Management in Agriculture. 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. Earthscan and IWMI. www.iwmi.cgiar.org/Assessment.



combined the two most recent global irrigation data sources available. One is based on maps of irrigation schemes (Siebert et al), which may include areas that could be, but may in fact not be, irrigated, the other is based on satellite data (Thenkabail et al).

The relative strengths and weaknesses of these two sources are open to debate, but they have at least one limitation in common: they show only the presence or absence of irrigation, not *how much* water is currently available or will be in the future. This is important because the future of irrigation is uncertain in many areas. Groundwater is being depleted in many important rice-growing areas such as the Punjab in India. Tube-well irrigation, which has boomed in India and Bangladesh, has become much less profitable because of the increased cost of fuel. Demand is also growing for nonagricultural water use, such as for clean drinking water from wealthier and larger urban populations (see the *Comprehensive Assessment* for a recent in-depth analysis).

So, we need to know more. More importantly, though, we need rice production technologies that enable farmers to use water more efficiently and rice varieties that are more tolerant of drought—not only in Africa, where irrigation is scarce, but also in more heavily irrigated Asia.

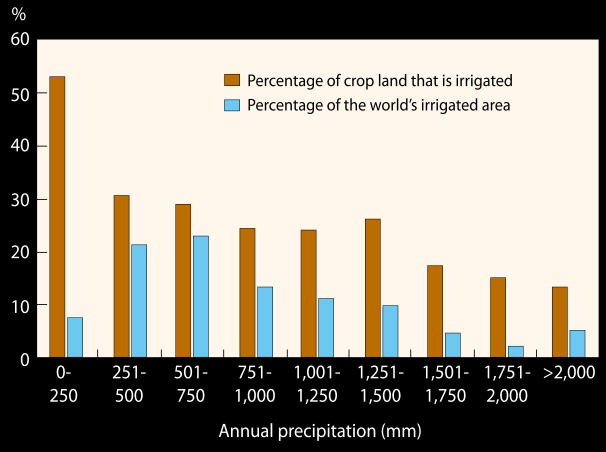


Figure 1. The percentage of global crop land that is irrigated, and the distribution of the world's irrigated crop land by annual rainfall.

The Rice AIDS of Africa

Poor farmers in Africa call it the "rice AIDS" because of its potential for devastation. But a strategy blending cutting-edge biotechnology with regional knowledge may yet stifle the impact of rice yellow mottle virus.

by Savitri Mohapatra

Unique to Africa, rice yellow mottle virus (RYMV) has become the continent's most rapidly spreading disease of rice since it was first discovered in Kenya in 1966. It has the potential to devastate lowland and irrigated rice throughout Africa, contributing to food scarcity in areas where rice is an important staple food.

"Unfortunately, all rice varieties traditionally grown in irrigated conditions and in lowland areas of Africa are susceptible to RYMV," says Africa Rice Center (WARDA) plant pathologist Yacouba Séré. "It is therefore a major threat to more than 3 million hectares of rice in sub-Saharan Africa."

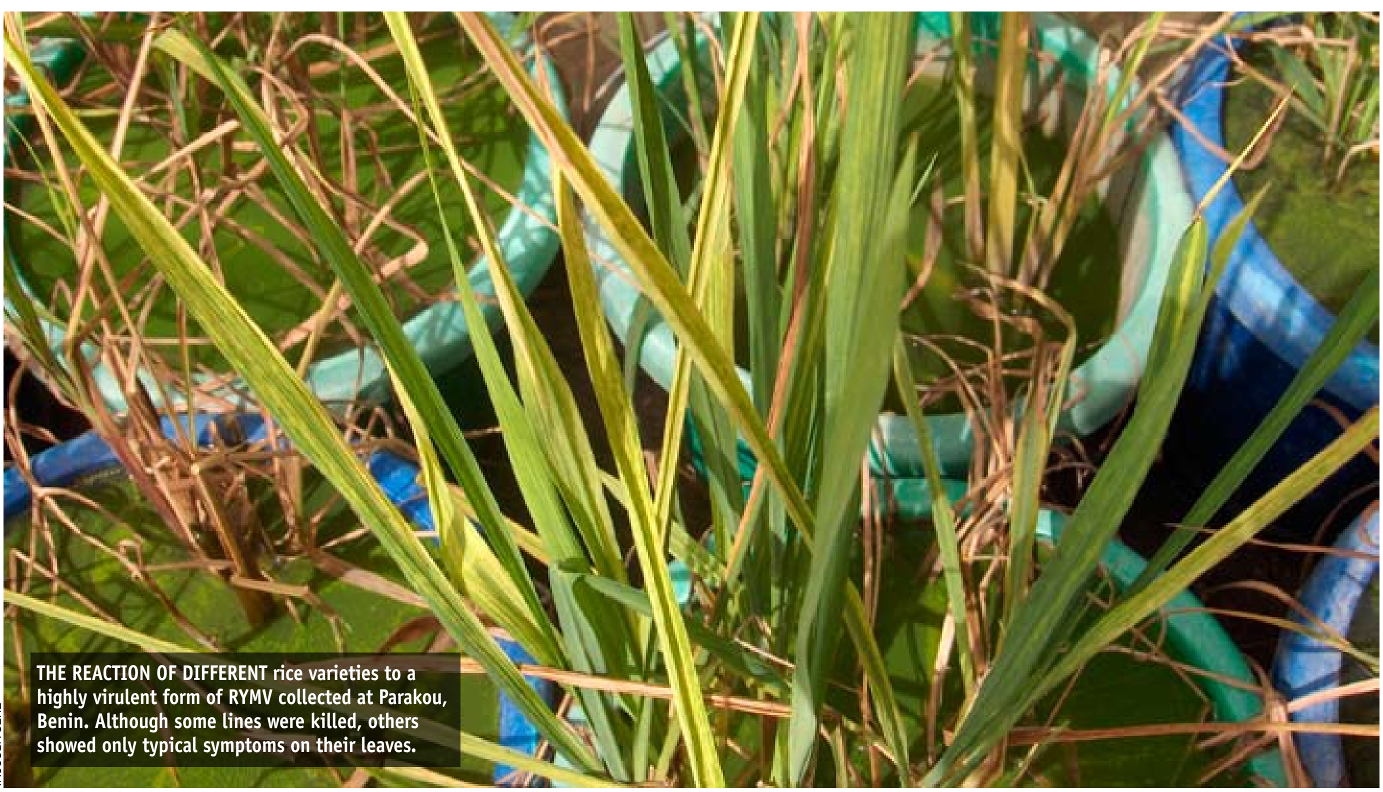
Rice farmers in the region have been worried ever since severe RYMV epidemics broke out in West Africa—the main rice belt in sub-Saharan Africa—in the 1990s, primarily because of the adoption of intensive rice cultivation methods, including irrigation, monocropping, and high-yielding but highly susceptible Asian rice varieties.

