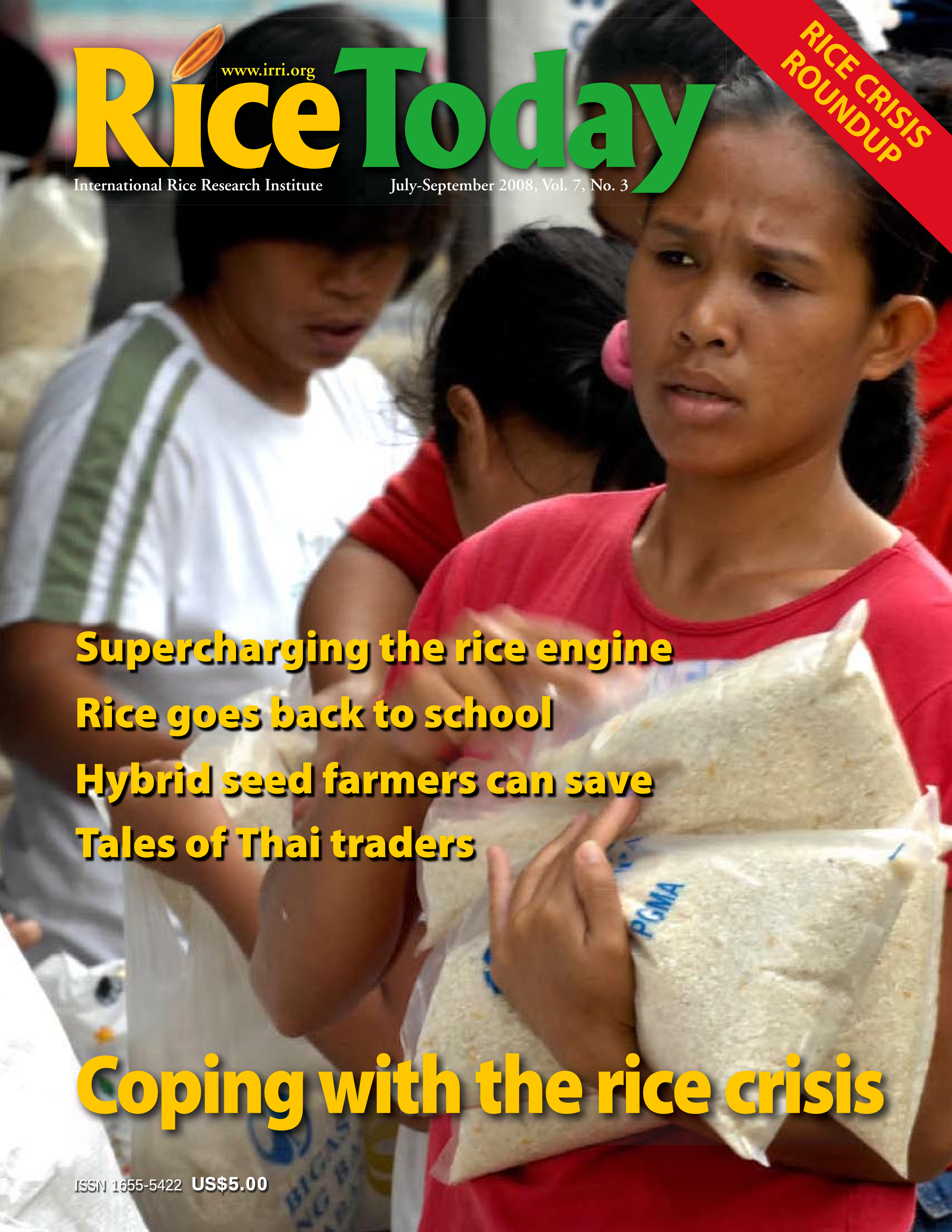

Rice Today

www.irri.org
International Rice Research Institute
July-September 2008, Vol. 7, No. 3

RICE CRISIS ROUNDUP

Supercharging the rice engine

Rice goes back to school

Hybrid seed farmers can save

Tales of Thai traders

Coping with the rice crisis

ISSN 1655-5422 US$5.00

5th International Hybrid Rice Symposium

Sustaining Development for Hybrid Rice

11-15 September 2008, Changsha, China
www.5thishr.cn

The organizing committee of the 5th International Hybrid Rice Symposium invites participants to submit papers on the following topics:

- Improvement in hybrid rice breeding methodologies and products
- Application of biotechnology in hybrid rice
- Technology of hybrid rice seed production
- Physiology and high-yielding field management of hybrid rice
- Improvement in hybrid rice grain quality
- Hybrid rice economics, public-private partnership, and intellectual property management

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contents

Rice Today
Vol. 7, No. 3

On the cover: A Filipino woman collects subsidized rice at a market in Quezon City, Manila. High prices have hit the urban poor, many of whom spend a large proportion of their income on rice alone.

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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).

A grain whose time has come

It's been an extraordinary 4 months since the last issue of *Rice Today*. To see rice prices and food security at the top of the agenda of the recent G8 summit in Japan, not to mention the World Food Summit in Rome a month earlier, was a clear signal that agriculture is back. Clearly, policymakers and government leaders are now acutely aware that agriculture means food production—which may sound obvious, but is a point that appears to have been missed for years—and that there is almost nothing more important to their voters than their food.

Agriculture in general and rice in particular found themselves on the front pages of newspapers, leading TV news bulletins, and clogging the Internet. IRRI became a magnet for journalists, as a torrent of correspondents from CNN, BBC, the *New York Times*, the *Wall Street Journal*, the *Economist*, and so on (not to mention Finnish TV and New Zealand Radio) streamed into Institute headquarters (see www.irri.org/media/articles.asp). Rice prices were exploding and the world wanted to make sense of it—who better to talk to than the people leading the research to improve rice production for the billions of poor farmers and consumers who depend on the grain?

The re-emergence of rice as a newsworthy topic was welcome. The circumstances that drove the news, however, were not. Higher prices across the world had a major impact on those who spend a large proportion of their income on rice alone. Civil unrest broke out around the globe. Several people died in Haiti's rice riots. The Philippine government threatened hoarders with long jail terms. Bangladeshi workers staged major protests over unaffordable prices.

The positive out of all this is that agriculture—and the importance of public agricultural research such as that conducted at IRRI—is back at the top of the political agenda. Several countries, including the Philippines, Malaysia, and Indonesia, have announced major programs to boost agricultural productivity through infrastructure improvement, dissemination of knowledge and technology, and research and development. Governments and funding agencies have emphasized the need to reinvest in agricultural research.

So far, all this talk has been mostly that—talk. There have been a few hopeful signs, such as the United States Agency for International Development likely reversing its decision to cut funding to IRRI and its sister institutes. But it remains to be seen whether or not the talk will really translate into action. If we are to avert crises like this in the future, it must.

Adam Barclay
Editor

Some relief but higher rice prices remain

After continuing to climb in May 2008, rice exports have fallen from their peak of more than US$1,000 per ton, but, as of late July, remained around double the December 2007 price. With the Food and Agriculture Organization of the United Nations (FAO) projecting a 2.3% growth in world paddy (unmilled) rice production to 666 million tons in 2008, economists are predicting that, assuming normal weather patterns, prices could drop further. Nevertheless, agricultural economists are warning that the world must get used to higher prices.

"My personal view is that prices will continue to decline but won't return to the pre-crisis level," said Sam Mohanty, head of the Social Sciences Division at the International Rice Research Institute (IRRI).

Although Vietnam contributed to the easing of prices by ending its export ban, the country has imposed a minimum export price of $800. With India indicating that its export restrictions would remain at least until the wet-season harvest in October or November, and with continuing high oil and fertilizer prices, the international market remains under pressure.

Poor consumers are still hurting, with domestic prices across Asia remaining high. Civil unrest broke out in several countries as prices spiked in April and May. Several people were killed in rice riots in Haiti, prompting the senate to fire Prime Minister Jacques Edouard Alexis. Also in April, 20,000 Bangladeshi textile workers rioted over high food prices—particularly rice—and low wages.

High prices also threaten to worsen malnutrition among the poor. Already, the Philippines has been forced to scale down its Food for School Program—which distributes iron-fortified rice to children in public schools—from 40 to 20 provinces.

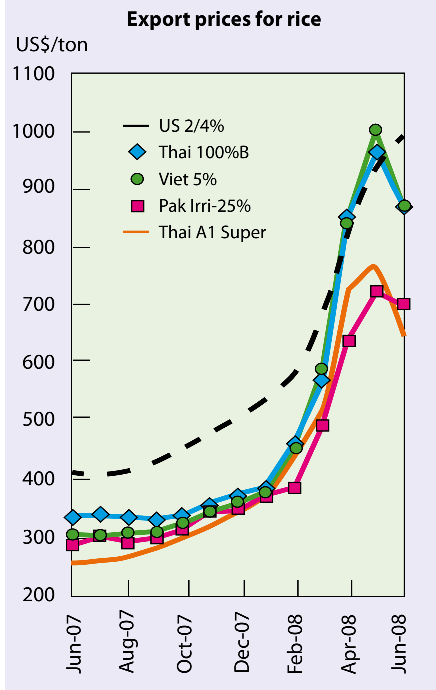
Cyclone Nargis devastated Myanmar's Ayeyarwady (Irrawaddy) Delta area on 3 May 2008, leaving more than 130,000 people dead or missing and causing an estimated 1.2-million-ton (6%) drop in rice production, jeopardizing the country's exports. News of the disaster caused rice prices to jump in an already jittery market.

The food crisis of early 2008 has pushed agriculture high onto the political agenda for the first time in decades. Several countries, including the Philippines, Indonesia, and Malaysia, have announced major initiatives, each of around $1 billion, to increase rice production and productivity through infrastructure development, technology and knowledge dissemination, and agricultural research.

During a 2 May 2008 visit to IRRI with President Gloria Macapagal-Arroyo, Philippine Secretary of Agriculture Arthur Yap and IRRI Director General Robert Zeigler signed a memorandum of agreement committing IRRI and the Department of Agriculture to a 5-year cooperative agreement to carry out the Philippines' rice self-sufficiency plan.

AT IRRI TO SIGN a memorandum of agreement on improving rice production (*from left to right*), Philippine Secretary of Agriculture Arthur Yap inspects an experimental field with President Arroyo, Dr. Zeigler, and IRRI senior scientist Darshan Brar.

ARIEL JAVELLANA



Source: FAO Rice Price Update July 2008

Many other agencies and leaders called for a reinvestment in agricultural research and development. The FAO hosted a High-level Conference on World Food Security in June, and food issues were high on the agenda at the July G8 summit in Japan, where the G8 leaders pledged to "promote agricultural research and development, and the training of a new generation of developing-country scientists and experts focusing on the dissemination of improved, locally adapted, and sustainable farming technologies, in particular via the Consultative Group on International Agricultural Research [which includes IRRI], and through partnerships such as the Alliance for a Green Revolution in Africa."

According to IRRI Development Director Duncan Macintosh, the sentiment is welcome but must be followed up. "IRRI has been calling for reinvestment in agricultural research for years, and it has taken record prices to really get the message across," said Mr. Macintosh. "Now, if organizations such as IRRI and its national partners are to develop technologies that can help avert future crises, the promising talk needs to result in genuine action from governments and funding agencies."

Building a new generation of rice scientists

A course designed to inspire young scientists will develop the research leaders who can help prevent food crises such as that seen in 2008. The "Rice: research to production" course, held for the second time on 19 May–6 June at IRRI, brought together 29 participants from 13 countries across the developed and developing world.

Sponsored by the National Science Foundation in the United States, the Gatsby Foundation in the United Kingdom, and IRRI, the course also seeks to reverse the one-way traffic that has seen thousands of young scientists from the developing world taking jobs in the developed world.

"Many developed-country researchers are unaware of the impact their work can have in helping people from poorer countries overcome problems that farmers in richer areas could hardly imagine," said Susan McCouch, who conceived the course with IRRI Director General Robert Zeigler and plant pathologist Hei Leung.

"By experiencing the challenges themselves, and meeting and spending time with people from Africa and Asia who have to deal with these challenges, the students gain insights and inspiration that are nearly impossible from the comfort of their home," said Dr. McCouch, a professor in the Department of Plant Breeding and Genetics at Cornell University in the United States.

Countries worldwide are struggling to attract people into agricultural research careers. Some African countries rely on a single rice breeder to develop locally adapted improved varieties. Many countries in Asia and Latin America also suffer a dearth of qualified researchers and plant breeders.

The course, which will run again next year, hopes to secure funding to continue beyond 2009.

MELANIE SANBORN, from the United States, tries to enlist the help of a carabao (Philippine water buffalo) in preparing a rice field for planting.

HARRIS TUMAWIS

THE LARGEST, solar-powered rice mill in the United States: Mitsubishi Electric & Electronics USA, Inc. has provided more than 5,500 photovoltaic modules for a one-megawatt solar electric system at Far West Rice Mills in Nelson, California. The system is expected to deliver 1,440,000 kilowatt hours (kWh) a year—approximately 75% of the plant's total energy needs.

BRIEFLY

Rice supercomputer

IBM and researchers at the University of Washington have launched a program to develop improved rice varieties. With processing power equivalent to the world's third-most-powerful supercomputer, IBM's World Community Grid will harness the donated power from nearly one million personal computers in the Nutritious Rice for the World project. The initiative will help researchers determine rice protein structures and use the information to breed varieties with improved traits, such as increased nutrition. The project, helped by a $2 million grant from the U.S. National Science Foundation, will achieve in 2 years what would take more than 200 years using existing conventional systems. IRRI researchers are helping to determine which proteins to target. Anyone with a computer and Internet access can donate unused computer time by registering at www.worldcommunitygrid.org.

Rat plague continues

The rat plague that has devastated rice production in the Indian state of Mizoram—jeopardizing the food security of around 1 million people—is now threatening tens of thousands of people in Myanmar's Chin State. Every 50 years, the flowering of native bamboo in Mizoram and neighboring areas of Myanmar and Bangladesh causes a boom in the rat population. Once the bamboo food source is exhausted, the rats move into rice fields, destroying entire crops. According to the Chin Famine Relief Committee, the United Nations Development Programme has been providing limited food assistance since the infestation began. Mizoram's agriculture department has estimated a 75% rice shortfall for 2007–08.

Gene for yield potential

Researchers from Huazhong Agricultural University in China have pinpointed a gene that plays a major role in determining yield potential in rice, as well as the plant's adaptability to cooler climates. The study was published in the 4 May 2008 issue of *Nature genetics*. Rice productivity is determined by several traits, including number of grains per panicle, the height of the plant, and its flowering time. By

Intensive rice production is sustainable

Intensive, continuous rice production with good management can maintain or even increase soil health. That is the main message from a study published in the *Soil Science Society of America Journal* ("Soil carbon and nitrogen changes in long-term continuous lowland rice cropping" in Vol. 72, No. 3, May-June 2008), which documents changes in soil carbon and nitrogen under long-term continuous rice cropping in four long-term trials managed by IRRI.

Further, under tropical conditions, maintaining soil organic matter in continuous (two or three crops per year) rice systems requires neither the application of manure or other organic materials nor retaining large amounts of straw.

According to IRRI Deputy General for Research Achim Dobermann, the research shows that, with good management and the right amount of fertilizer, farmers can sustainably produce 18 or more tons of rice per year.

"We have been doing this in the most intensive way for 45 years and we routinely produce about 80% of the theoretically possible yield," explained Dr. Dobermann. "The average irrigated rice farm in Asia is at about 60–65%."

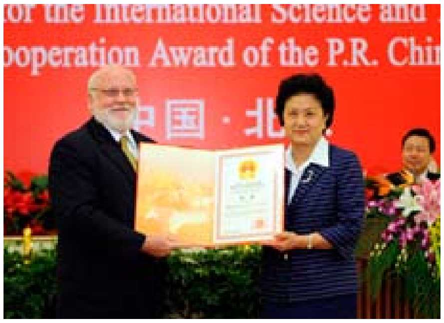
The system is sustainable because of the prolonged flooding of the fields, which allows conservation of soil organic matter and a free input of nitrogen from water and biological fixation sources amounting to about 120 kilograms per hectare per year—the equivalent of a grain yield of about 9 tons per hectare over three crops.

"No other of the world's major cropping systems has these unique features," said Dr. Dobermann. "It is for these reasons that rice monoculture systems have been around for thousands of years and sustained whole civilizations."

RICE IS GROWN three times a year in IRRI's long-term continuous cropping experiment.

ARIEL JAVELLANA

China honors IRRI



China has given one of its most prestigious scientific awards to IRRI for making an "important contribution to improve grain output, agricultural efficiency, and (the) income of farmers." IRRI Director General Robert Zeigler received the International Science and Technology Award of the People's Republic of China from China State Councilor Liu Yandong at a special award ceremony in Beijing on 5 June 2008 (pictured, *above*). Since official relations were established in 1981, IRRI has helped China develop higher yielding rice varieties, train and educate hundreds of Chinese rice scientists and researchers, and played a key role in the creation of the China National Rice Research Institute. Today, IRRI coordinates and works on a wide range of scientific projects across China.

screening thousands of rice plants, Qifa Zhang and his colleagues were able to identify a gene on rice chromosome 7 that influences these three traits. Deletion of the *Ghd7* gene causes plants that are shorter and have fewer grains per panicle. The researchers also found that natural mutants with reduced *Ghd7* function were better suited to cooler, temperate regions.

Radio soap cleans up

The Environmental Soap Opera for Rural Vietnam drama series has been awarded the Commendation Certificate by One World Broadcasting Trust for outstanding and unique contribution to the communication of sustainable development and human rights. The program, which started as IPM Radio in 2005, broadcast 235 episodes over the Voice of Ho Chi Minh City and five provincial radio stations. Farmers who listened to the drama used 30% fewer seeds for sowing, 9% less nitrogen fertilizer, and 60% less insecticide. IRRI entomologist K.L. Heong and former IRRI researcher Monina Escalada led the campaign's development.

Basmati blues

Norman Ellstrand, a geneticist from the University of California, Riverside, has been recruited to check the script of *Basmati blues*—"a film about love, adventure and ... genetically modified rice"— for the accuracy of its scientific content. Using GM agriculture as a backdrop, the film's story centers on a young American woman who works for a U.S.-based company working on GM rice in India. While in India, she gets caught up in a love triangle involving a scientist and a government official. The film, which is expected to be in U.S. theaters in mid 2009, will be dubbed into Hindi for Indian audiences.

Egypt joins Africa Rice Center

Egypt is the Africa Rice Center's (WARDA) newest member and the first from North Africa. WARDA's membership now stands at 22 countries, covering West, East, Central, and North Africa. Amin Abaza, Minister of Agriculture and Land Reclamation of Egypt, wrote in his request, "We wish to commend the Africa Rice Center as a continental organization serving all African countries."

Hybrid rice to benefit from new public-private partnership

A major new partnership aims to increase rice production across Asia via the accelerated development and introduction of hybrid rice technologies. The new effort comes at a crucial time for Asia as the region struggles with high rice prices caused by stagnating yields.

IRRI hosted the inaugural meeting of the Hybrid Rice Research and Development Consortium (HRDC) on 3–4 April 2008. Hybrid rice varieties have the potential to raise yields and thus overall rice productivity and profitability. Successful deployment of hybrid varieties, however, requires more effective cooperation between public research institutions and private-sector companies to overcome current constraints.

Participants at the meeting—which included 15 public-sector institutions from across Asia—learned about new plant genetic resources available or under development at IRRI, reviewed research on hybrid rice management, discussed new research priorities, and made decisions on other HRDC activities such as capacity building for both sectors.

Achim Dobermann, IRRI's deputy director general for research, said that rice farmers in Asia will benefit from accelerated access to hybrid rice-based technologies such as more and better hybrids, quality seed, knowledge, and services that can be provided by the new public-private partnership.

For more information, visit http://hrdc.irri.org.

GLOBAL CROP DIVERSITY TRUST

THE LATEST WORK of Japanese sculptor Mitsuaki Tanabe, which commemorates the Svalbard Global Seed Vault (see *The ultimate backup* on pages 10-11 of *Rice Today* Vol. 7, No. 2), will be permanently on display at the Global Crop Diversity Trust headquarters in the Food and Agriculture Organization (FAO) building in Rome, Italy. Mr. Tanabe, who also has a sculpture at IRRI headquarters in the Philippines, is seen here on 1 April 2008, unveiling the work, named *A seed of wild rice MOMI-2008*.

Pests thrive on pesticide

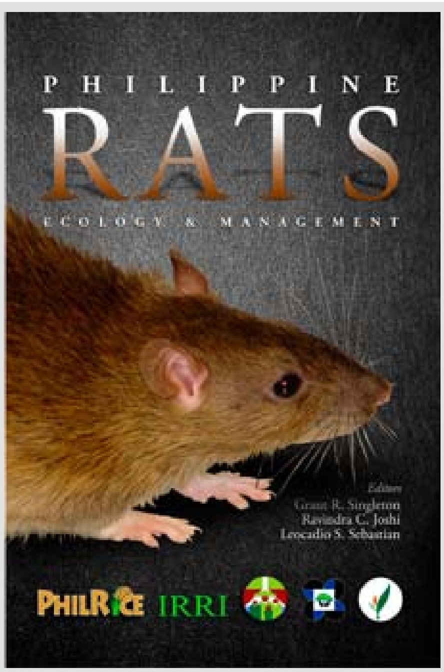
Pesticide overuse is, ironically, a major cause of planthopper infestations. This was a key message at the International Planthopper Conference, attended by 88 scientists at IRRI headquarters on 23–25 June.

Problems caused by planthoppers, a major insect pest that can destroy one-fifth of a rice harvest, have intensified across Asia in recent years, ravaging millions of hectares of rice in southern China and Vietnam and causing the loss of thousands of tons of the grain at a crucial time for global production

Planthoppers are normally kept in check by natural biological phenomena, such as other animals that prey on the pest. Over the past 20 years, developments such as integrated pest management, reducing unnecessary insecticide use, and breeding planthopper-resistant rice varieties have helped keep the pest under control. However, increasing insecticide resistance is becoming a concern.

"One of the key problems is overuse of pesticide," said IRRI entomologist and conference organizer K.L. Heong.

Peter Kenmore, chief of plant protection services at the Food and Agriculture Organization, said that farmers often overuse insecticides for fear of losing their production.



NEW BOOK—Philippine rats: ecology and management

Edited by G.R. Singleton, R.C. Joshi, and L.S. Sebastian; published by the Philippine Rice Research Institute; 215 pages.

The Philippines is home to more than 60 species of rats and mice, only a few species of which are serious crop pests. Those that do cause problems, though, can be devastating.

This book documents current knowledge on Philippine rodents, their ecology, systematics, diseases, and management. It covers a wide array of topics, including the shift in the management of rodent pests from heavy reliance on chemical control to the emergence of ecologically based rodent management; biology and management in complex agroecosystems; ecology of pest and native rodent species; and their impact on farming communities.

Philippine rats: ecology and management includes information on major social consequences of rodents in rural environments such as forgoing the planting of a second rice crop, sporadic acute production losses (often 30–60%), and the loss of labor and income because of diseases transferred to humans by rodents (including leptospirosis).

The book comes with two CDs: simple identification keys to quickly differentiate pest and nonpest rodent species in rice and nonrice habitats in the Philippines, and a searchable comprehensive bibliography and database on Philippine rodents.

For more information, contact Grant Singleton (g.singleton@cgiar.org). For ordering information, see http://tinyurl.com/5eavdy or contact Necitas Malabanan of PhilRice: phone +63 44 456 0651; email nmalabanan@philrice.gov.ph.

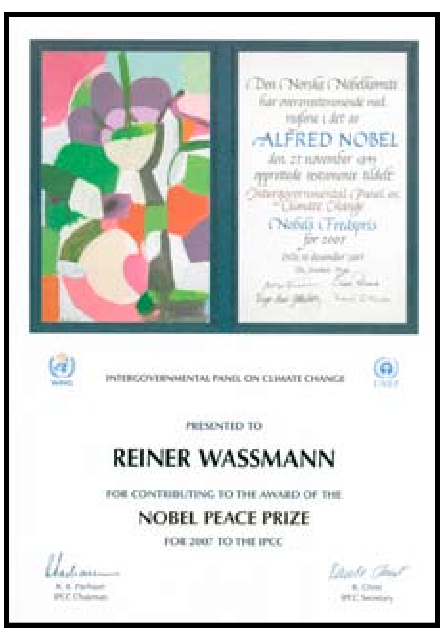
Awards and recognition

Sant Virmani, former IRRI principal scientist, received the Padma Shri Award from Indian President Prathiba Patil on 10 May in New Delhi (pictured, *right*). The award honored his contributions made at IRRI to the development and dissemination of hybrid rice technology in tropical countries, including India. Dr. Virmani was also honored by the city of Plano, Texas, where he now resides. Plano Mayor Pat Evans proclaimed 22 June to be "Dr. Sant Singh Virmani Day" in Plano. He was awarded a plaque from the Netlink Foundation in honor of his service to humanity in combating hunger and poverty around the world.

GOVERNMENT OF INDIA

IRRI Deputy Director General for Research **Achim Dobermann** is the recipient of the 2008 International Fertilizer Industry Association (IFA) International Crop Nutrition Award. The award recognizes Dr. Dobermann's pioneering research to fine-tune fertilizer and crop management practices to improve productivity of rice, maize, and soybean production systems in an environmentally sustainable way. He was honored at the IFA Annual Conference on 20 May 2008 in Vienna, Austria.

Reiner Wassmann, coordinator of IRRI's Rice and Climate Change Consortium, has been formally recognized by the United Nations Intergovernmental Panel on Climate Change (IPCC) for substantial contributions to the IPCC's Nobel Peace Prize award. The IPCC and former U.S. Vice President Al Gore were awarded the Nobel Peace Prize for 2007 "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change." Dr. Wassmann was one of the authors of the new guidelines to quantify national greenhouse gases emissions (the *2006 IPCC Guideline on National Greenhouse Gases Inventories*).



IRRI associate scientist **Romeo Cabangon** is the 2008 Outstanding Filipino Agricultural Engineer in the field of soil and water management. He was recognized for his contribution to the advancement of science in the field of soil and water conservation, specifically the development of water-saving technologies in rice-production systems in Asia.

Eugenio Castro, associate scientist at IRRI's Training Center, was named this year's Outstanding Professional of the Year in the field of agricultural engineering. The award recognizes Mr. Castro's expertise, manifested through his work in the design, development, and improvement of technologies in small-, medium-, and large-scale farming.

IRRI weed scientists were honored at the Annual Conference of the Pest Management Council of the Philippines held in Puerto Princessa, Palawan, on 6–9 May. **Joel Janiya** received the Pest Management Award in Research in recognition of his outstanding achievements on crop protection research. **Rolly Fuentes** won the Best Paper Award in Weed Science in collaboration with **Aurora Baltazar** and **Florinia Merca** of the University of the Philippines. **Teodoro Migo** was elected president of the Weed Science Society of the Philippines for 2008–09.

IRRI also received awards at the 38th Crop Science Society of the Philippines (CSSP) Annual Conference on 12–16 May in Iloilo City. Honors included Best Poster (Upstream Research), Best Poster (Downstream Research), Best Paper (Upstream Research), and a CSSP Achievement Award for Technology Development, won by Plant Breeding, Genetics, and Biotechnology (PBGB) Division associate scientist **Alvaro Pamplona**. **Renato Reaño**, CSSP president in 2006-07, received a Testimonial Award.

IRRI's 2007 nationally recruited staff awards were presented during the Institute's Board of Trustees meeting on 11 April. **Alice Laborte**, associate scientist in the Social Sciences Division won the Award for Outstanding Scientific Achievement for her work on land-use modeling. **Norberto Quilloy**, research technician in PBGB, won the Award for Outstanding Research Support for his work in plant breeding activities. Happily for *Rice Today*, the magazine's production and distribution team—**George Reyes**, **Juan Lazaro**, **Ariel Javellana**, **Jose Raymond Panaligan**, **Meg Mondoñedo**, **Emmanuel Panisales**, and **Chris Quintana**—won the Award for Outstanding Administrative Support.

Rice Today also had an excellent year in the Association for Communication Excellence (ACE) Critique and Awards Program, winning Gold (first place) awards for magazines and periodicals in the *Publishing* category (***Rice Today* production team**), for photography in the *Feature photo* category (**Ariel Javellana**), and for writing for magazines in the *Writing* category (**Adam Barclay**). Mr. Javellana also won a silver award in the *Environmental portrait or personality photo* category.

Keeping up with IRRI staff

Recent arrivals at IRRI include plant pathologist **Serge Savary**, senior scientist in the Plant Breeding, Genetics, and Biotechnology (PBGB) Division; plant pathologist **Laetitia Willocquet**, scientist, PBGB; agricultural economist **Samarendu Mohanty**, new head of the Social Sciences Division (SSD); **Digna Manzanilla**, postdoctoral fellow in SSD; **Deepinder Grewal**, postdoctoral fellow in PBGB; **Krishna Jagadish**, postdoctoral fellow in PBGB; **Matthieu Conte**, postdoctoral fellow in the Crop Resource Information Laboratory; **Xiangqian Zhao**, postdoctoral fellow in the Grain Quality, Nutrition, and Postharvest Center; **Sarah Covshoff**, postdoctoral fellow in PBGB; **Xin'ai Zhao**, postdoctoral fellow in PBGB; **Nobuko Katayanagi**, visiting research fellow in the Crop and Environmental Sciences Division (CESD); and **Yohei Koide**, visiting research fellow in PBGB.

U.S. Singh has become IRRI's South Asia regional project coordinator for developing abiotic stress tolerance. Based in New Delhi, he will help implement the project to reduce poverty and hunger and increase food and income security of resource-poor farm families and rice consumers in South Asia through the development and dissemination of rice varieties tolerant of abiotic stresses. The work is supported by the Bill & Melinda Gates Foundation project *Stress-tolerant rice for poor farmers in Africa and South Asia*.

Recent departures include **Gary Jahn**, entomologist and coordinator for the Greater Mekong Subregion; **Christine Kreye**, international research fellow in CESD; **Yuichiro Furukawa**, project scientist in CESD; and **Hector Hernandez**, head of Human Resource Services. **Paramjit Sachdeva** is acting head of HRS until the arrival of **Fiona Farrell**, who is scheduled to begin in September.

David Johnson, senior scientist in CESD, is the new coordinator of the Consortium for Unfavorable Rice Environments, taking over from **David Mackill**. **Bas Bouman** has been appointed leader of IRRI's program on *Sustaining productivity in intensive rice-based systems: rice and the environment*. He remains CESD head. **JK Ladha** has returned to the IRRI-India Office in New Delhi after a successful year-long fellowship at Cornell University. He remains IRRI representative and coordinator for the Rice-Wheat Consortium.

Federico Ramos, former superintendent of the IRRI Farm (now the Experiment Station), 1961–85 and father of University of the Philippines President and IRRI Board member **Emerlinda Roman**, passed away on 13 May.

Rice Today around the world

LIZZEL LLORCA

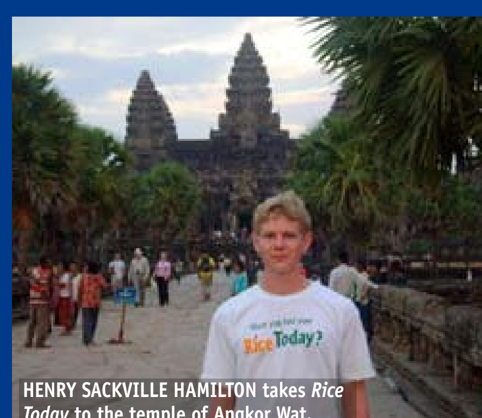
EMILY DEAMANO, former IRRI bioinformatics researcher, with *Rice Today* in front of Petronas Twin Towers, Malaysia.

RICE AND MANGOES: not a Thai dessert but a farm in Queensland, Australia. Mango grower Tom Castorina (*right*), shows off his mango farm in Bowen.

OFELIA NAMUCO

IRRI STAFF MEMBER Glenn Enriquez (*below*) won't go anywhere without his copy—even 15 meters under water at Cathedral Rock, Anilao, Philippines.

OLIVER VERAN



HENRY SACKVILLE HAMILTON takes *Rice Today* to the temple of Angkor Wat.

RORY KIRK

JOSE RAYMOND PANALIGAN

THE RICE CRISIS: WHAT NEEDS TO BE DONE?

IN EARLY 2008, SKYROCKETING RICE PRICES PUT THE GRAIN ON THE FRONT PAGES OF MAJOR NEWSPAPERS ACROSS THE WORLD. *RICE TODAY* EXPLAINS THE REASONS BEHIND THE RAPID INCREASE IN RICE PRICES AND WHAT MUST BE DONE TO ACHIEVE RELIABLE, PLENTIFUL SUPPLIES OF AFFORDABLE RICE.

The poorest of the world's poor are the 1.1 billion people with income of less than a dollar a day. Around 700 million—almost two-thirds—of these people live in rice-growing countries of Asia. Poor people spend up to half of their income on rice alone and, in many cases, receive more than half of all their calories from rice.

The world price of Thai rice, 5% broken—a popular export grade—in December 2007 was $362 per ton. By May 2008, the price had tripled (see figure on page 12), breaking through the $1,000 mark. As the Asian harvest brought new rice into the market in June, prices began to come down but, by July, remained around double the December 2007 price.

In early 2008, in response to supply problems, major exporting countries such as Vietnam and India imposed export bans or restrictions to protect their domestic consumers. By thus reducing the supply of rice in the world market, these restrictions accelerated the price rise. Consequently, importers rushed into the market to buy more rice to meet their consumption needs and build their own stock. Hoarding and speculation by traders added fuel to the fire.

What are the underlying reasons?

We are consuming more than we are producing. Many factors, both long- and short-term, have contributed to the rice crisis. At a fundamental level, the sustained rise in the price over the past 7–8 years indicates that we have been consuming more than we have been producing. Rice stocks are being depleted, with current stocks at their lowest since the 1970s.