The disease is transmitted by insect vectors, such as beetles and grasshoppers, or mechanically through injury to plants during hoe-weeding or transplanting in the presence of virus particles. The symptoms of RYMV-affected plants are stunted growth, mottled yellow leaves, reduced number of tillers, and sterile grains.

The best hope for significantly reducing the impact of RYMV lies in the use of resistant varieties in complement with measures such as direct sowing, removal of alternative hosts on which virus populations can survive during the off-season, and control of the insect vectors.

In response to strong demand from West African countries that were badly affected by the RYMV epidemic, WARDA took the lead in the mid-1990s to conduct research on the disease on a regional basis, building on the RYMV resistance screening work of the International Institute of Tropical Research.

As a result, a regional research strategy to address RYMV was developed and implemented with support from the UK Department for International Development, using



THE REACTION OF DIFFERENT rice varieties to a highly virulent form of RYMV collected at Parakou, Benin. Although some lines were killed, others showed only typical symptoms on their leaves.

YACOUBA SÉRÉ

an integrated pest management (IPM) approach. The main objectives of this strategy were to identify rice varieties resistant to RYMV to replace susceptible varieties grown by farmers; identify and characterize sources of resistance for use in breeding programs to develop resistant varieties; and understand better the disease epidemiology.

The high variability of the RYMV virus—meaning that virus strains vary from location to location—proved a major challenge for scientists because a rice variety that is resistant in one location may be susceptible elsewhere.

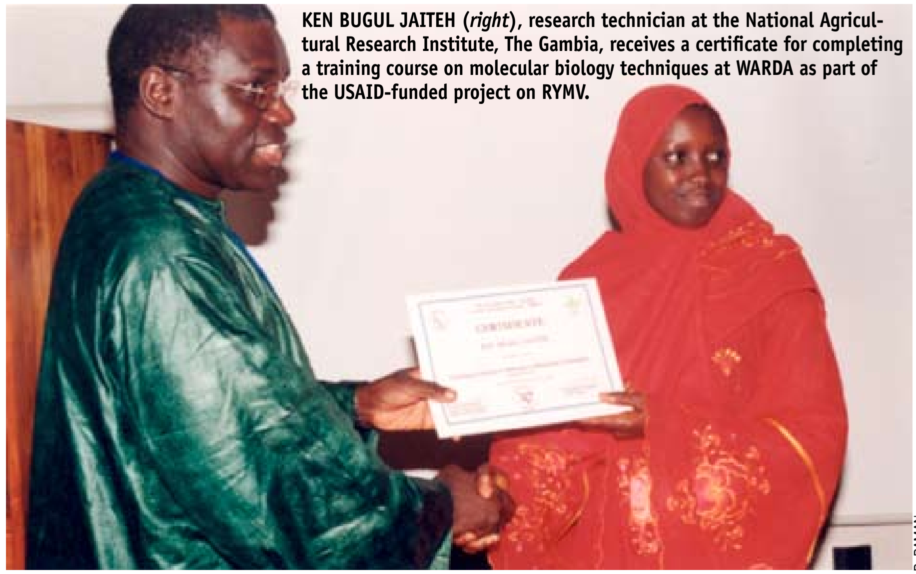
Over the past few years, however, scientists have made several important advances.

A rapid tool for diagnosing RYMV using antibodies (an immune response from animals and plants in response to virus particles) has been developed and shared with project partners. Several RYMV strains were identified and characterized. Rice varieties with resistance to RYMV have been identified and sent to national partners for testing. Most importantly, a few sources of high resistance to RYMV, such as Gigante, a traditional low-yielding rice variety from Mozambique, and several indigenous African varieties have been identified. Resistant lines were obtained through backcrossing, some of which have already been adopted by farmers.

As conventional breeding is slow and lacks precision, WARDA scientists are working in close partnership with advanced research institutes to fast-track the process of developing RYMV-resistant varieties using molecular biology techniques.

One of its important partners in this area is the Institut de recherche pour le développement (IRD) in France, which has identified a gene, *rymv1*, that confers RYMV resistance and molecular markers associated with it. A marker is a segment of DNA linked to an allele (a version of a gene) that controls an important trait and can easily be detected in the lab.

This achievement led to the launching by WARDA in 2004 of a 3-year project on marker-assisted selection (MAS) with support from the U.S. Agency for International Development to train national staff of four West African countries—Burkina Faso, Guinea, Mali, and The Gambia—in the application of MAS techniques to transfer the gene with RYMV resistance to popular rice varieties. (MAS involves linking a desired gene with a marker so that it can easily be bred into a rice variety.)



KEN BUGUL JAITEH (*right*), research technician at the National Agricultural Research Institute, The Gambia, receives a certificate for completing a training course on molecular biology techniques at WARDA as part of the USAID-funded project on RYMV.

R. RAMAN

Thanks to this innovative project, WARDA's national partners are benefiting in several ways. The resistance gene *rymv1* has been successfully transferred into various West African popular varieties that were previously susceptible to RYMV and rice seeds bearing the *rymv1* allele have been produced from the best lines. These seeds have been multiplied to produce enough seed for distribution to project countries for evaluation and use in national breeding programs.

Perhaps most significantly, the project has substantially boosted participating countries' research capacity. Eight scientists from the project countries underwent intensive hands-on training in the use of molecular techniques in their plant breeding programs. Functional biotechnology laboratories have been established in each of the four countries and 27 national scientific staff, including women, have been trained to use the laboratory equipment. To further increase the biotechnology capacity of Africa, students from Benin, Burkina Faso, Côte d'Ivoire, and Niger are doing their Ph.D. studies on RYMV under WARDA's supervision.

According to Marie-Noelle Ndjiondjop, WARDA molecular biologist, who is heading the project, this is the first time that national programs in the project countries have had access to laboratories equipped for this sort of science.

"The legacy of this project," says Dr. Ndjiondjop, "will be the availability of laboratories furnished with the equipment necessary to apply molecular biology techniques to rice breeding, as well as trained national staff who can apply these techniques across many different crops."

For the trainees—such as Ms. Ken Bugul Jaiteh, research technician from the National Agricultural Research Institute, The Gambia—the project has been valuable in building national research capacity in biotechnology. This will help them identify and adapt the technology to their country's needs and constraints.

The potential benefits of the project are expected to go far beyond the four project countries to reach all the African countries that grow rice and could eventually turn the tide in the battle against the disease.

MELISSA FITZGERALD (*right*) and Teodie Atienza analyze rice-grain quality.

JOSE RAYMOND PANALIGAN

Illuminating the gap

by Melissa Fitzgerald and Robert Hall

The new science of metabolomics is shining a light into the dark space between a rice plant's genes and the resultant qualities we appreciate when we eat rice

The publication in 2005 of the rice genome—the sum total of genetic information in the rice plant, encoded in its DNA—provided a huge boost to genetic research. But, as we try to find genetic answers to questions such as why one variety tastes delicious but another tastes mediocre, we fall into that dark space between genotype and phenotype—that is, the unknown processes at the subcellular level that are regulated by the genes, and that lead to the end result that humans can see, feel, and of course taste.

That dark and seemingly impenetrable gap is buzzing with chemicals and reactions. It is the place where a chemical compound or compounds can switch on a gene, link an amino acid onto a growing protein, connect a glucose molecule to a growing chain of starch, or join together to make the key aromatic compound in fragrant rice. These processes, which are regulated or carried out in families of reactions, involve tens of thousands of small chemicals and compounds known as metabolites, many of which chemists have never seen. The detection, identification, and quantification of these small compounds are the elements of a new science called metabolomics. Some of the small compounds dissolve in solutions and some are volatile. These features determine the equipment that can be used, or that needs to be developed, to identify and measure them.

For a person involved in unravelling the science of the traits of rice quality, an obvious application for metabolomics is to try to solve some of the mysteries of aroma. Even Westerners who don't grow up eating rice can discriminate between the taste of Thai jasmine and Indian/Pakistani basmati rice. Asians who eat rice from the moment they can manage solid food, on the other hand, can discriminate between basmati grown in the Punjab and basmati grown 50 km away, and between jasmine rice grown in different regions of Thailand. Besides jasmine and basmati, well-trained palates can discriminate between the many, many more aromatic rice varieties grown in Southeast, South, and Central Asia.

Scientists have found a gene for aroma, which is carried by both jasmine- and basmati-style rice varieties. However, science has not yet discovered what determines the *difference* in taste between jasmine and basmati, let alone geographic and seasonal effects on the taste. Presumably, jasmine and basmati rice have unique chemical signatures, and metabolomics should be the conduit to knowing and understanding those signatures. In this way, we hope to close the gap between the genes and the suite of compounds that interact to make what we detect as taste.

Rice researchers have not yet succeeded in developing new varieties with higher yield while still maintaining aromatic quality. Examples of this can be found all over Asia. Take the highly prized, traditional Thai jasmine variety, Khao Dawk Mali 105 (KDML105). The aroma of KDML105 is renowned around the world, and many Southeast Asian rice breeders have used the variety in breeding programs that aim to obtain higher-yielding or disease-resistant forms of the rice.

In one case, genes for resistance to the devastating blast fungus were incorporated into KDML105 through traditional breeding. In three studies, the blast-resistant form of KDML105 had less than half of the key aromatic compound, 2-acetyl-1-pyrroline (2AP), contained in KDML105 itself.

In another study at IRRI, a number of varieties developed from crosses with KDML105, and that had obtained the same fragrance gene, all contained less 2AP than KDML105. Why is aroma best in KDML105? This is the sort of question, lurking in the dark space between genes and taste, that perplexes breeders and cereal chemists, and disappoints rice farmers, rice consumers, and rice traders.

But are such questions still unanswerable? Metabolomics could be the torch that illuminates that darkness, thus enabling us to find some of the compounds that explain variability in taste. IRRI is a collaborator in the META-PHOR project, funded by the European Union, to develop and standardize methods for metabolomic profiling of plants, and to develop a database of soluble and volatile plant metabolites (see www.meta-phor.eu for more information).

The International Network for Quality Rice (INQR) has provided a platform for national rice research organizations interested in aroma to collaborate with the META-PHOR project. Network members from Thailand, Laos, Vietnam, Malaysia, the Philippines, Myanmar, Indonesia, Australia, Pakistan, India, and Iran have supplied a total of 32 of their highest-quality aromatic rice varieties to the META-PHOR scientists. Of the 32 varieties, 21 are traditional, five have fragrance from KDML105, and six carry fragrance from other traditional varieties.

This initiative is giving scientists a real chance to do four key things: determine the difference between jasmine and basmati rice, identify the key compounds that differentiate the different types of aromatic rice, determine how many different types of aromatic signatures there are, and develop a library of compounds to measure in the development of new aromatic varieties. This knowledge will put scientists in position to not only understand the fundamental biochemical basis of aroma in rice but also to formulate targeted strategies for improving such traits of quality.

The metabolomic profilers plan to shine their torches at a joint META-PHOR–INQR meeting in Laos in May 2008. They will report on their answers to the questions raised in this article and show their colleagues from national and international research organizations some of the compounds and reactions that lie in that dark space between the genotype and phenotype of these aromatic rice varieties.

The following people generously provided the rice that was used in the META-PHOR project

Supanee Jongee, Thailand
Rauf Ahmed, Pakistan
Sanjukta Das, India
Chanthakhone Boualaphan, Laos
Asafaliza Ramil, Malaysia
Dewi Indrasari, Indonesia
Russell Reinke, Australia
Fatemeh Habibi, Iran
Nguyen Thi Lang, Vietnam

Dr. Fitzgerald is the head of IRRI's Grain Quality, Nutrition, and Postharvest Center and chair of the International Network for Quality Rice. Robert Hall is coordinator of the META-PHOR project and deputy business unit manager, Bioscience, at Plant Research International, Wageningen, The Netherlands.

META-PHOR is an international project funded by the European Union in its 6th framework programme (FOOD-CT_2006-036220).

META-PHOR project coordinator Robert Hall.