Annual growth in yield is slowing. A major reason for the imbalance between the long-term demand and supply is the slowing growth in yield, which has decreased substantially over the past 10–15 years in most countries. Globally, yields have risen by less than 1% per year in recent years—slower than population growth and down from well over 2% during the Green Revolution period of 1970–90 (also see *Running out of steam* on page 41).

Reduced public investment in agricultural research, development, and infrastructure. The slowdown in yield growth has been exacerbated by reduced public investment in agricultural research and development—the very engine that drove productivity growth to begin with. Investments in irrigation, which peaked during the Green Revolution period, have decreased substantially. Existing irrigation infrastructure has deteriorated considerably.

Little room for expansion of rice area. The possibility of increasing the rice area is almost exhausted in most Asian countries. In many areas, highly productive rice land has been lost to housing and industrial development.

"Productivity growth through improved technologies is the key long-term solution for ensuring that affordable rice is available to poor rice consumers"

Demand growth. Three key factors have contributed to steady growth in demand for rice, which is increasing globally by around 5 million tons each year—more if rebuilding of stocks is taken into account. First, population growth is outstripping production growth. Second, rapid economic growth in large countries such as India and China has increased demand for cereals, both for consumption and for livestock production. Third, rice is an increasingly popular food in Africa, with imports into Africa accounting for almost one-third of the total world trade.

Oil prices. The price of oil has increased rapidly during the past year. This has pushed up freight costs for countries that import rice. The world price of oil-dependent fertilizers—essential for rice production—has increased sharply, with the price of urea exploding (see figure on page 12). The rapid growth of the biofuel industry has also increased pressure on international trade of grains and livestock feed, as well as on agricultural land in some countries.

Extreme weather. Natural disasters, such as flooding, drought, and typhoons, have contributed to recent production shortfalls. Climate change is expected to increase the severity and frequency of such extreme weather events. Global warming is also projected to hurt rice production.

Reoccurring pest outbreaks. Many pests that caused major problems for rice intensification programs in the 1970s and 1980s have returned as major threats to production, primarily due to breakdowns in crop resistance and the excessive use of broad-spectrum, long-residual insecticides that disrupt natural pest control mechanisms.

How do price rises affect poor rice consumers?

Although more expensive rice may help farmers who produce more than they consume, a rise in the price of rice is equivalent to a drop in real income for the majority of the poor who are net consumers of rice. Higher prices increase the number of poor people and push people deeper into poverty and hunger, forcing them to sacrifice essentials such as more nutritious food, health care, and children's education—thus condemning future generations to a vicious poverty cycle. Higher food prices also affect the poor indirectly as international relief agencies are forced to reduce or cut programs.

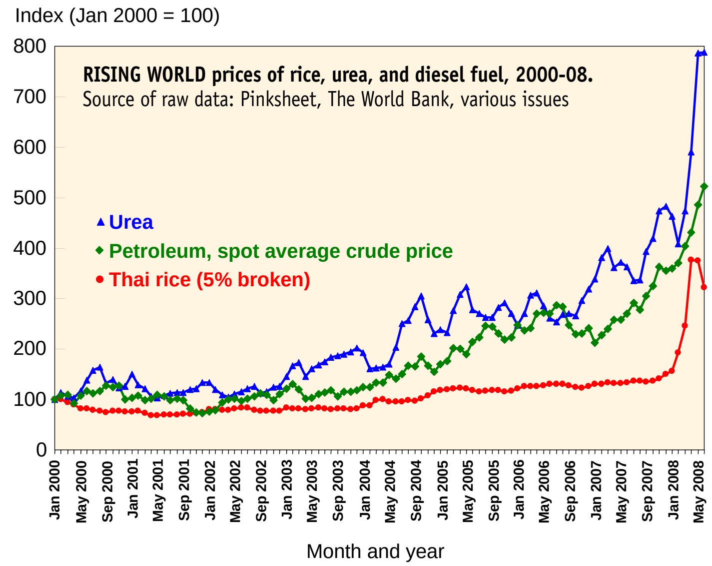
How do we prevent shortages and price rises?

Given the structural reasons that contributed to the price rise in 2008, rice prices are not expected to fall to anywhere near their historic lows. And, without the buffer of high stock levels, there is an increased risk of additional sharp price rises.

The best strategy for keeping the price of rice low is to ensure that production increases faster than demand. Rice production can be increased by expanding the area planted to rice, by increasing the yield per unit area, or by a combination of the two. With limited opportunity for increasing Asia's rice area, the main source of additional production will need to be yield growth.

Productivity growth through the development and dissemination of improved technologies is the only key long-term viable solution for bringing prices down, preventing future increases in price, and ensuring that affordable rice is available to poor rice consumers.

To achieve this, a second Green Revolution is needed now as much as the first was needed to avoid famine and mass starvation. Increased research investment together with policy reforms that make rice markets more efficient will help bring rice prices down to a level affordable to the poor and, ultimately, reduce poverty.



What needs to be done?

Recent advances in science and technology offer unprecedented opportunities to not only solve current problems but also develop agricultural systems that can help millions of rural poor lift themselves out of poverty. In the near term, urgent actions from national governments and international agencies are needed on two fronts: rapidly exploiting existing technological opportunities for increasing rice yields and policy reforms to improve poor people's food entitlements. Rice production can be revitalized, but there are no silver bullets. Investment by the world community is essential.

For more information, visit http://solutions.irri.org

The International Rice Research Institute's action plan

Some of the following actions deal with the immediate crisis while others provide long-term solutions to prevent future crises.

1. ***Bring about an agronomic revolution in Asian rice production to reduce existing gaps between achieved and potential yield.*** Yield improvements of 1–2 tons per hectare can be achieved through the use of better crop management practices, particularly in irrigated environments.
2. ***Accelerate the delivery of new postharvest technologies to reduce losses.*** Postharvest includes the storing, drying, and processing of rice. New and existing technologies can substantially reduce the considerable postharvest losses—in terms of both quantity and quality—suffered by most Asian farmers.
3. ***Accelerate the introduction and adoption of higher yielding rice varieties.***
4. ***Strengthen and upgrade the rice breeding and research pipelines.*** The steady decline in funding for the development of new rice varieties must be reversed in order to develop the new varieties and crop and resource management systems required for sustained productivity growth.
5. ***Accelerate research on the world's thousands of rice varieties so scientists can tap the vast reservoir of untapped knowledge they contain.***
6. ***Develop a new generation of rice scientists and researchers for the public and private sectors.*** Asia urgently needs to train a new generation of rice scientists and researchers—before the present generation retires—if the region's rice industry is to successfully capitalize on advances in modern science.

Lost in transmission

Have recent dramatic increases in world rice prices been bad for consumers and good for producers? Well, yes … and no. The real answer seems to be: It depends. *Rice Today* analyzes the situation.

by David Dawe

World market rice prices tripled between April 2007 and April 2008, with most of the increase coming early in 2008. While the world market price is an important indicator of scarcity, rice-consuming and -producing households do not buy and sell directly on the world market. Thus, an important question for food security is the extent to which changes in world prices are transmitted, or passed through, to domestic consumers and producers. Price transmission from world to domestic markets is influenced by many factors, but two of the most important are exchange rates and government policies. Inadequate infrastructure can also play an important role, but this is less relevant in the Asian context, where infrastructure is much better than in Africa, for example.

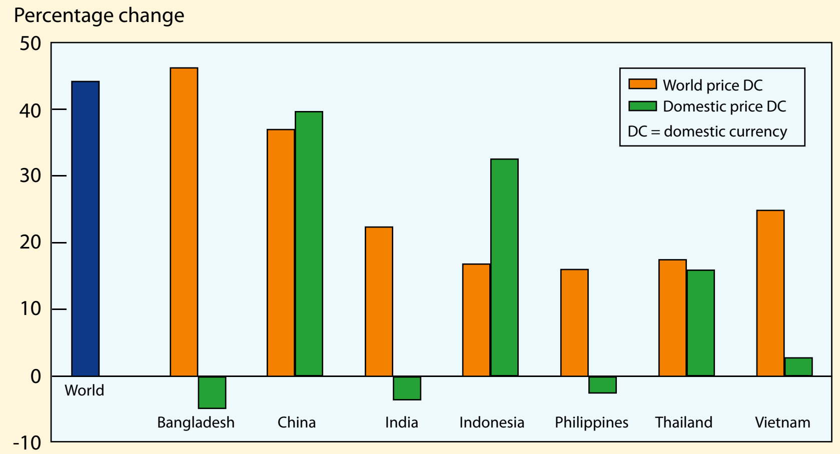


Fig. 1. Cumulative percentage change in real rice prices, first quarter 2003–first quarter 2007.
Data for Vietnam are annual, not quarterly, and refer to change between 2003 and 2006.

Exchange rates

Even before the sharp increase in early 2008, world rice prices had been steadily increasing since early 2004: they increased 44% from the first quarter of 2003 (Q1 2003) to Q1 2007 in inflation-adjusted US-dollar terms (see the leftmost column in Figure 1). But, for many Asian countries, this "headline" price increase was illusory because the US dollar was steadily depreciating against a wide range of regional currencies. For example, during these 4 years, the Philippine peso strengthened against the dollar from 54.2 in 2003 to 46.1 in 2007. Thus, the world price as measured in Philippine pesos did not increase nearly as much as the world price as measured in US dollars. In Figure 1, the left column for each country makes this adjustment (using inflation-adjusted exchange rates), showing that world rice prices during this time typically increased much less in inflation-adjusted domestic-currency terms than in inflation-adjusted US-dollar terms, although Bangladesh was an exception.

Government policies

In addition to exchange rate movements, domestic rice policies such as procurement, storage, and variable tariffs also determine how world prices are transmitted to domestic markets. Many Asian countries actively try to stabilize domestic prices, and the right column for each country in Figure 1 shows that, for several countries, the change in domestic consumer (either retail or wholesale) prices was much less than the change in world prices during this time, even when the change in world prices is adjusted for exchange rate movements.

Bangladesh, India, the Philippines, and Vietnam all fall into this category of countries that stabilize domestic prices. For all of these countries, the volatility of domestic consumer prices during the past few years has been less than that of world prices, thus justifying the use of the term "stabilizer." As one example of the results of this type of stabilization, Figure 2 shows the evolution of monthly domestic retail rice prices in India between 2003 and 2007. Clearly, domestic prices were more stable than international prices during this time.

Historically, Indonesia has also stabilized domestic rice prices, but, in recent years, its trade policy has been dominated by domestic political considerations that have served to destabilize domestic prices by restricting imports.

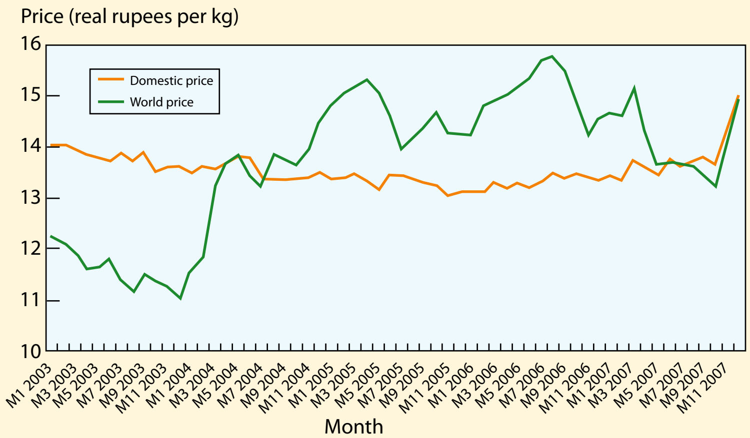


Fig. 2. Monthly domestic rice retail prices in India and world rice prices, 2003–07.

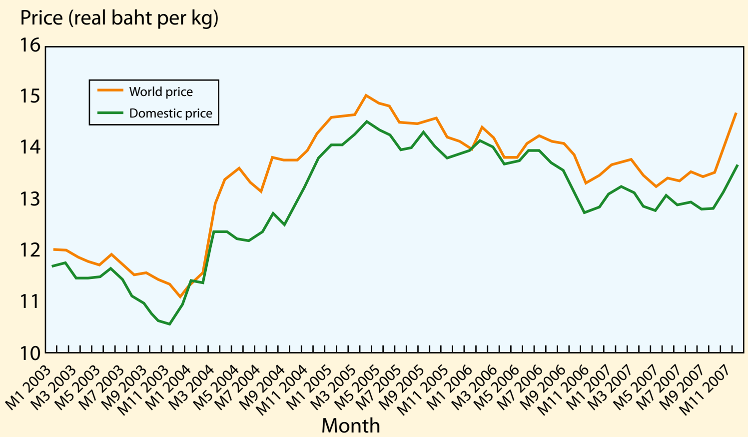


Fig. 3. Monthly domestic rice wholesale prices in Thailand and world rice prices, 2003–07.

Thus, in Indonesia, the increase in domestic consumer prices from Q1 2003 to Q1 2007 was actually greater than the increase in world prices in real rupiah terms.

Thailand and China during this time acted more as "free traders." Thailand has some government intervention in terms of procurement and storage, but domestic prices nevertheless follow world prices very closely (see Figure 3). China does not allow the private sector to trade at all, much less without restriction, so it is not a free trader in the sense that economists use the term. But, at least through the early part of 2007, it was allowing changes in international prices to be reflected more or less fully in domestic consumer prices.

Recent events

Many countries, including India, Vietnam, and Cambodia, restricted or banned exports in late 2007 or early 2008. These moves led importers to aggressively enter the world market in fear that supplies would become even more constrained in the future, which exacerbated the shortages and caused prices to soar. This was a major factor in world prices surging from $393 per ton in January 2008 to $1015 per ton in April.

Because very few trades took place at the high world prices, domestic prices did not increase nearly this rapidly; again, transmission was only partial. But domestic prices nevertheless increased substantially. In real terms, domestic rice prices in April or May of 2008 were 47% and 30% higher in Bangladesh and the Philippines, respectively, compared with prices in April or May a year earlier. Domestic prices increased even more in Thailand and Vietnam, where the increases were 131% and 85%, respectively, over the same period. Price increases were more restrained in India (14% year on year). All of these price changes were above and beyond the reported increases in the general consumer price index, which indicates the overall level of inflation of consumer good prices.

The substantial increases in domestic prices in a range of countries suggest that, in many cases, government policies can insulate the domestic economy from external shocks, but only for a limited period of time. For example, releasing stocks from storage can dampen price increases, but eventually stocks will run out. Import tariffs can be lowered for a time, but eventually hit a lower bound at zero. Once the tariff reaches zero, it is possible to subsidize imports, but as the world price increases, the subsidies may become fiscally unsustainable. General market psychology may also make it difficult to dampen price transmission: if prices are rising rapidly on the world market and are expected to continue rising, farmers, traders, and households may begin to hoard supplies, therefore reducing domestic supply and forcing domestic prices up. Thus, even when price transmission is less than complete, events on world markets eventually have important repercussions for food security.

There is no doubt that price changes of this magnitude can have substantial adverse impacts on the poor, many of whom buy most of their food on markets and often spend 20–40% of their income on their staple food in normal times. Poor families must thus cut spending on other essential items in order to maintain a minimal level of energy intake. A study in rural Central Java in Indonesia found that when rice prices increased in the late 1990s, mothers in poor families responded by reducing their caloric intake in order to better feed their children, leading to an increase in maternal wasting.[1] Furthermore, purchases of more nutritious foods such as eggs were reduced in order to afford the more expensive rice. This led to a measurable decline in blood haemoglobin levels in young children (as well as in their mothers), increasing the probability of developmental damage. A negative correlation between rice prices and nutritional status has also been observed in Bangladesh.[2] Another study estimated that a 20% increase in food prices would increase the number of undernourished people in Asia by 158 million.[3]

Are changes in consumer prices being reflected in farm prices?

While many people worry that prices may be increasing for consumers but not for farmers (with traders increasing their margins), the evidence for Asia in recent years does not support these fears. Figure 4 shows that, for a range of countries, the percentage change in farm prices has been nearly identical to the percentage change in consumer prices.

Fertilizer prices

Urea is the main source of nitrogen for Asian rice farmers and is their most important fertilizer input. World urea prices have increased substantially since 2003; indeed, they have increased even more than grain prices on world markets. As with grain prices, some of these increases have been mitigated by exchange rate appreciation, but the increases in real domestic currency terms have still been substantial.

Because fertilizer accounts for only a small share of gross revenue for farmers, equivalent percentage changes in output prices and fertilizer prices would increase farmer profits. Data collected at the International Rice Research Institute in the late 1990s showed that the share of urea fertilizer in gross revenue was often about 10%. This implies that a 10% increase in urea prices would be fully offset by just a 1% increase in the output price.

In the Philippines, between March-May 2003 and March-May 2008, farm prices for paddy (unmilled) rice increased by 20% in real terms—more than enough to offset the impact of an approximately 60% increase in real urea prices. However, urea prices began increasing in the Philippines long before farm paddy prices, which have increased only recently. Thus, even though farm profitability has increased now, it was most likely declining for the past few years. Further, the costs of other farm inputs, including fuel (for irrigation and transport, for example), other fertilizers, and wages have also risen. Thus, it is quite possible that the profitability of rice farming has decreased even though output prices have increased.