PLANT RESEARCH INTERNATIONAL

Conducted by Gene Hettel

JERBY AGUIHON (3)

Reflections of a rice widow

Carolyn Moomaw Wilhelm and her late husband, James ("Jim") Curtis Moomaw, arrived at International Rice Research Institute (IRRI) headquarters in Los Baños, Philippines, in November 1961 with an infant son in tow and ready for a grand adventure. After 8 years as IRRI's first agronomist (1961-69) and important posts in Africa and Taiwan, he passed away prematurely at age 55 in 1983. During a recent visit to IRRI—her first in 26 years—Carolyn spoke fondly about meeting and marrying Jim and their time at and beyond IRRI. Here are edited highlights of the interview.

Getting together at Washington State

Jim was the grandson of a very famous pioneer in the field of soil science, Dr. Curtis Fletcher Marbut, who did quality international work in South America, the Soviet Union, and Africa, as well as in the United States. This was always on Jim's mind and it honed his interest in doing similar research. Jim grew up on the Branch Experiment Station in Dickinson, North Dakota, where his father, Leroy Moomaw [also an agronomist and noted for his work with crested wheat grass], was superintendent for many years. Jim had a degree in botany (ecology), with a particular interest in applied agronomy involving soils, pastures, and grasses.

I met Jim at Washington State University—Washington State College in those days—in a class on soil microbiology. We were both graduate students, but he had been there several years before I met him during the 1954 fall [autumn] semester. He had come back from Alaska on crutches because he had "chopped" the wrong limb! He made an impression on me because he was on crutches—and he was my lab partner.

A year passed and we didn't pay much attention to each other. Then he visited me in the summer of 1955, when I was working at Yellowstone National Park during a break from my graduate studies. Suddenly, I realized this older man—he was 5 years older!—who had impressed me was interested in me. We were married almost immediately (within 6 months). He finished his very long research project, a study of grazing and burning of pastures in the Columbia Basin Region; I did a

GENE HETTEL

MRS. MOOMAW WILHELM stands in front of IRRI's long-term continuous cropping experiment, which her late husband started in 1963. Currently in its 132nd crop, it is the most intensively cultivated experimental site in Asia, and has provided important data on the effects of such a cropping system.

biochemical research project for an M.S. in the Bacteriology Department. Both of us completed our orals on 19 September 1956, packed up, and left that night en route to his first job as assistant professor of agronomy and soil science at the University of Hawaii. Hawaii in 1956 was not yet a [U.S.] state, but still a territory—and that in itself was new territory for us.

IRRI-bound on the USS Hoover

Jim was being courted by the Rockefeller Foundation, which by then [along with the Ford Foundation] had decided to establish IRRI. Originally, they were thinking Jim might go to Japan to do research in Sendai on Hokkaido. Then, Sterling Wortman [IRRI associate director, 1961-64], who had known and worked with Jim occasionally, suggested that Jim be considered for IRRI's first agronomist position. So, Jim was invited to see IRRI as it was being built [July 1961] and to meet [Director General Robert F.] Chandler and the rest is history. We were excited, very excited. We packed up and traveled by ship on the USS Hoover from Honolulu to Yokohama [Japan] and Hong Kong prior to docking in Manila. We spent several weeks in the Manila Hotel while waiting for our house to be finished and our household effects to be cleared.

That was the beginning of some very exciting times for us. Since I had already circumnavigated the globe with Jim (East Africa, Delhi, Calcutta, Bangkok, Hong Kong, and Tokyo during a Fulbright year to and from Kenya), I was not so shocked by the poverty we saw in the Philippines when we first arrived.

As a child, rice certainly was not something that I ever thought of. My mother would serve it to me with cinnamon and sugar—rice pudding. Now, thanks to IRRI, we think of it in an entirely different way. I'm very snooty about rice, even today you see. I don't want to buy that old stock that's in the market. I know some good Asian rice stores in Dallas and New York and where I live now [in Oklahoma].

James Moomaw on the world food crisis, summer 1976

The current climate of rapidly climbing grain prices, along with increasing reports of civil unrest due to unaffordable or unavailable food, makes the 32-year-old comments of Dr. Moomaw—then director general of the Asian Vegetable Research and Development Center in Taiwan—eerily prescient.

MOOMAW FAMILY COLLECTION

The food crisis is the result of specific failures in specific locations, for specific causes—usually weather or technology. It is not the trend, but the deviation from the trend, that causes disaster. Conceptually, the idea of a sudden "food crisis" is misleading. History has always known hunger, and, in fact, hunger was much more severe in the past, when populations were much lower. One hundred years ago, China had a drought that killed more than three million people. India has had food failures for the duration of its recorded history. Compared with past famines—the one in the 1880s claimed almost a fifth of their total population—hunger has been a negligible problem for India in the 20th century.

Nevertheless, there is no question that population growth exacerbates the problem of hunger, and, of course, many other social problems. It narrows the margin between the trend of production and the trend of human needs, making otherwise trivial deviations in production trends disastrous in their human consequences.

Agricultural technology will continue to solve problems. But can it keep up? That is what Robert Chandler, first director of both IRRI and the Asian Vegetable Research and Development Center (AVRDC), and George Harrar, former president of the Rockefeller Foundation), have been asking for 25 years. People cannot average their appetites—if your technology fails for whatever reason at just one time, you have disaster on your hands.

The areas of the world where the threat of future hunger runs highest, I believe, are the high-density, low-income nations, with relatively limited resources on a per capita basis. India, Indonesia, and mainland China all face difficulties. Although there has been less starvation, proportionately and in absolute terms, in this century than the last, it is possible that, with enough bad luck and bad planning, there could be as much by the end of the century, or more.

Go to www.irri.org/publications/today/Pioneer_Interviews.asp for more observations on a variety of topics by Dr. Moomaw, then AVRDC director general, excerpted from a 1976 interview conducted by journalist Nick Eberstadt.

There were very few Americans at IRRI in the beginning, but there were many other nationalities and they were also excited to be a part of this new venture. However, in some respects, the women [spouses] with whom I interacted were often quite lost and lonesome without the extended families they were accustomed to. The Chinese, the Ceylonese [Sri Lankan], the Indians came from cultures in which they had strong support systems. Coming [to IRRI] was a much greater sacrifice for them than it was for me or for any of the American women [who came to IRRI with their husbands in those days].

Going to Ceylon

[In 1967] IRRI received a grant from the Ford Foundation for rice research in Ceylon (today's Sri Lanka) and Bob Chandler offered Jim the opportunity to lead the project. [At first] I didn't want to go. We had four little boys (ages 7, 5, 2 and a half, and 1+) and I couldn't see myself coping and I was worried about obtaining potable water, milk, good food, and

ALVIN W. REGIER

CAROLYN WITH HER brood (*from left*, Bill, Charlie, Martin, and John) in front of their house at IRRI on 22 January 1967. Later that year, they joined Jim in Ceylon as IRRI's first outposted family.

other basic necessities. In the end, I agreed to go and we were quite a unit going into the IRRI program at Kandy [south-central Ceylon].