As in the Philippines, much of the increase in world urea prices has been passed through to farmers in Vietnam. In Bangladesh, however, the government kept nominal urea prices roughly constant through late 2007, implying a decline in the inflation-adjusted domestic urea price over the past few years. Coupled with higher farm prices, it seems likely that rice production has become more profitable in Bangladesh in the short run.

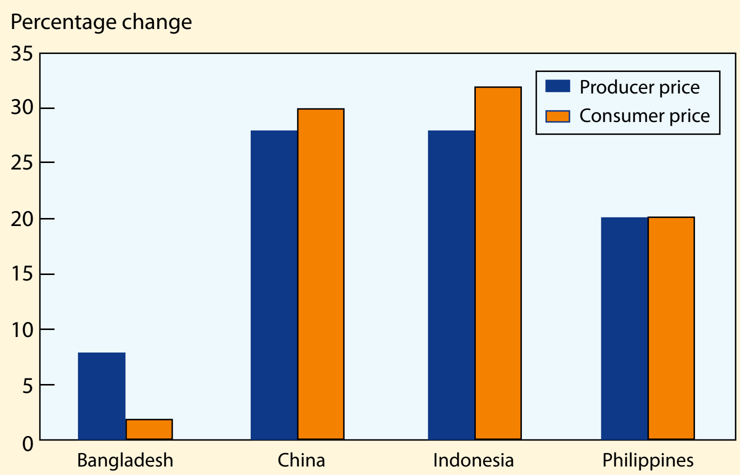


Fig. 4. Cumulative percentage change in real rice producer and consumer prices, 2003–07.
Data for the Philippines compare March to May 2003 with March to May 2008.

Looking to the future

It is not yet clear how world and domestic rice prices will change for the rest of 2008 and beyond. However, rice prices have already increased in some countries by enough to substantially hurt the poor, even if prices subsequently fall later in the year (as has already started to happen in some countries). In addition, as long as world oil prices remain high and volatile, rice prices are likely to behave in a similar manner due to the new linkages that biofuel demand has forged between energy markets and agricultural markets. This will present challenges for governments to manage these price fluctuations in order to minimize the impact on the poor.

Dr. Dawe is a senior economist at the United Nations Food and Agriculture Organization.

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[2]Torlesse H, Kiess L, Bloem MW. 2003. Association of household rice expenditure with child nutritional status indicates a role for macroeconomic food policy in combating malnutrition. *J. Nutr.* 133(5): 1320–1325.
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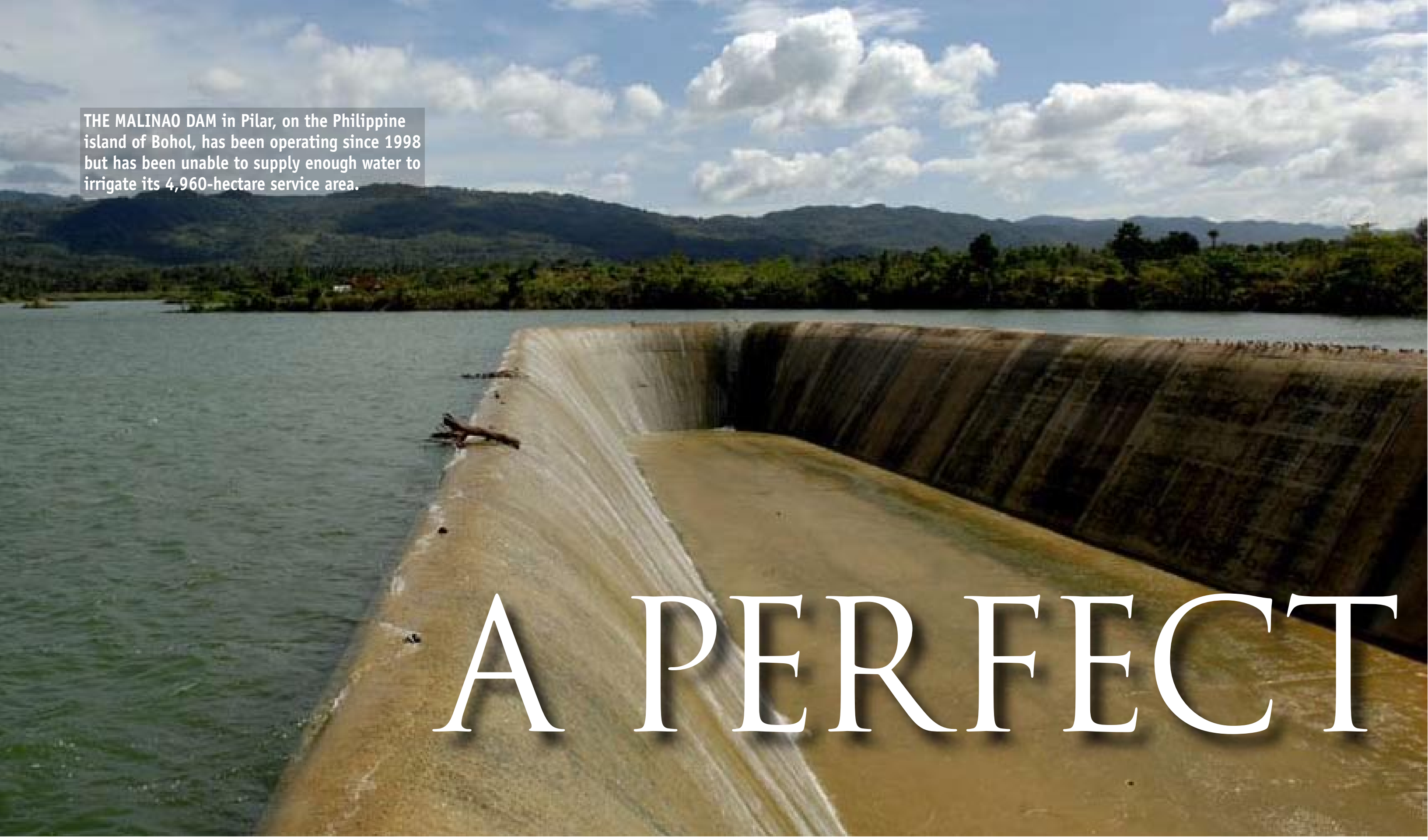


THE MALINAO DAM in Pilar, on the Philippine island of Bohol, has been operating since 1998 but has been unable to supply enough water to irrigate its 4,960-hectare service area.

WATER-SAVING TECHNOLOGIES FIND THEIR WAY TO THE PROVINCE OF BOHOL IN THE PHILIPPINES AND PROVE TO BE A PERFECT MATCH FOR THE REGION'S CLIMATE AND IRRIGATION SYSTEMS

Story by **Meg Mondoñedo**
Photos by **Raymond Jose Panaligan**

With three major reservoir-fed irrigation systems operating in the area, it's easy to think that Bohol, one of the biggest rice-growing areas in the Philippines' Visayas region, is free of water problems for irrigated rice. Think again.

Despite these dams, the rice farmers of Bohol have been struggling to irrigate their crops, for the simple reason that the province does not have enough water. Bohol has what is known as a Corona climate type IV, characterized by evenly distributed rainfall throughout the year. There is no clear-cut wet or dry season, though there is a higher likelihood of heavy showers from November to January. The average annual rainfall is estimated at around 1,600 millimeters per year.

The three national irrigation systems operating in Bohol, covering a total area of 10,260 hectares, are the Capayas Irrigation System in Ubay (1,160 hectares), the Bohol Irrigation System 1 (BIS 1; 4,960 hectares), and the Bohol Irrigation System 2 (BIS 2; 4,140 hectares).

The Malinao Dam of BIS 1 in Pilar, the Bayongan Dam of BIS 2 in San Miguel, and the Capayas Dam in Ubay are all reservoir-type dams. However, Bayongan Dam, which was constructed under the Japan Bank for International Cooperation (JBIC) loan program, was built in such a way that it had to rely primarily on BIS1. Water from Bayongan Dam will come mostly from the excess water flowing from Malinao Dam. The technical functionality of BIS 2 is therefore very much dependent on the efficient operation and management of BIS 1.

Since the start of operations in 1998, however, BIS 1 has performed poorly because of inefficient water use. The dam has been beset by problems—declining available water, asynchronous farming activities resulting in wasteful use of water, and poorly maintained irrigation facilities. All of these have, in turn, affected farm productivity and contributed to low farmer incomes.

A JBIC mission conducted in March 2005 reported that water from BIS 1 failed to cover the designated irrigation area and that the nonirrigated areas are mostly located farthest from the canals.

Usually, there is insufficient water available during the year's second cropping (November to April), especially for downstream farmers who live farthest from the dam. This problem is aggravated by the practice of unequal water distribution and unnecessary water use by farmers who insist on continuous

MATCH

IRRIGATED RICE fields near the town of Carmen, Bohol.

TWO BOYS paddle their way across the Malinao Dam.

flooding to irrigate their rice crop.

In the face of declining irrigated rice production in Bohol since 2000, the National Irrigation Administration (NIA) created an action plan for the Bohol Integrated Irrigation System. The plan focused on improving water distribution equity and efficiency; improving operations; strengthening coordination among the NIA, irrigators' associations (groups of farmers who share an irrigation canal), and local government units; rehabilitating and upgrading irrigation facilities; and establishing demonstration farms on water-saving technologies.

A major component of this plan was the implementation of a project to improve the performance of irrigation systems and increase water productivity. Thus, a water-saving project team for Bohol was established, with NIA as the lead agency. To achieve its goal, the project made use of water-saving technologies developed by scientists of the Irrigated Rice Research Consortium (IRRC) Water-Saving Workgroup based at the International Rice Research Institute (IRRI).


FARMERS FROM CARMEN, Bohol, thresh their rice after harvesting.

"After our initial success in Tarlac (see *The big squeeze* on pages 26-31 of *Rice Today* Vol. 7, No. 2), the national office of NIA got hold of the technologies," says Ruben Lampayan, IRRI postdoctoral fellow and leader of the Water-Saving Work Group. "Since Bohol didn't have enough water to irrigate their rice area, despite its three dams, NIA decided to bring water-saving technologies, specifically alternate wetting and drying (AWD), to Bohol."

Consequently, the introduction of AWD (also called controlled irrigation) debunked the widespread belief that rice has a continuous, insatiable thirst for water. In fact, rice 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 as long as the soil remains flooded throughout the flowering period. Up to a quarter less water is needed, there is no drop in yield, and farmers don't need to make any other major changes in the way they manage their crop.

"Many farmers came to realize that rice doesn't need lots of water throughout its life cycle," says NIA Engineer Edmund Mendez. "They saw first-hand, from the demo plots, that rice doesn't have to be flooded all the time. It only needs puddled water during the critical stages of growth."


IRRI WATER-SAVING researcher Ruben Lampayan.

In Pilar, a municipality in the province of Bohol, where the project was first launched, water from the dams started to decline 3–4 years ago. Only upstream farmers (those near the main irrigation canals) could get sufficient water, leaving downstream farmers with almost nothing. Water from the dams was not enough to serve all the farmers' fields.

Today, about 150 farmers in Pilar alone are using AWD to grow rice twice a year.

"We really saw the need for AWD and aerobic rice technologies," says Jardy Bolanio, head of a local farmers' group in Pilar. "Even during


NATIONAL IRRIGATION Administration Engineer Edmund Mendez.


PILAR FARMERS' group leader Jardy Bolanio.


BIS SUPERINTENDENT Olympio Galagala, Jr. is also a farmer.

the rainy season, we still needed to save water in the reservoirs as backup for drier days to come."

"So far, our yields using AWD have been the same as those we get from growing rice in flooded fields," he says. "However, weeds have been a minor problem. Since flooding controls weeds, AWD is more prone to weed growth because of the dry stages. But it can be solved easily through manual weeding. The weed problem is nothing compared with the water we save and the consistent income we now get."

AWD's success didn't happen overnight though. With many farmers' resisting the switch from flooded methods, NIA and its partners carried out information campaigns, farm-level demonstrations, and farmers' field days where the technology was introduced.

Farmers were scared that AWD might reduce their yield and they would not earn as much—but it didn't happen.

"There was no disadvantage from using AWD," says BIS Superintendent Olympio Galagala, Jr., who also farms rice in Pilar. "Our yields were the same, and, best of all, our water problem was solved."

According to Dr. Lampayan, AWD in Bohol was adopted by farmers not because they liked it. "It was adopted because it was forced on them in a way, as a solution to the weaknesses of the water delivery systems," he explains. "Before the project was implemented, the NIA people tried to rotate the water in such as way that everyone would get a fair share, at least within an area served by one dam. AWD complemented that water rotation scheme because the demand for water became lower and farmers became less worried about their crops dying if they didn't get enough water.

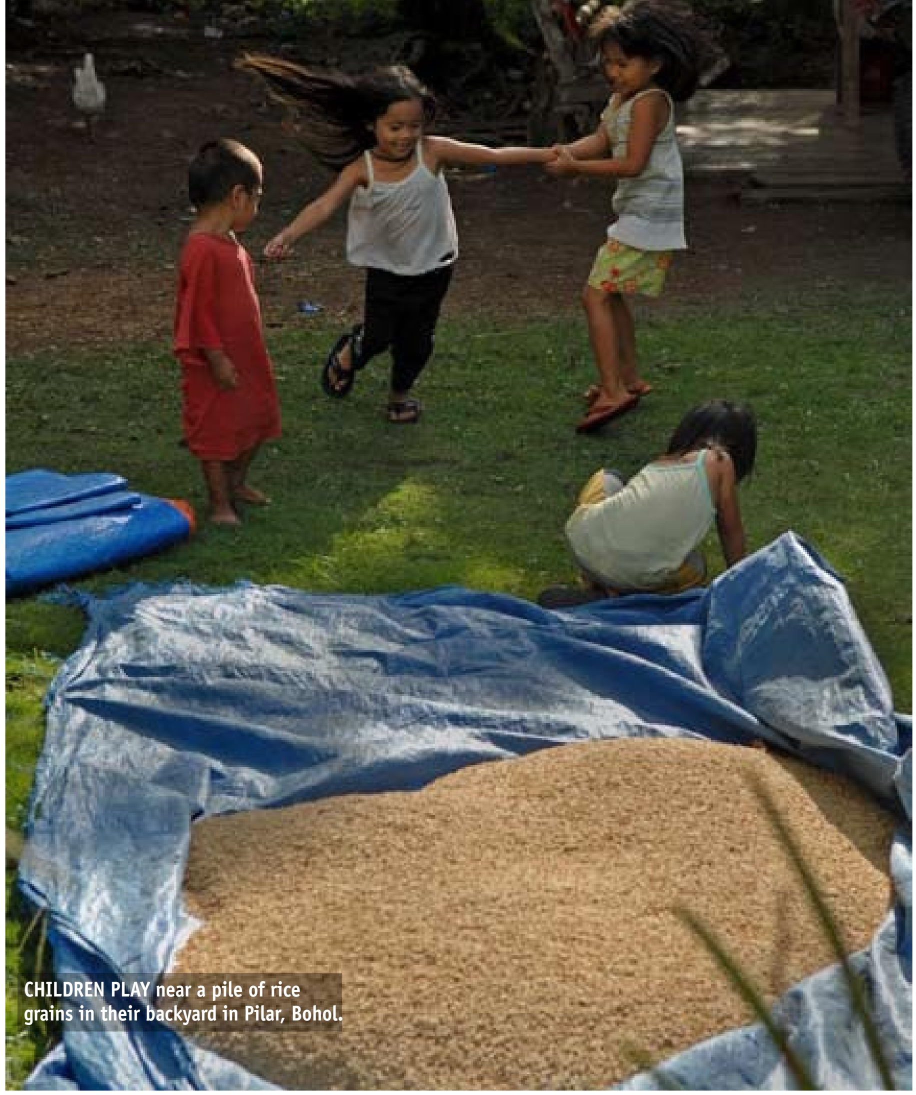
"Farmers always thought that the more water they had, the more yield they would get. AWD proved this wrong. The farmers are happy not only because they don't worry about water anymore, but also because life is more harmonious—they no longer compete for water."

With more and more farmers seeing the benefits of using AWD, the Bohol experience could be a potential model for success of the Water-Saving Work Group's country sites across Southeast Asia.

"There is so much potential in AWD because water scarcity is a real threat," stresses Dr. Lampayan. "People are aware of the water problem, but they don't realize its extent. Our next step is to scale out and spread the technology to other problematic areas, not just in the Philippines."

While the IRRC helps Bohol with the water shortage problem, it also recognizes the need to address other production constraints such as soil fertility, labor, and postharvest losses. Through the IRRC's Country Outreach Program, initial efforts have been made to integrate AWD with other IRRC technologies to optimize rice farmers' incomes.

As the number of Bohol farmers who use AWD grows, the IRRC continues to search for the next perfect match.



CHILDREN PLAY near a pile of rice grains in their backyard in Pilar, Bohol.

THE ENDANGERED Philippine tarsier (*Tarsius syrichta*), endemic to the southern Philippines, including Bohol, is one of the world's smallest primates.