Most of the time, Jim was in the field. He was all over that island. He was so motivated to see everything and to get as many rice plots established as possible. He worked all the time and so I had my own responsibilities taking care of four sons. All of a sudden, we were the only ones [IRRI people in Ceylon and almost the only Americans!] and so everybody who was coming through, of course, either stayed with us or we entertained them. That was really fun for me. It was a very, very nice 2 years that we spent there. It wasn't easy, but it was nice.

Into Africa

After Ceylon, I was disappointed that we didn't come back to IRRI. I wanted to come back. I wasn't all that keen on going to Africa. We had arm-twisting sessions in New York with [Richard] Bradfield [IRRI agronomist, 1963-71] and the Rockefeller people who talked us into the job. We knew that it was important. We knew that this new institution [the International Institute of Tropical Agriculture (IITA)] needed what Jim could offer, and in the end we decided that we would do it and we went to Nigeria [in 1970].

Jim enjoyed IITA. He first went there as the rice specialist. Together with the resident Nigerian rice breeder, he developed the rice program and then became the farming systems leader. This broadened his scope a lot to include economics and soil and water management. Some of the people whom he hired in the department were just very, very good and very motivated—including Eugene Terry [a future director general of WARDA, the Africa Rice Center, 1987-96]. It was a big department with respected Nigerian staff too.

Then, Jim was offered the outreach director position. He accepted and traveled all over Africa putting in programs. I don't think he ever got to South Africa; he traveled mostly in the middle part of Africa. It was dangerous in many respects, mostly traveling in a small plane. It was very nerve-racking for me. Internal travel while we were in Nigeria was really very difficult because the roads were so bad. So, I didn't get to do very much traveling in Africa myself.

Still alive

Without Frank Byrnes [IRRI's first communications specialist, 1963-67], I would have lost contact with the international life after Jim died [of a brain tumor at the age of 55 in New York] in 1983. He's the one that made a real effort to keep me informed of what was going on at IRRI. His friendship continued after I moved to Dallas about 3 years after Jim died. I really didn't emerge for several more years until Frank invited me to Winrock [International; a nonprofit organization associated with the Rockefeller Foundation, where several former IRRI staff worked] in February 1989. This sort of jolted me out of my grief. It took me such a long time to recover because the boys were my major concern, and my fledging career and our move to Dallas were also major distractions. So, I really hadn't come out of it until I met Frank at Winrock. Finally, I could say I'm still alive; I'm still here.

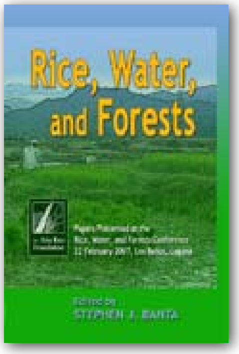
Dirty boots and rice widows

Bob and Sunny Chandler were incredible people—inspiring, energetic, devoted, and generous. Bob had very little patience for trivia, however. He wanted everybody—all the scientists—to get their boots dirty right away, be out in the field. In fact, the story was he would go around and look at the boots. If a staff member hadn't been in the field that day, there were questions. Of course, Jim had no problem with that. Agronomy is the field. We admired both of them greatly and I learned so much from Sunny. Apart from my mother, she had more influence on me as a developing, maturing young woman than anyone else in my life and that holds true today.

Yes, we [the spouses of the early IRRI international staff] were rice widows. I think Bob Chandler actually coined that phrase. And that's what we called ourselves. He was an empathetic man and recognized our plight, but IRRI scientists, often away from home for long periods, had a job to do and we appreciated and supported that.

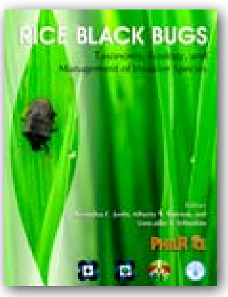
Go to www.irri.org/publications/today/Pioneer_Interviews.asp to read the full transcript of the Carolyn Moomaw interview in which she discusses more of her family's life at IRRI headquarters and in Ceylon, gives her no-nonsense impressions of other pioneer IRRI staff and their families, and describes how attitudes in Asia and Africa are completely different.

Rice, water, and forests



Edited by S.J. Banta; published by the Asia Rice Foundation; 300 Philippine pesos (US$7.30).

Three systems—rice, water, and forests—are inexorably linked. The rice that so much of Asia depends on for its huge population uses vast amounts of water. The water comes down from the mountains and hills. If upland forests are denuded or thinned for any reason—natural or human-induced, legal or illegal—the water is not captured as groundwater and may be lost to agriculture. This book explores these and many other more complex interrelationships among the three systems from the viewpoints of those involved in the separate disciplines and from an interdisciplinary stance. Implications for policymakers are suggested. The book is available at the Asia Rice Foundation, College 4031, Los Baños, Laguna, Philippines, phone +63 (49) 536-2285, asia_rice@agri.searca.org.

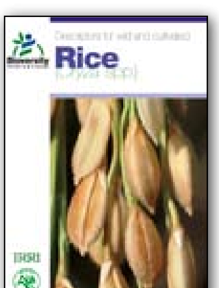


Rice black bugs: taxonomy, ecology, and management of invasive species

Edited by R.C. Joshi, A.T. Barrion, and L.S. Sebastian; published by PhilRice; 800 pages; Philippines P2,500, developed countries $102, developing countries $52.

This book includes ecologically sound management approaches to rice black bug (RBB) outbreaks, country reports of RBB invasions, and clarifications of confusing RBB taxonomy. This reference manual reinterprets old problems and introduces new ecological techniques for RBB management. The book comes with a searchable DVD containing more than 300 articles on RBB from experts around the world, dating from as far back as 1864 up to 2006. Orders: email prri@philrice.gov.ph or visit http://tinyurl.com/2su32m.

Descriptors for wild and cultivated rice (*Oryza* spp.)



Published by Bioversity International with the International Rice Research Institute (IRRI) and the Africa Rice Center (WARDA); 63 pages; free (pdf).

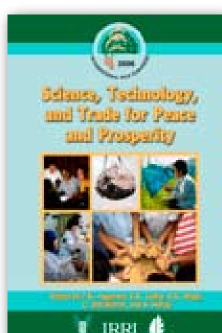
Descriptor lists ensure standardized metrics for describing plant varieties. This new set of rice descriptors, which updates the original 1980 list, has been expanded to include wild relatives of the genus *Oryza* and to harmonize the descriptors with those of the International Union for the Protection of New Varieties of Plants, which are geared to new commercial varieties. The list, which will help curators and researchers make better use of genebanks, offers a rapid, reliable, and efficient means to store, retrieve, and communicate information about rice diversity. A free pdf version is available at http://tinyurl.com/2waduw.

Global rice and agricultural trade liberalisation: poverty and welfare implications for South Asia

Edited by M.A. Razzaque and E. Laurent; published by the Commonwealth Secretariat; 223 pages; £20 ($40).

Rice has long been one of the protected commodities in world trade. Now, the probable significant liberalization of trade in rice is likely to have huge welfare implications for many countries dependent on its production and trade, particularly those in South Asia. This book explores the poverty and welfare implications of this liberalization for India, Bangladesh, Pakistan, and Sri Lanka, and identifies the effects on different groups within poor rice-dependent developing countries. For more information: Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX, UK; phone +44 (0)20 7747-6342; fax +44 (0)20 7839-9081; email publications@commonwealth.int; www.thecommonwealth.org/publications. Available in the USA from Stylus Publishing LLC, PO Box 605, Herndon, VA 20172-0605, USA; phone +1-703-661-1581 or 1-800- 232-0223; fax +1-703-661-1501; email styluspub@aol.com; www.styluspub.com.

Science, technology, and trade for peace and prosperity: Proceedings of the 26th International Rice Research Conference, 9-12 October 2006, New Delhi, India

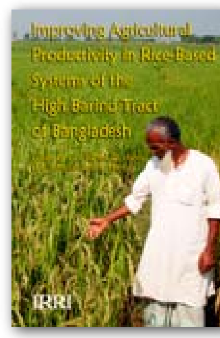


Edited by P.K. Aggarwal, J.K. Ladha, R.K. Singh, C. Devakumar, and B. Hardy; Published by IRRI, Indian Council of Agricultural Research, and National Academy of Agricultural Sciences; 782 pages.

The world faces sharply rising rice prices and global stocks are plummeting to levels not seen for nearly 30 years. Many nations today thus confront the second-generation challenge of producing more rice at less cost in a deteriorating environment. The 2nd International Rice Congress was held to provide a common platform for sharing knowledge and expertise on research, extension, production, processing, trade, consumption, and related activities with all stakeholders of rice. The knowledge base in this book will help meet the challenge of producing more rice with greater efficiency and profitability in a changing global environment.

Improving agricultural productivity in rice-based systems of the High Barind Tract of Bangladesh

Edited by C.R. Riches, D. Harris, D.E. Johnson, & B. Hardy; published by IRRI; 215 pages; $16.



The High Barind Tract of northwest Bangladesh is an area of low and erratic rainfall with limited irrigation potential. Research described in this book has led to cost-effective ways of increasing the productivity of both rice and winter *rabi* crops in the Barind. The improved practices that have been validated by farmers are knowledge-intensive. The challenge now is to make this information widely available to farmers in the Barind so that the reliability and productivity of agriculture in this marginal cropping area, as well as food security and income from agriculture, can be increased. The book discusses the application of validated technologies to the High Barind Tract and similar drought-prone environments in Bangladesh and identifies opportunities and requirements for enhancing the scaling-up of these technologies in extension programs.

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The power of policy

by Nelissa Jamora and Debbie Templeton

Safer and more effective pesticide use by Philippine farmers provides a striking example of the impact of good policy, but good research must be a starting point

In the late 1960s, newly developed, high-yielding rice varieties launched the Asian Green Revolution, which rapidly pushed up yields and allowed rice production to keep pace with population growth.

In the Philippines, as in many other countries, widespread use of pesticides expanded in step with the new varieties. This was largely due to concerns that crop losses from pest infestation would negate the benefits of planting modern rice varieties. Even the release of pest-resistant varieties did little to curb the growing use of pesticide during the 1970s and into the 1980s. Indeed, the Philippine government at the time promoted the wide and intensive use of agro-chemicals among small farmers from 1973 to 1986 under the *Masagana 99* scheme.

By the 1980s, it was clear that indiscriminate use of pesticides could exacerbate, rather than alleviate, pest problems. In addition, there was growing evidence of the ill effects of the injudicious use of toxic pesticides on both the environment and human health. Moreover, research undertaken by the International Rice Research Institute (IRRI) showed that farmers' private health costs were greater than any economic benefits gained from using pesticides without appropriate health, safety, and environmental knowledge and the attendant precautions.

In response, and in keeping with international protocols, the government under President Fidel Ramos (1992-98), through the Fertilizer and Pesticide Authority (FPA), instigated a new suite of pesticide regulatory policies and implementing guidelines. These aimed to ban or restrict the use of commonly used but highly toxic pesticides in rice production, and encourage safer pesticide management practices (these initiatives are collectively referred to here as the 1992-96 pesticide policy package, or PPP).

However, even with the best political will, getting millions of farmers in a developing country to adopt new regulations is difficult. To determine whether or not the regulatory policy changes made a real difference on farms, IRRI conducted a survey of rice farmers in 2007 in Quezon, Nueva Ecija, and Laguna provinces. The survey results were compared with corresponding data collected in 1989-91 surveys undertaken before the policy changes as part of IRRI-led research on types and quantities of pesticide used, pesticide application and storage practices, incidence of farmer poisonings, and the overall effects of pesticide use on the health of Philippine rice farmers.

The primary policy advice arising from this research was to restrict the use of hazardous pesticides by imposing and implementing bans on those pesticides that pose acute or chronic health effects or adversely affect the environment—a recommendation that was reflected in the PPP.

Changes in types of pesticide used

Prior to the PPP, Philippine rice farmers commonly used pesticide classified as World Health Organization (WHO) Hazard Class I (highly or extremely hazardous) and II (moderately hazardous).

On 1 June 1994, the FPA banned or restricted the use of all Class I and some Class II pesticides. Despite this, importation and use of banned or restricted pesticides continued for a number of years. In response, an task force was formed to minimize pesticide smuggling. In addition, the FPA allowed the use of legal generic-brand pesticides, resulting in lower costs that reduced the attraction of cheap, but illegal, pesticides.