Supercharging the RICE ENGINE

by Dilantha Gunawardana

AN AMBITIOUS PROJECT TO RE-ENGINEER RICE PHOTOSYNTHESIS HAS THE POTENTIAL TO TRANSFORM RICE PRODUCTION AS MUCH AS, IF NOT MORE THAN, ANY SINGLE ADVANCE SINCE AGRICULTURAL RESEARCH BEGAN

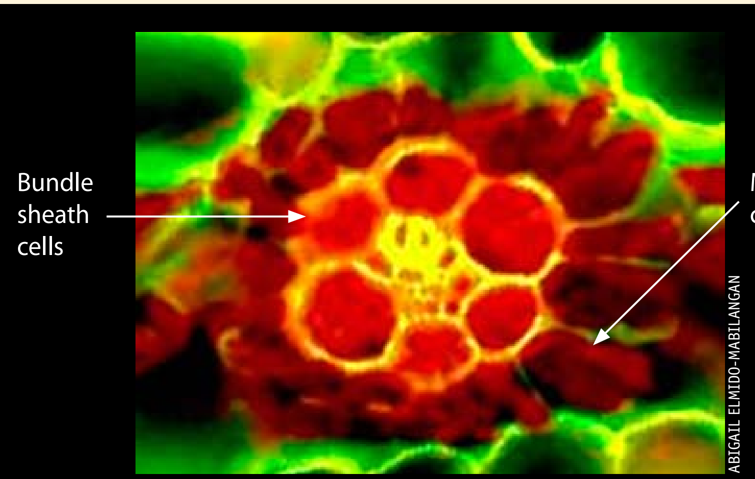
In his 1988 Nobel Prize in Chemistry acceptance speech, German scientist Hartmut Michel, quoting the Royal Swedish Academy, described photosynthesis as "the most important chemical reaction on earth." Dr. Michel, who solved the three-dimensional structure of the primary protein complex responsible for the initial light capture in photosynthesis, knows a thing or two about the means by which plants derive energy and—happily for we humans—convert carbon dioxide to oxygen in the process.

The sheer importance of photosynthesis is a plain truth that we tend to ignore in spite of constant reminders: the trees outside our windows, the ingredients of the food we ingest, the energy we expend on the sports field, and even the intellectual power that goes into formulating simple sentences. One way or another, all of this derives from the chemical energy synthesized from solar irradiation by photosynthesis.

The energy captured from light during photosynthesis is used to convert atmospheric carbon dioxide into different sugar molecules that are used in diverse metabolic pathways and conveyed via the food chain to humans. However, the process of photosynthesis is not the same for all plants. Whereas species such as rice have an ancestral mode of photosynthesis in which the capture of carbon dioxide is relatively inefficient, many crop species, such as maize and sorghum, have evolved a much more efficient (and, in evolutionary terms, newer) photosynthetic pathway. This mechanism, known as C_4 photosynthesis because of the initial formation of a molecule possessing four carbon atoms, can be distinguished from the ancestral "C_3" photosynthesis by the initial 3-carbon compound formed.

The inefficiency of C_3 photosynthesis means that the potential growth rates and yields of rice are lower than those of a C_4 crop such as maize. Considering that more than 90% of the world's rice is consumed within Asia and is the major staple for hundreds of millions of poor—and often undernourished—people, improving the efficiency of photosynthesis in rice could have an enormous beneficial impact.

Driven by the need to improve rice yields, International Rice Research Institute (IRRI) scientist John Sheehy and his team are embarking on an ambitious but realistic goal to develop rice with C_4 photosynthesis. Due to the magnitude of the task and the multi-faceted nature of converting a plant's complete photosynthetic pathway—which entails changes in leaf anatomy, photosynthesis biochemistry, and plant physiology—IRRI formed an international consortium of some of the world's leading experts on photosynthesis including Julian



Kranz Anatomy

WREATH-LIKE configuration of bundle sheath and mesophyll cells around veins in a maize leaf.

UNDERSTANDING the workings of maize—which uses more efficient C_4 photosynthesis—is crucial to developing a C_4 rice plant. Here, researcher Florence Danila mounts a maize leaf onto a microscope.

Hibberd of the University of Cambridge, Jane Langdale of the University of Oxford, and Tom Brutnell of Cornell University.

C_4 photosynthesis is distinguished from its C_3 equivalent by the presence of unique anatomical features within leaves, known as the Kranz Anatomy. The capture of carbon dioxide and its conversion to a four-carbon compound is performed by so-called mesophyll cells in concert with bundle sheath cells, which synthesize six-carbon sugars, the building blocks of most biological polymers. Rice and other C_3 species do possess these two cell types—though in ratios, and with accompanying underdeveloped structures (mostly chloroplasts), that make carbon capture inefficient. One of the primary goals in the mission to deliver C_4 rice is to identify or construct the cellular architecture of C_4 plants—the Kranz Anatomy—in rice leaves. This will include microstructural analysis of many plant lines including *Oryza sativa* (cultivated rice) and many wild rice species. Initial studies with wild rice have demonstrated that some features of C_4 photosynthesis, such as close spacing of leaf veins and favorable ratios of the two cell types of Kranz Anatomy, do exist in rice.

C_4 photosynthesis evolved from C_3 photosynthesis within the past 25–32 million years, a relatively short time frame in terms of evolutionary adaptation (by comparison, the two basic structural forms of plants, monocot and dicot, diverged from a common ancestor as early as 200 million years ago). The relatively short time scale of C_4 evolution, coupled with the presence of remnant C_4 photosynthesis genes in rice (genes that don't have a C_4 function in rice, but evolved such functions in C_4 plants), has the consortium optimistic that the incorporation of the C_4 photosynthesis pathway into rice is a realistic goal.

Dr. Sheehy's team is also looking for the genetic basis of the reversal of C_4 photosynthesis back to the ancestral C_3 pathway. The team has induced random genetic mutations in the C_4 crops sorghum and maize to investigate the changes in leaf structure away from Kranz Anatomy. By analyzing the genomes of those mutant plants that diverge from "C_4-ness," the researchers should be able to gain insights into which genes are responsible for regulating the differentiation between C_3 and C_4.

Decline in carbon dioxide levels, higher temperatures, low availability of water, and high soil salinity are all reasons attributed to the evolution of C_4 photosynthesis. Considering the success of C_4 plants in such unfavorable environments, it is anticipated that C_4 rice, as well as giving higher yields, will also have lower requirements for water and nitrogen (fertilizer). Therefore, the potential benefits of C_4 rice are not restricted to boosting productivity; they also include environmental sustainability and climate control.

Creating C_4 rice will require considerable effort and the forecast time for reaching a prototype plant is at least 15 years. However, given the encouraging initial results, the next year is likely to provide many more answers in the quest to supercharge the rice engine. If the project succeeds, the benefits for the poor of such an improvement in the face of increasing world populations, increasing food prices, and decreasing natural resources would be immense.

Dr. Gunawardana is a postdoctoral fellow working on IRRI's project to develop C_4 rice.

TECHNICIANS in the C_4 group take samples of maize leaves in the field.

Jose Raymond Panaligan

A young boy with rationed rice in Quezon City, Manila, Philippines. Government-subsidized rice has become a necessity for the urban poor.

Giving farming a CHANCE

Story by Meg Mondoñedo and photos by Jose Raymond Panaligan

A youth field school in the Philippines trains young students in rice farming and agriculture in the hope of perpetuating the nation's dying breed of farmers

"Farmers are getting older and older. When they are gone, who will produce the food? Few farmers today want their children to become farmers or even agriculturists. The farmer will just say: there is no future in this for my child."

This is the bleak reality, as explained by Father Francis B. Lucas, president of the Infanta Integrated Community Development Assistance, Inc. (ICDAI), a community-based nongovernmental organization (NGO) in Infanta, in the Philippine province of Quezon.

In 2007, ICDAI, in partnership with the Philippine Rice Research Institute (PhilRice) and the International Rice Research Institute (IRRI), launched the Youth Field School (YFS) as part of the PhilRice-IRRI project on "Improving knowledge exchange

HIGH SCHOOL STUDENTS at the Binulasan Integrated School in Quezon, Philippines, are all smiles during a hands-on exercise on pest management in their school's rice paddy.

and decision making among rice stakeholders through information-and-communication-based technology promotion and delivery systems," better known as the PhilRice-IRRI Cyber Village project.

The project, which started in 2006 and is scheduled to finish in 2008, tests and develops approaches that deal with the range of problems faced by farmers. It then takes these approaches and makes them more widely known at the village and municipal levels through the use of information and communication technology (ICT). The project also looks into the effectiveness of computer-based information and knowledge dissemination to rural farmers and extension workers (who take technology and training to farmers).

70% of Infanta's population is below 21 years old. Why are we teaching only the farmers and not their children?

In Infanta, one of the project's pilot sites, the YFS was an off-shoot of ICDAI's long-running program, the Farmers' Field School, which started in the 1980s. In these schools, a team of agriculturists and farmer-trainers gave training courses and workshops on ecological pest management, integrated soil management, livestock training, and other agricultural services in villages and towns upon request of organized farmer groups. The Farmers' Field School was a tremendous success; however, through the years, fewer and fewer farmers attended, so ICDAI developed another strategy—the Youth Field School—wherein the transfer of agricultural technology was delivered not to farmers but to their children.

"Seventy percent of the population of Infanta is below 21 years old. Why are we teaching only the farmers and not their children?" asks Father Lucas. "The technology taught to the older generation will die with it—and not only the technology, but the wonder in appreciating the source of life: its food and agriculture."

"We wanted to start the students early in agriculture," he says, "so the Grade 6 student can say: 'Wow! Farming is a global pursuit! We are connected nationally and internationally!' We want them to see that agriculture is not only about their own farms, it's a global issue. These children do not even know how many people in the world eat rice. Hopefully, with the YFS, they would want to become farmers."

Che-Che Morilla, head of ICDAI's sustainable agriculture program, which handles the YFS, explains, "We just want the students to appreciate the farming activities, to love the farmers, their parents who are farmers. We are also very happy that these students are helping us by teaching their families. In effect, they become very good extensionists—very

FATHER FRANCIS LUCAS, president of Infanta Integrated Community Development Assistance, Inc., talks about the beginnings and goals of the Youth Field School.

CHE-CHE MORILLA, head of ICDAI's sustainable agriculture program.

EVA CRISOSTOMO, teacher and guidance counselor at Binulasan Integrated School.

LUDIE LIGUTAN, a farmer and volunteer Youth Field School facilitator, stands by her rice field, which she inherited from her parents. Being a farmer makes it much easier for her to teach the students.

effective trainers for their families."

Ms. Morilla says that because students also learn how to use the Rice Knowledge Bank (RKB)—IRRI's digital repository of information on rice production (www.knowledgebank.irri.org)—they are becoming the conduits of information to their farmer-parents.

The connection between the PhilRice-IRRI Cyber Village project and the YFS lies in the use of the RKB as the source of computer-based information and knowledge dissemination. In Infanta, however, students, not just farmers, are given direct access to agricultural information.

The YFS was incorporated into students' regular subjects and graded just like, say, mathematics or science. On Thursdays, YFS facilitators, composed of ICDAI staff members and farmer-volunteers, teach the young students about growing rice, managing pests and diseases, using the RKB, and many other aspects of growing rice.

To the happy surprise of ICDAI staff members, the students enjoyed the field school subjects so much that they began attending school more often.

"My co-teachers and I were very pleased to see the impact of the YFS on the lives of our students," relates Eva Crisostomo, teacher and guidance counselor at the Binulasan Integrated School in Infanta, an ICDAI pilot school for the YFS. "They went to the field, they cleaned, they planted, and they were very eager to learn. Normally, our classes do not have full attendance, but, every Thursday, the rooms are full!"

Ludie Ligutan, a volunteer YFS facilitator and a farmer herself, explains that ICDAI gives her materials with which to teach a particular topic, such as seed health management or sustainable agriculture.

"I try to make the classroom lessons interesting by making jokes and telling stories," says Ms. Ligutan, "but once its time to go out into the field, the students are uncontrollable! They dive into the mud and start identifying the insects and memorizing their names. They prefer hands-on exercises to lectures, they like seeing how the lessons are applied in the actual field."

For the students, the rewards come in the discovery that they can make a real difference to their families' lives.

"The YFS has helped me a lot because my father is a farmer," says Sheena Orozco, a high-school student at Binulasan. "I tell him whatever I learn from the field, like how and when to apply fertilizer, and which are the harmful insects and which are the good ones."

Her classmates are quick to agree.

"We really learn a lot!" enthuses Kristell Barrival. "Whenever my parents have a question, I look it up in the RKB and I know the answers are there."

The YFS helps not only the students learn about rice farming and agriculture but also their parents.

Alvin Romantiko

Sheena Orozco

HIGH SCHOOL STUDENTS surf IRRI's Rice Knowledge Bank for information about rice production at the Binulasan Integrated School's computer room, which houses about 20 donated computers.

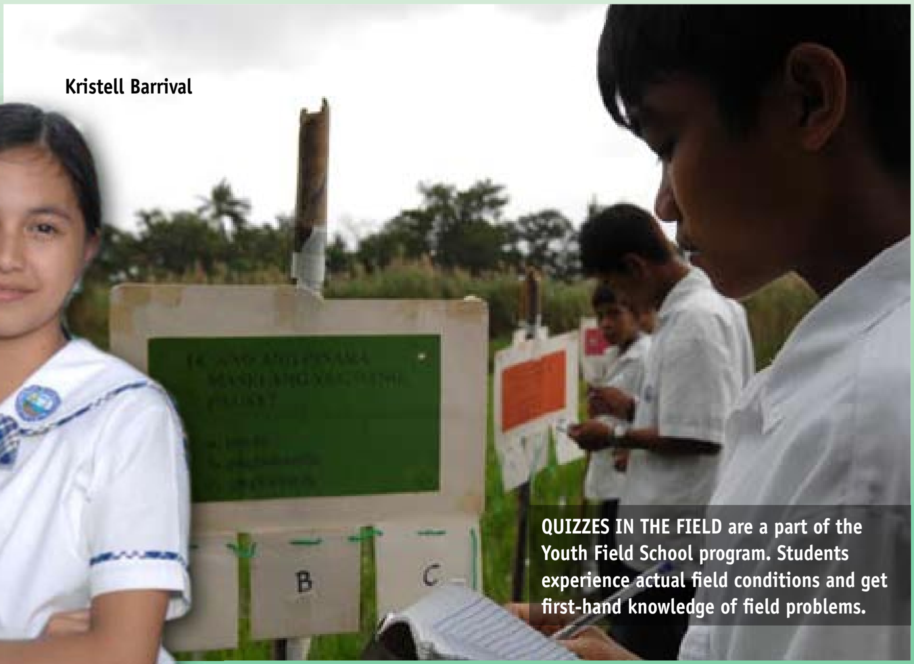
"Sometimes there are parents who don't listen to the field lectures," says Ms. Ligutan, "but their children listen, and at home, when it's their own children who tell them about the lessons, they listen and learn."

Alvin Romantiko, also a high-school student in Binulasan, sums it up perfectly. "Since they started with the YFS, they've taught us a lot," he says. "We learned about rice and vegetables, but rice was the most important to me. I realized that if all of us became successful engineers, lawyers, or IT specialists, then who would plant rice: who will feed us? If we all think of becoming professionals, then who will become farmers? Everybody needs to eat. Even the most successful businessmen and scientists need to eat. We should make sure there is food security first, and everything else will follow."

It is encouraging to know that these students are giving farming a chance, helping to lessen the worry that farming will become an endangered profession. However, many challenges remain.

According to Father Lucas, a lot of poor people are victims of industrialization. "When industries come in, people get sucked into their centers," he says. "When that happens, the environment is neglected—the basis of food and production is neglected because when you remove the farmer, they sell the land, hoping to have their children study anything other than agriculture. At the end of the day, though, they lose: they don't have land and they don't have jobs, and nobody can break the cycle."

Breaking this cycle is what the YFS aims to achieve. By training school students in farming and agriculture early on, young people learn about the importance of food, and, more specifically, the importance of rice in the lives of millions not in only in the Philippines but also around the world.



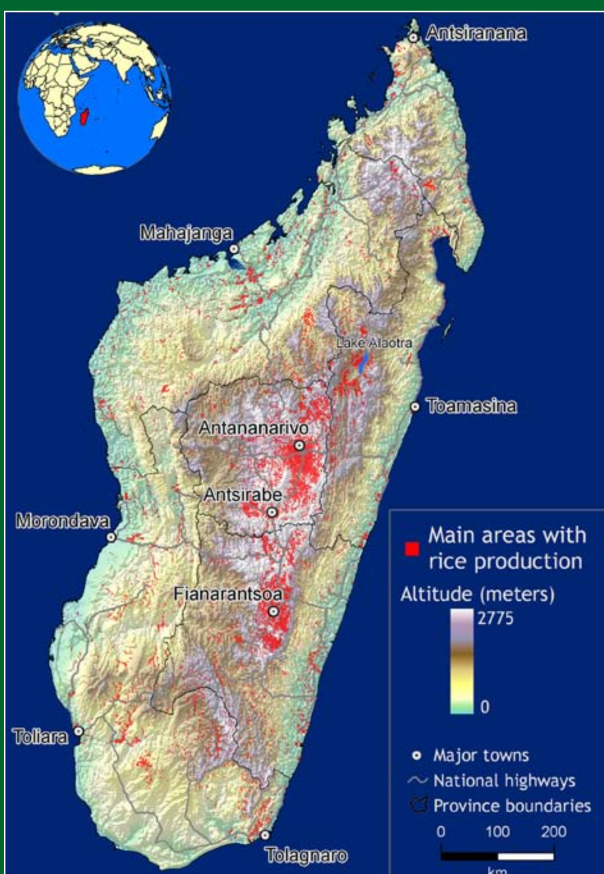
QUIZZES IN THE FIELD are a part of the Youth Field School program. Students experience actual field conditions and get first-hand knowledge of field problems.

Kristell Barrival

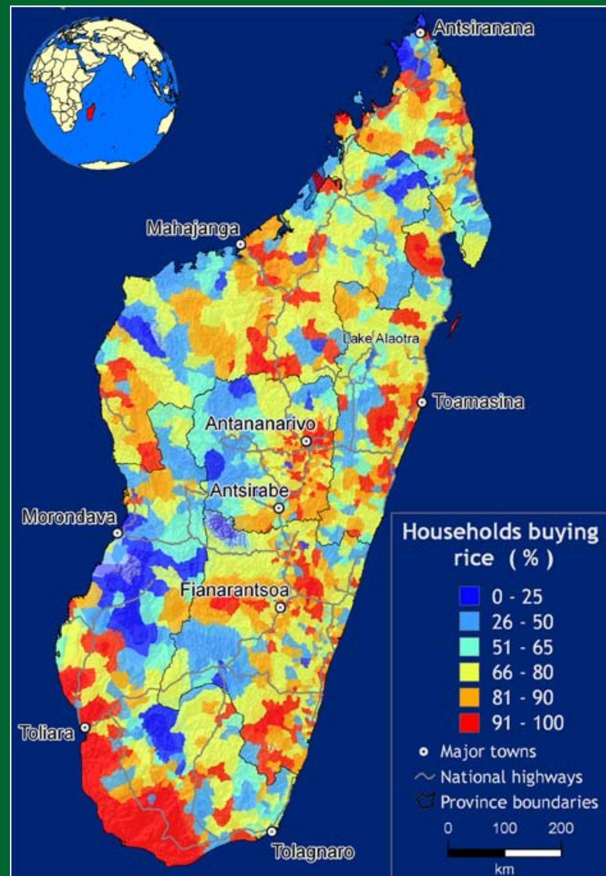
THE PRICE OF RICE IN MADAGASCAR

by Robert Hijmans and Alice Laborte
IRRI Social Sciences Division

Rice is the staple food of Madagascar, and 60% of the workforce is involved in rice farming. The crop is grown all over the country, except in the arid southwest of the island (Map 1). The principal rice production areas are in the central highlands. About 1.25 million hectares are planted to rice each year, with an average yield of 2.8 tons per hectare. Rice is produced mainly in flooded conditions and is mostly rainfed with limited opportunities for irrigation. Slash-and-burn agriculture characterizes Madagascar's steep eastern slopes, threatening



Map 1. Elevation and major rice-producing areas in Madagascar.
Source of rice data: Government of Madagascar (Ministère des Eaux et Forêts), 1994. Inventaire Ecologique et Forestier National, 1994.



Map 2. Percentage of households buying rice, at any time of the year 2007, in communes of Madagascar.

remaining refuges of the country's unique flora and fauna. There is also nonflooded rainfed rice in more permanent agricultural fields on the high plateau.

Around 60% of Madagascar's population earns less than a dollar per day. The price of rice, therefore, has a major impact on the welfare of both rice producers and consumers. Here we illustrate how rice prices vary between regions and seasons, using data from commune censuses of 2001 and 2007 in which the rice price was recorded for each quarter[1] (Madagascar is subdivided into more than 1,500 communes). Rice prices in Madagascar are lowest after the main April-June harvests and then increase by about 40% in December. The high prices during the "hunger season" reflect the increasing demand and the cost of storage, capital, transportation, handling, and losses. During this period, the rice price is effectively capped by the price of imported rice.

Many households sell rice after the harvests because they need cash, only to buy rice again later in the year. In April-June, only 18% of these communes have more households that buy rice than sell rice. In October-April, however, 77% of communes have a

[1] The 2001 commune census is described by Minten B, Randrianarisoa J-C, Randrianarison L (eds.) 2003. Agriculture, pauvreté rurale et politiques économiques à Madagascar (USAID, Cornell University, INSTAT, and FOFIFA). This insightful book, which contains a wealth of information on rice and agriculture in Madagascar, includes 54 maps and is available at www.ilo.cornell.edu/ilo/book.html. For a thorough discussion of rice prices in Madagascar, see also Bart Minten and Paul Dorosh (eds.) 2006. Rice markets in Madagascar in disarray: policy options for increased efficiency and price stabilization. Africa Region Working Paper Series 101.World Bank. www.worldbank.org/afr/wps/wp101.pdf.

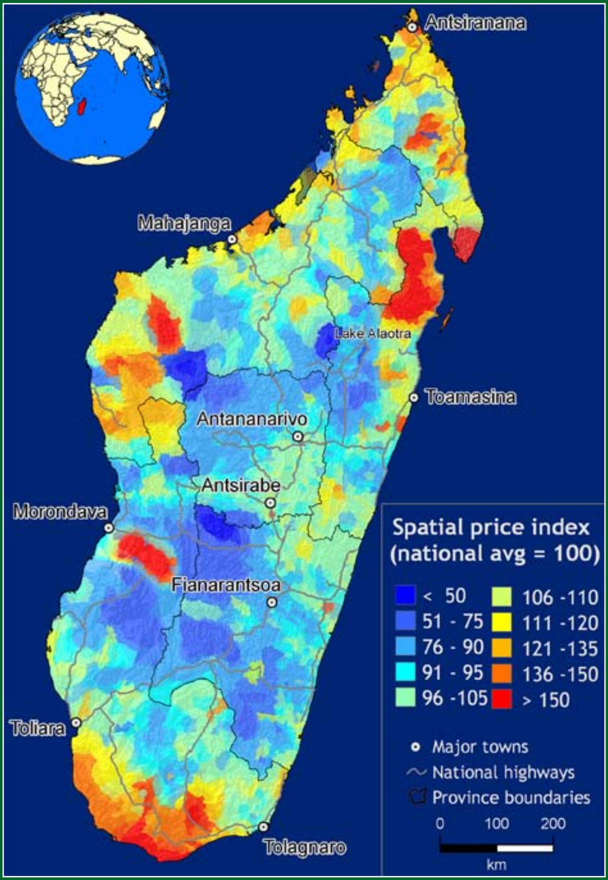
majority of rice-buying households. Map 2 shows the peak percentage of households that buy rice at any time during the year (in most communes, the peak buying time occurs in the first quarter of the year).

Large differences in prices and in price fluctuations exist between regions. Map 3 shows a spatial price index, based on an average over four trimesters for 2001 and for 2007. The national average has an index of 100. Areas with low rice prices are in blue and areas with high prices are in red. Eleven percent of the communes have a price that is, on average, 20% higher than the national average, and 10% of the communes have a price that is 20% lower than the national average. The highest prices tend to occur in the more isolated areas where there is little rice production.

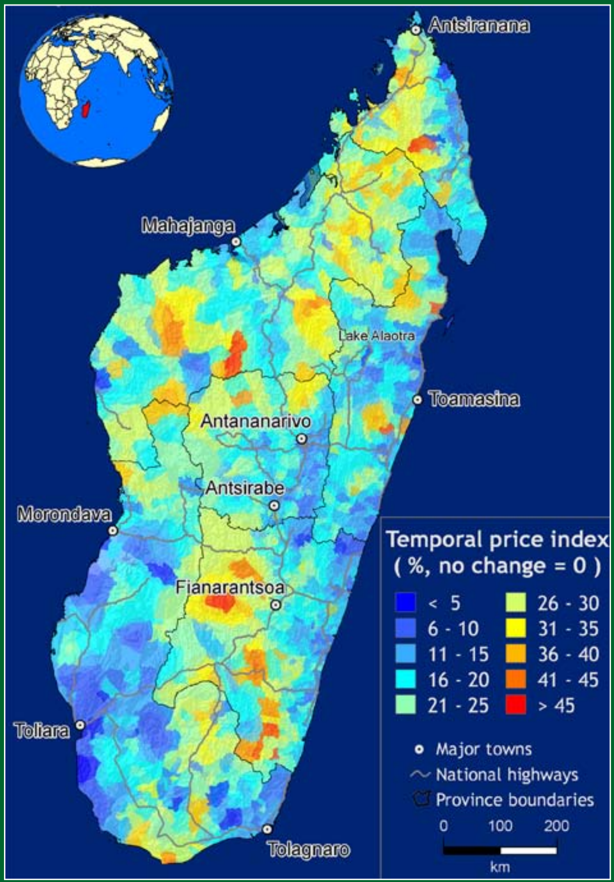
Map 4 shows the temporal variation in prices, computed as the average within-year variation of the rice price, expressed as the average deviation from the mean annual price. Areas with a stable price throughout the year are colored blue, and areas with large fluctuations are colored red. Half the communes have an average yearly price variation of 20% or more.

In the harvest season, the price of rice tends to be higher near cities because of lower transportation costs from farm to market. In other words, in the harvest season, rice in more remote areas is sold at lower prices to make up for higher transportation costs to the market. In contrast, because storage tends to be in larger towns, off-season prices tend to be highest in remote areas because of additional transportation costs. This partly explains why spatial and temporal variabilities in rice prices are not at all correlated (correlation coefficient = 0.1). Many additional factors play a role in determining rice prices. Flooded roads in the wet season, which isolate some areas, are particularly disruptive, while the northern part of the country is vulnerable to cyclones. Each year, such events cause the formation of "enclaves"—temporally isolated areas that can experience sharp hikes in the rice price.

Rice production in Madagascar has not kept up with population growth, despite a decrease in per-capita rice consumption. About 10% of the country's rice is imported and the government has called for a Green Revolution to change this situation. Knowledge of the factors that shape spatial and temporal variation in the rice prices[2] could help guide investments to help people who are most vulnerable to high prices.



Map 3. Average spatial variation in rice prices in communes of Madagascar. Average for 2001 and 2007.



Map 4. Mean variation across four trimesters (% change from average price) of the rice price in communes in Madagascar. Average for 2001 and 2007.

[2]Such data are currently collected by the "Observatoire du riz," an impressive government program that tracks weekly rice prices throughout markets in Madagascar.

GENE HETTEL (3)

The problem solver

After 26 years at Cornell University in the United States, Nyle C. Brady became the International Rice Research Institute's (IRRI's) third director general in 1973. During 8 years at the helm, he pioneered new cooperative relationships between the Institute and the national agricultural research systems in Asia. After IRRI, he served as senior assistant administrator for science and technology at the U.S. Agency for International Development from 1981 to 1989 and was also a senior international development consultant for the United Nations Development Programme (UNDP) and the World Bank in Washington, D.C. Born in Colorado in the U.S., he earned his BS in chemistry from Brigham Young University in 1941 and his PhD in soil science from North Carolina State University in 1947. Now an emeritus professor at Cornell, he is the co-author (with Ray R. Weil) of the classic textbook,* The nature and properties of soils*, now in its 14th edition. He and his wife Martha are retired and live near Albuquerque, New Mexico.

Coming to IRRI

Having worked at the nearby University of the Philippines at Los Baños as a visiting Cornell professor, I knew of the area and the plans of Bob Chandler [IRRI's first director general] and his group to set up the Institute in the early 1960s. In 1972, Frosty [Forrest F., Ford Foundation vice president of overseas development] Hill, chairman of IRRI's Board of Trustees, asked me if I wanted the job of director general [DG]. I had been working at Cornell University as director of research in the College of Agriculture. I asked a few friends what they thought and they said that it would be a good thing. So, I decided to try it. Of course, I also had to get permission from my wife [Martha] and she was delighted to go back to the Philippines with me.

Challenges and achievements

In those days, I thought the greatest challenge for IRRI was to influence, to the degree it could, quality research for our collaborators in developing countries. IRRI had made great progress, but it did not always communicate well. [We needed to foster] international cooperation between IRRI scientists and those in the developing world's rice countries.

This also involved inter-disciplinary collaboration to increase rice production around the world. When I arrived [at IRRI], there were four separate rice improvement research programs—i.e., in plant breeding, entomology, plant pathology, and agronomy. This was good because it was competitive, but I said, "Let's see what we can do if we can get together to develop a truly interdisciplinary collaborative research program." And we did, making full use of the thousands of genetic accessions [seed samples] in IRRI's germplasm bank.

Back then, the germplasm bank holdings were in paper bags! A fire could have destroyed everything. So, the first thing we had to do was to build [in 1976–77] a truly modern facility to store the seeds [see photo]. Second, we began evaluating those cultivars [housed in the new Rice Genetic Resources Laboratory, which on 24 October 1981 would be named the N.C. Brady Laboratory] for their resistance to different insects and diseases and for their tolerance of acidic, saline, and toxic soils and drought. Every department was involved. The plant breeders' products were evaluated by the entomologists, the plant pathologists, the agronomists, and the social scientists in terms of what was useful to them and to the farmers whom they were representing. This is how the Genetic Evaluation and Utilization Program (GEU as it was known) came into existence. I think it really revolutionized, internally, our ability to provide the world with products that could be used in breeding programs elsewhere.

The GEU was basically a plant breeding and genetic improvement program that the whole Institute was concerned with. And as far as I was concerned, it was fantastic! When we first started working on [this concept], there were some in the group who were not exactly enthusiastic, at least in dealing with me on this. But very soon, I began to listen to them as they gave speeches talking about this Institute-wide genetic evaluation and utilization program, which basically involved evaluation of rice lines the breeders had developed.

Not the most popular DG

I wasn't always the most popular DG. You could ask anyone who stayed there for a while. Some thought maybe I was too demanding when I called them late at night for something. As a manager, I could have probably used more kid gloves. Sometimes, I was rather adamant on what I wanted done and, I guess, if I could do it again I'd be a little more gentle in my interactions with people and in working with them.

But what is of interest to me is that when I called upon scientists to go out of their way to do extra work or to take on an assignment over the weekend, I was never turned down. This was not because they were afraid of me, but because they loved their work and they loved IRRI. They were dedicated to the Institution and it was a great joy for me to see that happen.

Challenges for IRRI today

I think IRRI needs to make effective use of biotechnology and other modern research tools to help the plant breeders develop rice lines that efficiently utilize plant nutrients, that tolerate adverse conditions such as drought, and that are resistant to insects and diseases, thereby reducing the need for pesticides.

To do this, IRRI must have linkages with scientists in both the developing and the more developed countries. This is advice the whole CGIAR [Consultative Group on International Agricultural Research] system [which includes IRRI] could accept. I recognize the political reasons why this is difficult because some countries don't want to use biotechnology. But the developing countries need the improved crops much more than we do in the U.S. So, I think this is the direction in which IRRI and other such centers should and could go.

IRRI must also continue to push what it has been doing lately—more after I left than when I was there—to recognize the consequences of what we do to the environment in terms of pesticide use and fertilizer use, i.e., nitrogen getting into the water causing troubles later on. I think this is an opportunity for IRRI to develop high-yielding, quality rice in such a way that the soil, water, and atmosphere will not be adversely affected. It's a real challenge to know exactly how to do this, but I think it can be done. I'm not suggesting that the Institute is not doing it; it has already made remarkable progress.

We were there to solve problems

My IRRI experience ranks very high. I had three careers: one at Cornell as a professor and a teacher, one at IRRI, and then one in Washington, D.C. with the U.S. Agency for International Development, UNDP, and The World Bank. I won't say which one was the more critical. I will say that my experience at IRRI, not only for me but for my wife and family, was a highlight because we were involved in something that would help humanity. I felt I was working with a group of individuals, men and women, who wanted to improve the lot of people. They were not there just to do research and write papers; they were there to solve problems.

I remember one time, I think, grassy stunt virus suddenly invaded the Philippines. What did we do? Within a month, we had already evaluated and found certain lines that were resistant to the grassy stunt virus and our plant breeders were already crossing them to develop acceptable rice varieties. That kind of effort really is heartwarming.

It's IRRI class

I'll tell one story that relates to not the scientists but to a member of the [non-research] staff at the Institute, a Filipino. The CGIAR was holding one of its annual meetings in Manila and the participants decided to visit IRRI on a Sunday. When checking to see that everything was prepared for the luncheon to be served to this group, I approached one young lady who was helping with the service.

"Well, do you think it is first class?" I asked.

"No sir," she said, "it's better than that. It's IRRI class."

This exchange told me that she had pride in IRRI and in being associated with the Institute, which I thought was just great.

Go to www.irri.org/publications/today/Pioneer_Interviews.asp *to read the full transcript of the Nyle Brady interview in which he discusses more about his IRRI experience including the establishment of the International Network for the Genetic Evaluation of Rice (INGER) and IRRI in Africa.*

IRRI

ON 9 NOVEMBER 1976, IRRI Director General Nyle Brady ceremoniously sinks the first pile for the Rice Genetic Resources Laboratory, a structure that would officially (unbeknownst to him at the time) bear his name only a few years later.