In the 2007 survey, 93% of the farmers said they could no longer find the banned chemicals in the marketplace, and 90% said they no longer use the banned pesticides. Further, more than 99% of the chemicals being used by the respondents were registered for use in rice production in the Philippines, even though 29% of the respondents said that they would still use the banned pesticides if they were available despite recognizing the health and safety issues.

In sum, the survey results indicated that the FPA has largely been successful in promoting the use of less toxic pesticides. Of the registered alternatives now available, 61% are classified as Category II (moderately hazardous), 28% as

Table 1. Pesticide management and safety practices (% of farmers), Nueva Ecija, 1991 and 2006.

Preventive/safety measures	Nueva Ecija (% of farmers reporting) 1991	2006
Avoid smoking while spraying	61	92
Avoid spraying into the wind	63	94
Avoid spraying when very hot (before 8:30 a.m.)	72	92
Eat or drink before spraying	9	78
Wash immediately after spraying	6	86
Wash sprayer after use	83	84
Wash-water not thrown in irrigation canal	17	64
Recap bottle after use	83	86
Do not recycle empty bottles	17	34

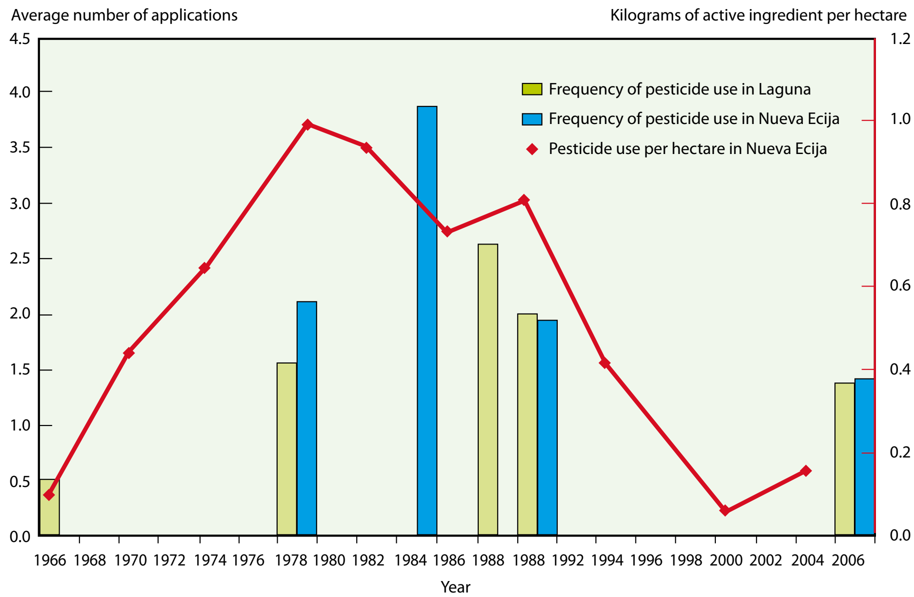
Table 2. Deaths due to pesticide poisoning.

1982-85		1991-95		2000-01	
Cases	Deaths	Cases	Deaths	Cases	Deaths
1,704	332	336	63	327	18

Category III (slightly hazardous), and 11% as Category IV (unlikely to present a hazard in normal use).

Unsafe pesticide practices in the Philippines have been documented in several studies. The 1989-91 IRRI studies found that, even if farmers were aware that pesticides were hazardous, they often lacked knowledge of proper pesticide management. As part of the PPP, the FPA thus encouraged pesticide companies to improve their safety information and implemented a hazard awareness campaign aimed at teaching rural health officers to recognize and treat pesticide poisoning cases. Dealers, farmers, and Department of Agriculture field personnel were trained in the safe handling of pesticides, and their judicious use was promoted through a mass media campaign and integrated pest management workshops.

Data collected before and after the PPP show significant increases in the number of farmers following recommended pesticide safety measures (Table 1). For example, in 1988-89, only 2% of the farmers in Laguna and Nueva Ecija wore both long sleeves and long pants when spraying, compared with 85% in 2006. In 1988-89, 61% of the farmers avoided smoking while spraying and 63% avoided spraying into the wind; by 2007, more than 90% of the farmers had adopted these safety practices. The number of farmers who wash immediately after using pesticides rose from 6% at the end of the 1980s to 86% in 2006.



Trends in pesticide use and frequency of application, Central Luzon (1966-2000), Laguna (1966-2000), and Nueva Ecija (1979-2006).

Pesticide poisoning

Unsafe pesticide application, storage, and disposal practices all contribute to pesticide poisoning. Sadly, however, the majority of recorded cases are intentional. Of the 4,031 acute pesticide poisonings reported by government hospitals from 1980 to 1987, 603 cases resulted in deaths, and almost two-thirds of these were suicides.

A series of three studies led by the Philippine Department of Health (DOH) showed a clear drop in both the number of cases of, and deaths due to, pesticide poisoning before and after the introduction of the PPP (Table 2). These data are not directly comparable because the number of regions covered in each study varies; however, the incidence rates (the number of poisonings per 100,000 people) fell from 3.27 in 1982-85 to 1.08 for the 5-year period 1991-95. Further, from the late 1980s to 2007, the percentage of farmers reporting pesticide illness fell by almost half.

Although the aim of the 1992-96 PPP was to bring about a change in the type of pesticide used (from more hazardous to less hazardous) and pesticide management (toward safer application and storage methods) rather than the quantity used, the changes in quantity and number of applications are of interest for two reasons.

First, they provide a measure of changes in pesticide exposure not necessarily due to the policy change. As can be seen from figure above, the amount of pesticide used began to drop before the PPP was introduced. This drop may have continued, albeit at a slower rate, even if the PPP had not been implemented.

Second, because the more hazardous pesticides are cheaper than their less hazardous counterparts, the PPP bans indirectly raised the cost of chemical pest control. Therefore, some of the fall in quantity of pesticides used and number of applications can be attributed to the PPP-induced price increase. The 2007 IRRI surveys showed that, on average, farmers in 2004 used one-fifth the amount of pesticide they used in 1991. Over the same period, frequency of sprays fell from around two applications per season to 1.4.

The success of the PPP offers a good example of the value of high-quality, independent agricultural research. By contributing to the body of research on the health effects of pesticide use, IRRI played a role in bringing about policy changes that drove a reduction in the use of hazardous pesticides, improved awareness of and adherence to their safe use, and reduced the incidence of pesticide poisoning. The PPP also had an indirect role in reducing the overall amount and frequency of pesticide use. Thus, the PPP contributed substantially to an improvement in Filipino farmers' health and well-being, and produced very large benefits in terms of private health costs avoided.