AFRICA

Opportunity from crisis

by Savitri Mohapatra

From the chaos of the recent rice crisis comes opportunity for African countries intent on boosting production of the continent's fastest growing staple


LOCAL AND IMPORTED rice in Cotonou, Benin.

"Everyone to the farm," is the new decree of President Wade of Senegal—a country that has seen massive riots in the last few months, when thousands of citizens carrying empty rice sacks on their heads marched in protest against soaring rice prices.

The President has just unveiled an ambitious agricultural plan called the *Great Offensive for Food and Abundance* (GOANA), which aims to make Senegal self-sufficient in food staples, especially rice. GOANA's target is to produce in the next season 500,000 tons of rice—2.5 times more than the current production.

Senegal, where rice-fish called *cebbu jen* is the most popular daily dish, consumes about 800,000 tons of rice per year and nearly 80% of this is imported at a cost of more than 100 billion CFA francs (US$247 million). Some Senegalese call this the "tyranny of rice" because of its huge negative impact on the national economy.

President Wade has said that GOANA will help free Senegal from this tyranny, urging farmers to grow more rice (and even asking his ministers and government officials to farm at least 20 hectares each). The government has earmarked 750 billion CFA francs ($1.85 billion) for boosting national rice production. The money will be used to improve irrigation facilities and farmers' access to seed, fertilizer, and equipment.

Similar announcements have been made by governments of several African countries in the wake of the rice crisis—news that comes as a relief to local rice farmers.

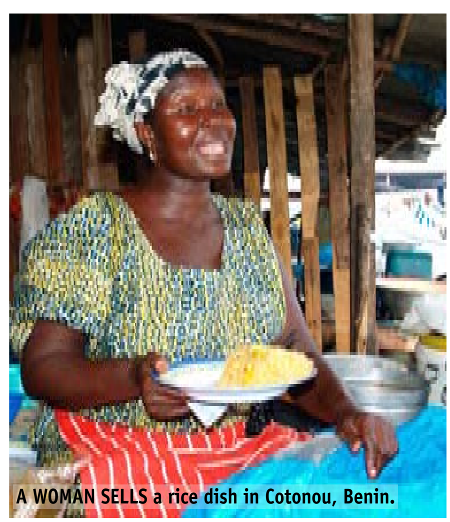
"We think that the crisis has forced our government to pay attention to local rice production, which has been neglected for so long," says Abdoulaye Ouédraogo, a rice farmer from Burkina Faso, which is now investing massively in agriculture. He added that if the government had listened to the farmers earlier, the country would not have been in such a crisis, referring to food riots that recently broke out in the cities.

As expected, in contrast to urban consumers, African farmers are happy about the high price of rice. "I have never seen this kind of price hike in 30 years," says Abdoulaye. "Just a few months ago, 1 kilogram of paddy [unhulled] rice was selling here for 110 CFA francs [$0.27] and now it is 225 CFA francs [$0.56]."

In neighboring Mali, the grain is so much in the limelight today that some citizens joke the country will soon have a Minister of Rice. In April 2008, the government launched an *Initiative riz* (rice initiative) as "a structural response to the rice crisis."

The aim of this program is to double Mali's annual milled rice production in 2008-09 to 1 million tons, which will not only meet domestic demand but also provide a surplus of 100,000 tons for export. In addition, Prime Minister Modibo Sidibé is placing considerable importance on the national rice research program. "There is no agricultural development without research," he said.

According to the Africa Rice Center (WARDA), the rice crisis offers a big opportunity for Africa to use its latent potential for production and break from decades of policy bias against agriculture. Except for Egypt, Africa is a net importer of rice with Nigeria, South Africa, Senegal, and Côte d'Ivoire ranking among the top 10 importers of rice in the world.


A WOMAN SELLS a rice dish in Cotonou, Benin.

A RICE MARKET in Cotonou, Benin.

R.RAMAN (WARDA) (3)

With nearly 40% of the continent's total rice consumption coming from the international market, African national rice economies are more exposed to unpredictable external supply and price shocks than those of other continents. Africa is especially vulnerable because of the high prevalence of poverty and food insecurity.

"Africa faces not only problems of affordability of rice but also of availability in the international market because of the rice export bans by several countries," says WARDA Director General Papa Abdoulaye Seck. "Since 2006, WARDA has been systematically alerting the governments of its member states to a looming rice crisis in Africa."

According to Dr. Seck, the best option for Africa to manage the crisis is to combine emergency responses in the short term with measures that favor sustainable expansion of the continent's rice supply in the longer term.

Short-term measures include reduction of customs duties and taxes on imported rice and setting up of mechanisms to avoid speculation in rice markets. At the same time, governments must avoid undermining incentives for domestic rice production. In the medium and long term, taxes on all critical inputs, cost-saving agricultural machinery and equipment, and postharvest technologies need to be reduced.

Governments should also facilitate access to credit for farmers, expand rice areas under irrigation, and improve rural infrastructure. There also needs to be concerted investment in regional research capacity to support the development of rice varieties resistant to major pests and diseases and sufficiently robust to withstand drought and climate change-induced environmental shocks.

To assist the African countries that have been severely hit by soaring prices, an Emergency Rice Initiative for Africa was launched in June 2008 by WARDA, the Food and Agriculture Organization of the United Nations (FAO), IFDC (an international center for soil fertility and agricultural development), Catholic Relief Services, and the International Fund for Agricultural Development.

Urgent assistance will be provided to 11 pilot countries in four major areas: seed, fertilizer, best-bet technologies, and postharvest and marketing. WARDA, the International Rice Research Institute, FAO, and Sasakawa Global 2000 will play a key role in enhancing Africa's rice research capacity and facilitating access to important rice information and knowledge.

As a complement to ongoing national and regional initiatives, the Alliance for a Green Revolution in Africa, the New Partnership for Africa's Development, and the Japan International Cooperation Agency announced the establishment of the *Coalition for African Rice Development* (CARD) with the aim of doubling Africa's rice production in 10 years. The announcement was made during the Tokyo International Conference for African Development in May 2008.

"Given the critical rice situation in Africa, CARD is timely," said Dr. Seck. "We're convinced of rice farming's enormous future in Africa, which has more potential than any other area of the world because of its land and water resources."

NO SEX, PLEASE—WE'RE APOMICTS

DESPITE ITS YIELD ADVANTAGE, HYBRID RICE IS SHUNNED BY MANY POOR FARMERS BECAUSE OF THE NEED TO PURCHASE NEW SEEDS EVERY SEASON. WORK TO DEVELOP "APOMICTIC" HYBRID RICE AIMS TO SOLVE THAT PROBLEM.

by John Bennett and Xin'ai Zhao

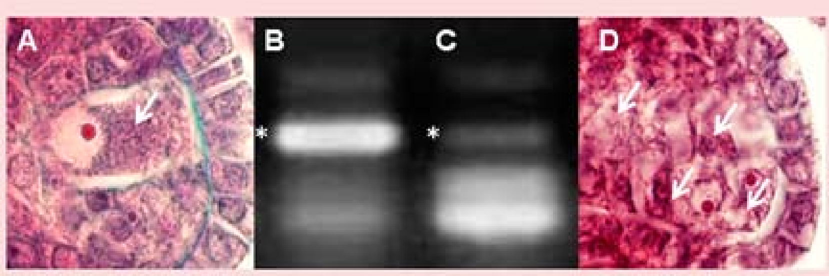
The high cost of hybrid rice seeds is considered a major disincentive to poor farmers to adopt this beneficial technology, which offers yields substantially higher than those of nonhybrid (inbred) rice. Not only are hybrid seeds more expensive per kilogram than seeds of inbred lines but they must also be purchased fresh each season. Inbreds breed true and may be reproduced by self-pollination (selfing), even in farmers' fields. By contrast, hybrids lose their yield advantage and genetic uniformity when selfed. They must be produced repeatedly from inbred parental lines in large and specialized nurseries. Although farmers sow hybrid seed at a somewhat lower density to reduce the impact of the higher price, considerable research is being focused on ways of reducing the cost of hybrid seed production. In addition, for the last 20 years, the International Rice Research Institute (IRRI) has studied the feasibility of an alternative breeding system for hybrid rice, one that fixes the special genetic constitution of hybrids so that they will breed true in farmers' fields. This new breeding system is known as apomixis—asexual reproduction through seeds.

The term "apomixis" means "without mixing," where "mixing" refers to the important and beneficial role of sexual reproduction in generating offspring with novel combinations of maternal and paternal genetic material. In sexual plants, the embryo in the seed is derived from a single cell, the zygote, which is a fusion between a sperm cell from the pollen and an egg cell from the ovule. To avoid doubling the genetic content of cells every generation, the sperm cell and egg cell contain half the genetic content of normal cells. This halving of the genetic content of sperm and egg can be traced back to a process known as meiosis, which occurs in the microspore mother cells (MiMCs) of the anthers and the megaspore mother cells (MeMCs) of the ovule, respectively.

The MiMCs and MeMCs are among the most highly specialized cells of the plant. All other dividing cells first double their DNA content and then divide the two DNA copies equally between the two daughter cells (the process known as mitosis). In contrast, MiMCs and MeMCs, after doubling their DNA content, recombine it in a complex way before dividing twice to give a tetrad of cells. It is this recombination that constitutes genetic "mixing." Apomicts avoid meiosis during embryo formation and so produce offspring that are genetically identical with their maternal parent. Although the paternal parent does not contribute to embryo formation, it may contribute to the formation of the endosperm—the starchy tissue that provides nutrients for the developing embryo (and for human rice consumers).

Among the more than 250,000 species of flowering plants, about 400 are known to be apomictic, so while the trait is not rare, it is not as common as sexuality. For reasons that are not clear, apomictic species are almost invariably polyploid, with four or more copies of the genetic material, compared with sexual species, which are mostly diploid, with two copies. One of IRRI's first activities in apomixis research was to screen accessions of cultivated and wild germplasm, including polyploids, for apomixis or its component traits. However, when it became clear that, unlike wheat, maize and pearl millet, rice possesses no close apomictic relatives, two alternative approaches were adopted: artificial mutagenesis and genetic engineering. However, the artificial mutagenesis approach was soon abandoned when studies elsewhere showed that the genetic control of apomixis is more complex than previously thought. The careful screening needed for detecting apomixis would not be feasible with the large mutant populations required to catch rare multiple mutations.

IRRI's genetic engineering



The ovule of a normal rice plant (A) has only a single megaspore mother cell (*arrowed*), because of the expression of the *OsTDL1A* gene (*strong band asterisked in B*). However, when RNA interference is used to reduce the expression of *OsTDL1A* (*faint band asterisked in C*), multiple megaspore mother cells are formed (*arrowed in D*) and undergo meiosis, as revealed by the fibrous appearance of the chromosomes. The next task is to produce extra megaspore mother cells that bypass meiosis and form aposporous initials.
A,D: ovules stained with fast green and safranin. B,C: detection of messenger RNA of *OsTDL1A* gene.

approach to apomixis for hybrid rice began in 1997 when the Australian Centre for International Agricultural Research started to fund collaboration between IRRI and two laboratories of Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). One laboratory, in Canberra, specialized in research on sexual reproduction in the model plant *Arabidopsis thaliana* and the other, in Adelaide, focused on apomixis in citrus and hawkweed. The collaboration was conceived as a 15-year, three-phase program. The second phase of the project ended in June this year.

There are three main apomictic mechanisms in plants: adventitious embryony (as in citrus), apospory (as in hawkweed), and diplospory (as in tripsacum, a close relative of maize). During Phase 1, IRRI focused on achieving adventitious embryony. This was attempted by first identifying *Arabidopsis* genes that appear to cause embryos to form in unusual sites within the plant and then overexpressing the equivalent genes in rice. Although this approach succeeded in expressing seed-specific genes in leaves, it did not generate adventitious embryos.

During Phase 2, the focus shifted to achieving apospory, the most common form of apomixis among the grass family, to which rice belongs. This shift was stimulated by reports on a mutant of maize, *multiple archaesporial cells1* (*mac1*), which has lost control over the number of MeMCs in the ovule and MiMCs in the anther. We saw a parallel between the extra MeMCs that form alongside the primary MeMC of *mac1* and the multiple structures known as aposporous initials (AIs) that form alongside the single MeMC in aposporous apomicts such as *Hieracium pilloselloides* (tall hawkweed). IRRI proposed to identify the rice equivalent of the *MAC1* gene, to inactivate it by mutation or by RNA interference

Using conventional hybrid rice (*pictured*), farmers must purchase new seed each time they plant. The seed of apomictic hybrids can be saved and planted.

FANGMING XIE

(RNAi), and to confirm the expected *mac1*-like phenotype (exhibiting extra MeMCs in the ovule). The next step would be to bypass meiosis in the extra MeMCs in the expectation that one or more AIs would form and develop into aposporous embryos without the need for fertilization.

In 2003, when Phase 2 started, a group in Japan identified a mutant of rice that mimicked *mac1* in both the ovule and the anther. Because the mutation added a DNA tag to the affected rice gene, it was possible to identify the gene as one encoding a type of protein known as a leucine-rich repeat receptor kinase. Named MULTIPLE SPOROCYTES1 (MSP1), this gene is closely related to a gene in *Arabidopsis* that encodes the protein EXTRASPOROCYTES (EXS). The *exs* mutation caused similar symptoms in the anther but appeared to have no effect on the ovule. It turned out that the mutation of a different *Arabidopsis* gene, encoding the protein TAPETUM DETERMINANT1 (TPD1), produced the same symptoms as *exs*, suggesting that EXS (and, by extension, MSP1 in rice) does not work alone in controlling MiMC numbers.

The *msp1* mutant of rice is not suitable as a platform for building aposporous hybrid rice because one effect of the mutation is to cause sterility in the anthers. With help from the CSIRO, IRRI identified the equivalent of TPD1 in rice and named it OsTDL1A (for TAPETUM DETERMINANT1-like1A) and used RNAi to downregulate its expression. Fortunately, these so-called *OsTDL1A*-RNAi lines produced multiple MeMCs in the ovule (see figure, *opposite*) while the anthers were unaffected, meaning that the plants were fertile. This ability of RNAi to inactivate expression of a gene in some tissues but not in others is a major advantage of this approach over mutation, which usually knocks out the function of the gene in all tissues. Figure 2 shows the presence of a single MeMC in the ovule of a normal rice plant and of multiple MeMCs in the ovule of an *OsTDL1A*-RNAi line.[1]

The full fertility of the *OsTDL1A*-RNAi lines makes them a suitable platform for the project's next stage: bypassing meiosis in the extra MeMCs. To achieve this objective, IRRI is conducting basic research on the initiation of meiosis in plants. Meiosis is best understood in two types of fungus, budding yeast and fission yeast, where it is induced by nutritional stress—specifically, a deficiency of nitrogen and sugars. However, the initiation process is completely different in the two yeasts, which are in fact not closely related, in spite of their names.

Overall, meiosis in plants and animals is more closely allied to meiosis in budding yeasts, and this is consistent with IRRI's recent finding that certain crucial aspects of the initiation of meiosis are highly conserved between budding yeast and rice. With this knowledge, IRRI has a chance of developing a simple procedure to bypass meiosis—a major step in the development of apomictic hybrid rice.

Dr. Bennett worked as a senior biotechnologist at IRRI from 1992 to 2007 (see Where science meets art *on pages 17-19 of* Rice Today *Vol. 6, No. 4). Dr. Zhao is a postdoctoral fellow at IRRI.*

ADAM BARCLAY

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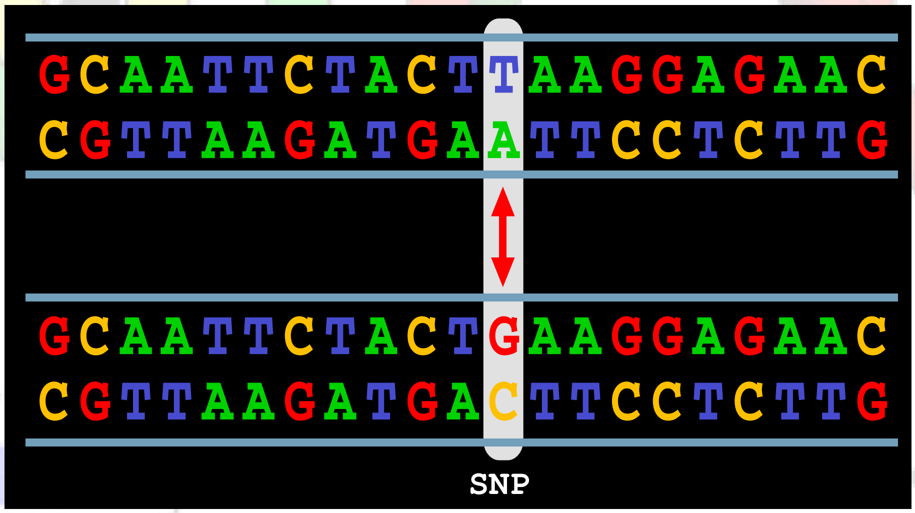
[1] Zhao X, de Palma J, Oane R, Gamuyao R, Luo M, Chaudhury A, Hervé P, Xue Q, Bennett J. 2008. *OsTDL1A* binds to the LRR domain of rice receptor kinase MSP1, and is required to limit sporocyte numbers. *The Plant Journal* 54:375-387.