Nelissa Jamora is an agricultural economist in IRRI's Social Sciences Division (SSD). Debbie Templeton worked as an Impact Assessment Specialist in SSD from 2005 to 2008.

BY KEI KAJISA

The revolution keeps rolling

It has been well documented that the Asian Green Revolution (GR), which began in the 1960s with the introduction of modern, high-yielding rice varieties, has contributed to poverty alleviation by reducing the real rice price on the world market by more than half without depleting producers' profit. The poorest of the poor, such as urban laborers and rural landless and marginal farmers, have benefited most from this price reduction because they are net buyers who spend a large portion of their income on staples.

An emerging consensus from recent research is that the GR had an impact on not only the generation of farmers who directly benefited but also on multiple succeeding generations. It has become clear that the GR produced long-term benefits much greater than those mentioned above, including a reduction in childhood malnutrition, which affects people for their entire life and is thus considered more serious than adult malnutrition (also see *Do rice prices affect malnutrition in the poor?* on page 37 of *Rice Today* Vol. 5, No. 3).

Another less-recognized benefit is improved children's education. Several recent studies, including one by the International Rice Research Institute (IRRI),[1] reveal that the GR vigorously enhanced schooling investments for children—often considered a luxury many poor cannot afford. Agricultural development catalyzed by the GR led to an initial growth in farm income, which accelerated parents' schooling investments for their children, resulting in further income growth via educated children's participation in the relatively lucrative nonfarm sector. Thus, the GR contributed to faster poverty alleviation for the children of GR farmers.

The Green Revolution has produced long-term benefits much greater than previously thought

The Indian state of Tamil Nadu offers an example of how the GR has increased schooling investment. For farmers in many parts of the state, farming depends on rainfall-supplemented irrigation systems or direct rainfall. Therefore, the GR increased farm income the most in areas that received sufficient rainfall. The table (*above right*) shows that, as expected, areas with higher average rainfall (thus, higher farm income) have achieved faster growth in school enrollment rates.

School enrollment rates (%) by age group and average annual rainfall in Tamil Nadu, India.

Years	Middle school (11–14 years)		Secondary school (15–16 years)		Higher secondary school (17–18 years)	
	High-rainfall	Low-rainfall	High-rainfall	Low-rainfall	High-rainfall	Low-rainfall
1993-1994	77	70	58	57	32	30
1999-2000	83	64	76	65	54	46

Source: Cost of Cultivation of Principal Crops, Tamil Nadu Agricultural University.
Notes: The figures for primary-school age groups are not shown as universal primary education had been almost achieved in Tamil Nadu by the early 1990s. High-rainfall group: villages with annual rainfall greater than the mean. Low-rainfall group: villages with annual rainfall less than the mean.

However, there are concerns that such GR-led educational progress makes farm families in favorable areas wealthier, but leaves the poor in unfavorable areas behind. Nevertheless, the Tamil Nadu data, which also show that the income gap between the high- and low-rainfall areas has narrowed, contradict this. What is happening?

The increase in nonfarm job opportunities in unfavorable farming areas is also a key to income growth, given the disadvantages of farming such land. In particular, the expansion of unskilled or semiskilled job opportunities (jobs in household goods factories or in the rural service sector, for example) is important for the uneducated in unfavorable areas. And, to this end, there is evidence that the GR-driven development of the agricultural sector contributes through increased demand for nonfarm products and services in rural areas. Indeed, nonfarm industries are often established in agriculturally unfavorable areas a moderate distance from urban centers, where they can take advantage of lower wage rates without losing their access to markets. Thus, the GR has had an indirect positive effect on income growth in unfavorable areas.

The link from the GR to the development of the nonfarm sector and then to income growth in unfavorable areas therefore provides another example of a long-term indirect impact. More research is required to confirm this link, but, if confirmed, the long-term benefits of the GR would be boosted even further.

[1] Keijiro Otsuka, Jonna P. Estudillo, and Yasuyuki Sawada, editors. Forthcoming. *Rural Poverty and Income Dynamics in Asia and Africa*. Abingdon (UK): Routledge.

Dr. Kajisa is an agricultural economist in IRRI's Social Sciences Division.

INTERNATIONAL CONFERENCE
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Planthoppers

New threats to the sustainability of intensive rice production systems in Asia

Keynote addresses

Science and politics in planthopper management in Asia
Dr. Peter Kenmore, Chief, Plant Protection Service, Food and Agriculture Organization, Rome

Ecological engineering for pest management
Professor Geoff Gurr, Professor of Applied Ecology, Charles Sturt University, Orange, Australia

Topics

- Planthopper-transmitted virus diseases
- Migration of planthoppers
- A new planthopper problem in hybrid rice
- Genetics and breeding for host-plant resistance to planthoppers
- Insecticide resistance
- Farmers' perceptions in planthopper management
- Factors causing planthopper outbreaks
- Synthesis of current situation in the region

Pests and diseases threaten the sustainability of rice production. Planthoppers are pests that are normally kept in check by naturally occurring biological control services. In the 1970s and 1980s, planthoppers threatened rice intensification programs in Indonesia, Thailand, India, the Solomon Islands, and the Philippines. IRRI organized the first brown planthopper (BPH) international conference in 1977, bringing together scientists from all rice-producing countries. Activities triggered by this meeting—including integrated pest management (IPM), reducing unnecessary insecticide use, and breeding BPH-resistant rice varieties—helped keep BPH under control for the next 20 years. However, in the last 5 years, planthopper problems have intensified in several countries, including China, Korea, Japan, and Vietnam. Increasing insecticide resistance is also a concern.

Since the first BPH conference, genetics, ecology, and pest management have advanced considerably. Ecological research showed that planthoppers are secondary pests induced by ecological perturbations. To build sustainable systems that will keep planthopper densities low, researchers must engage in ecological engineering to enhance ecosystem services and improve ecosystem resistance and resilience. In the last 30 years, scientific advancements have coincided with the development of ecosystem-services frameworks and lessons from breeding resistance, understanding farmer decisions, implementing IPM, and improving communication campaigns. The new knowledge can allow novel approaches and research for more sustainable management. This conference, which will bring together regional experts and policymakers, will be an important starting point.

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第5届国际杂交水稻学术研讨会
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