DECIPHERING THE CODE

by **Jill E. Cairns** and **Ken McNally**

An international drive to generate data on tiny genetic differences will help scientists develop high-yielding, high-quality rice varieties that can better withstand pests, diseases, and environmental stresses



A SINGLE nucleotide polymorphism (SNP) is a difference between one pair of DNA nucleotides.

Variation is the spice of life. In humans, plants, and animals, genetic variation within species is immense. This variation, or genetic diversity, is a result of different mixes of genes and is fundamental to the adaptation and survival of species. When the environment of a species changes—because of the occurrence of a new disease or fluctuations in rainfall patterns, for example—the small gene variations occurring in a population are essential for its adaptation. The more diverse the population, the more likely that individuals will exist that can cope with a changed environment or withstand a new pest or disease.

Low genetic diversity was a contributing factor of the infamous 1840s potato famine in Ireland. At this time, Irish farmers were reliant on, essentially, a single potato variety. The lack of diversity had a devastating consequence when an outbreak of potato blight fungus hit Ireland, destroying the vast majority of the potato crop and causing an estimated 1 million deaths from starvation and disease. With approximately the same number emigrating, Ireland's population fell by around 20%.

The fundamental basis of genetic diversity lies in one particular class of difference in the sequence of the nucleotides—named adenine (A), cytosine (C), guanine (G), and thymine (T), these are also referred to as bases—that form the DNA within the cells of organisms. These tiny differences in DNA sequence, known as single nucleotide polymorphisms (SNPs, pronounced "snips"), are the smallest level of genetic variation.

A difference in only one DNA base (see figure, *above*) can cause a large difference in physical appearance or behavior (this physical manifestation of an organism's genetics is known as its phenotype). For example, in humans, a single SNP in one gene is responsible for red hair associated with people from Celtic descent. SNPs in the genetic code of other genes have been associated with the stickiness of ear wax and patterns of baldness.

Genetic diversity provides a potential gold mine for scientists to explore. With the steadily increasing human population, decreasing land availability, climate change, and outbreaks of pests and diseases, there is enormous pressure to create high-yielding, high-quality rice varieties with increased tolerance of abiotic stresses (such as drought, flooding, and salinity) and biotic stresses (pests and diseases). The challenge is tough, yet within the rice gene pool lies incredible DNA diversity that can be exploited to develop new varieties that can help not only feed the billions of people dependent on rice as their staple but also lift millions out of poverty.

The challenge is to decipher the code and identify key alleles (different forms of a gene) that can increase yield, improve quality, and provide resistance to pests and tolerance of harsh environments. Rice has an estimated 50,000 genes encoded in its genome, which comprises 400 million base pairs. If translated into text, the rice genome would take up the equivalent space of 130 copies of Tolstoy's epic *War and peace* (one copy has around 500,000 words). Detecting these minute, yet important, differences in DNA sequence is an immense undertaking.

In 2003, an ambitious research project was undertaken by International Rice Research Institute (IRRI) molecular geneticist Ken McNally to look at genetic variation

DAVID HALL (GRINGER)


JOSE RAYMOND PANALIGAN

DR. CAIRNS (*left*) and Dr. McNally test rice plants for desirable traits such as drought tolerance.

within 10 genes related to plant performance under drought stress. Lack of adequate water during rice production is a major factor reducing yield, particularly in poorer areas, where farmers rely on rainfall. Worldwide, research to understand the genetic basis of drought tolerance in rice and other species has identified many genes (known as candidate genes) thought to influence plant response to water shortages. Dr. McNally's vision was to relate variation (in the form of SNPs) within key genes to plant performance in the field and to link these genes to yield, the most important trait for farmers.

Over 3 years, a team of 15 researchers worked together at IRRI to document DNA variation within 10 genes in more than 1,500 diverse rice varieties and measure simultaneously performance under drought stress in the field in the same varieties. The results have linked specific sequences of genes to performance under field stress, confirming the potential of such an approach to identify alleles suitable for improving drought tolerance. For example, unique variations within the gene that codes for the protein trehalose-6-phosphatase (a regulator of sugar metabolism) were discovered within a few plants and, in some cases, were found to be associated with improved performance under water-limited conditions.

For Dr. McNally, these results confirmed the potential of such an approach but realized an important limitation. "Over 3 years, we were only able to look at 1/6250th of the estimated total rice genes," he explains. "At this rate, we would need 18,750 years to complete the task!"

Not being a man to avoid a challenge, Dr. McNally, along with collaborators Hei Leung, David Mackill, Richard Bruskiewich, Jan Leach, and C. Robin Buell, organized an international consortium, named OryzaSNP. The consortium set about raising the funds and applying the proven "array-based" technology of Perlegen Sciences, Inc. to sequence a significant proportion of the unique (non-repetitive) regions of the rice genome within key rice varieties. By mid-2007, the sequencing of 20 rice varieties had been completed.

With the results delivered by Perlegen, and by applying additional tools for SNP prediction from the teams of Detlef Weigel and Günnar Raescht at the Max Planck Institute in Germany, the rice community now has access to a database containing more than 400,000 SNPs. For the 100 million base pairs of the rice genome, the project identified an average of 4.2 SNPs per thousand DNA base pairs. Further, OryzaSNP is collaborating with Carlos Bustamante's team at Cornell University in the USA to identify regions of shared SNPs between different types of rice and other data that can help uncover population structure and genetics of rice.

While the results of this project, representing about 30 gigabytes of data, were remarkable, the ability to identify unique SNPs associated with high yield and performance under abiotic and biotic stresses is limited because it includes results from only 20 of rice's tens of thousands of varieties. Nevertheless, these data provide a foundation upon which a second phase of SNP genotyping will be laid. An international team of partners under the International Rice Functional Genomics Consortium is being formed to use the OryzaSNP and other sources of SNP data to create a high-density SNP genotyping platform similar to technology used in human genetics and capable of identifying millions of SNPs. This technology will be used to genotype a collection of more than 2,500 rice varieties representative of global rice diversity. The resulting dataset will create a rice "hapmap"—a map of the regions in the rice genome that pinpoint key genetic differences. Additionally, these materials will be phenotyped in great detail for as many traits as possible. Together, the two data sources will open a treasure trove of information, enabling the discovery of specific alleles and genetic regions associated with particular traits. The knowledge will boost breeding programs worldwide.

What started as an ambitious idea to link tiny differences in a handful of important genes to performance in the field is surpassing all expectations. The stakes have been raised to look at millions of genotypes in more than 2,500 rice varieties involving a large international team of researchers. The potential is enormous, both in terms of improving rice production and simply learning more about the grain that feeds half the world. It brings to Dr. McNally's mind a quote by Albert Einstein: "The important thing is not to stop questioning. Curiosity has its own reason for existing."

Dr. McNally works in IRRI's T.T. Chang Genetic Resources Center and Dr. Cairns, a plant physiologist, works in IRRI's Crop and Environmental Sciences Division.

NAVIGATING A SEA OF RICE

Story and photos
by **Bob Hill**

Amid the cutthroat world of rice trading, one Thai company has chosen a different path

It's easy to think of rice as a commodity that sells itself.

Demand is growing faster than production, so any novice merchant with a warehouse full of paddy and a telephone can sell it. Just offer a slightly lower price than the others and hope your supplier holds up his end of the deal. Oh, and never mind the quality. Just mix enough of variety C with premium variety A to suit the price you're getting and hope that nobody notices.

Welcome to the "red ocean" of rice trading. It's a term used for a saturated market in which competition is both fierce and ruthless; where just about everything is compromised in the battle to survive. Hence the connotation of blood in the water. As unattractive as the picture may be, it is nevertheless an accurate portrayal of rice trading in many Asian countries.

There is another way. It regards rice and rice consumers in a more reverential fashion, and, perhaps, because of the growing affluence of rice consumers, it may be the way of the future.

Wanglee Company Ltd. was formed in Bangkok in 1871, but its principals had traded rice even before that, buying from bloated rice barges plying the country's river system. It grew to own five rice mills on the banks of the Chao Phraya River before the ocean began to turn red, and the risks became too great. The company diversified into real estate, banking, and insurance and all but forgot about rice trading until 1988, when it formed a new company called Chaitip, to resurrect its rice business.

Then, just 3 years ago, a fifth-generation son of the Wanglee family joined Chaitip after gaining a master's degree in business administration from Vanderbilt University in Nashville, Tennessee. Viput Wanglee, 35, had earlier begun his university education with a bachelor's degree in architecture, and the rationale behind the switch says a lot about his approach to his job.

"Architecture is a way of thinking," he says. "It teaches us to think from different angles. Importantly, architecture is a commercial art. What an architect designs has to respond to the issues it is attempting to resolve. It must work; it must sell. It is business mixed with art."

He served a working apprenticeship by marketing consumer goods for firms like Unilever and Johnson & Johnson before joining his father, Vuttichai Wanglee, at the helm of Chaitip.

His father is managing director, Mr. Viput is assistant to the managing director for sales and marketing, and his brothers Vuttiphol and Thinnaphan are assistants to the managing directors for production and accounting and finance, respectively.

Surprisingly, the company that is stretching the boundaries of modern marketing still occupies

VIPUT WANGLEE (*left*) **and his brother Vuttiphol, assistant to Chaitip's managing director for production, examine the company's premium quality Thai jasmine rice in the Chaitip warehouse.**

the same buildings in Bangkok's Thonburi District that have been the seat of the family's fortunes for more than 150 years.

When Mr. Viput joined the company, Chaitip was enjoying success as an exporter to Hong Kong. Its *Qing Ling Zhi* brand of premium grade Thai jasmine rice had an 8% share of the Hong Kong market, amounting to a value of US$9 million per year. Importantly, it was selling at $800 per ton when others were selling the same product for $700, simply because it gave an assurance of consistent quality and worked hard to deliver what it promised.

"The quality of our *Qing Ling Zhi* brand rice never changes, and consistent quality in rice is very difficult to achieve because agricultural products are very inconsistent," says Mr. Viput, adding that Chaitip prides itself on its honesty, accountability, and focus on customers' interests. It also gives its word that, even in times of rising raw material costs, it will still deliver at agreed rates.

However, it never attempts to deliver at low prices. "We are not cheap. We charge premium prices," Mr. Viput says.

"When I joined the company, we decided to diversify into the domestic market because exporting was very risky, particularly with volatile currency exchange rates. In consumer products, the large margins mean you can afford to make a few mistakes. But with rice, you can't make any mistakes at all. It's hugely risky. So we decided to concentrate our efforts on the local food service sector."

The prospect of diving into Thailand's red ocean rice market was not attractive, so Mr. Viput, a follower of modern marketing practices, set out, in a centuries-old industry, to create a new market; to find a niche in which Chaitip could enjoy its own "blue ocean"—a market with little or no competition.

"Everyone eats differently, everyone has a different taste in music, every person enjoys different things on TV. That's why we have cable TV," Mr. Viput explains. "We had to define the needs of our target consumers; to find out what they needed above everything else. We had to find a niche market that matched what we had to offer. And what we had to offer was the finest quality Thai rice, reliability, consistency, and honesty."

VIPUT WANGLEE (*right*) **and Thai Executive Chef Vichit Mukura examine cooked rice in the kitchens of the Oriental Hotel's Baan Rim Naam.**

He hired a research firm to survey leaders in the food service industry and found that the biggest need of hotels, restaurants, and chefs was an assurance that the quality of their cooked rice would not change.

"They were saying: 'I don't want any headaches, I don't want complaints from my customers, or they won't come back again.' And no one in the market was responding to those needs."

Mr. Viput's niche market began to take shape. But he realized that the concerns of his target customers were focused purely on the dining table. He was left wondering how

A WINDOW INTO the past: Viput Wanglee shows off his family's ancestral home, where his father was raised as a child. The old house, built in traditional Chinese style, shares the same site, fronting the Chao Phraya River, occupied by Chaitip's current offices.

THE MODERN MARKETER of rice: Viput Wanglee at work, with his mobile phone, computer, and a whiteboard crammed with calculations.

he might maintain the quality of his company's rice from the delivery truck to the dining table, given its hazardous passage through storage and cooking along the way.

He called in his researchers again and found that, normally, when rice was delivered to a hotel or restaurant, it was stored away out of sight. Sometimes it could wait months, on the bottom of the stack, before being delivered to the kitchen. In big hotel kitchens, there could be up to 10 people cooking rice at any given time, and all of them cooked it differently.

"We decided that if we were going to deliver them consistent quality, we would have to be involved in everything," Mr. Viput says.

That was 2 years ago. What Chaitip has ended up delivering is a full-scale service—what some may call service above and beyond the call of duty. Mr. Viput regards the company's brand name, *Panom Rung*, as a service brand and not simply a brand of rice.

Chaitip has built a 10,000-square-meter production plant in Saraburi Province, near Bangkok. It has a capacity of 288 tons of rice per day. Importantly, the plant includes a rice laboratory designed to test and analyze the physical and chemical qualities of milled and steamed rice. Chaitip has developed 15 formulas for the grades of rice it offers and for each of them it has fixed a precise ratio of water to rice in the cooking process to deliver a consistent product.

In its premium product, 100% Thai jasmine rice, it painstakingly maintains cooking quality throughout the year by mixing old crop with new crop rice and analyzing the resulting texture until it reaches its established standard. A special grade of rice is also offered for making fried rice because the premium jasmine varieties are unsuitable.

Having developed a consistent product, Chaitip takes over the storage of rice at its customers' premises. Its drivers ensure that the rice is stored away from moisture, off the floor and away from walls, and is used on a first-in, first-out basis so there is a healthy circulation of stock.

Then it has a customer service team that goes to kitchens and advises chefs and kitchen staff on how to cook their rice properly. This involves the quality of cooking vessels, water-to-rice ratios, and cooking time.

"It can be a bit awkward at first," Mr. Viput says, "but most people are happy to accept our advice." Importantly, since they have been produced for cooking consistency, there is only one set of rules for the water-rice ratio and cooking time for each of Chaitip's products.

As well as all this, Chaitip conducts small surveys of its customers' diners, asking them to rate the food, the rice, the prices, and their level of satisfaction. The results are then discussed with Chaitip's customers. Moreover, any new staff hired by Chaitip must, as a first priority, undertake a 2-day rice course.

"We accept and respond to complaints within 1 day, and we replace the rice immediately, with no questions asked, if it is accidentally contaminated," Mr. Viput says.

In 2 years, Chaitip has climbed from 0 to 1,400 customers in Bangkok. All are in the food service sector, including many of the large international hotel chains.

"We need customers that value honesty, quality, and consistency," Mr. Viput says. "If all they're after is cheaper prices, then they're not the customers we want. We charge premium prices. If the market goes up, we go up. If it comes down, we come down. But we never strike a deal and then mix the rice to achieve a low price. This way, our customers are loyal to our service and our brand and not to a price. Everyone is happy because nobody has ever done these things before."

He says Chaitip hasn't yet "become aggressive." It is concentrating on building up a more efficient distribution system before building upon its "premium group that pays attention to quality."

It has, however, entered the domestic retail market. And, typically, it is approaching it differently. With a brand named "*Panom Rung I'm Chef*," it not only promises that the rice is of the same quality as that used by leading chefs, but also offers printed information, including recipes from leading hotels, cooking tips from famous chefs, tips on buying raw materials, and even advice on setting a perfect table.

And while the denizens of the red ocean fret and struggle with cutthroat competition based on price cutting, Chaitip sails its new blue ocean, alone and unhurried.

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

Running out of steam

By David Dawe
Senior economist at the United Nations Food and Agriculture Organization

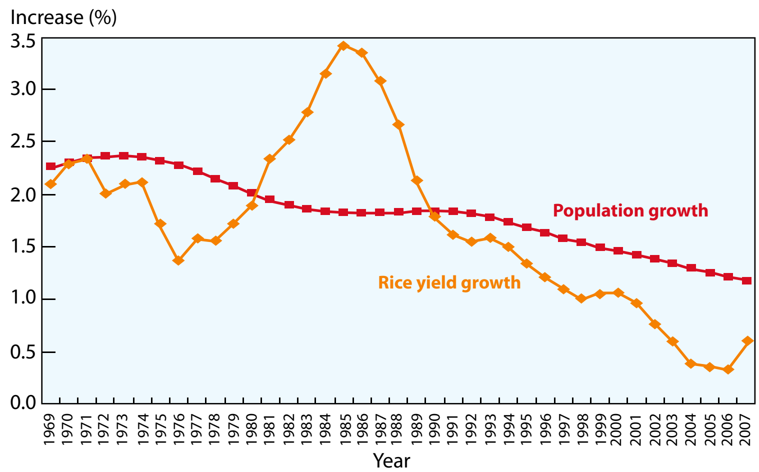
One cause of today's high rice prices is slowing productivity growth—suggesting it is time to step up investment in international agricultural research

Even before the dramatic price spike in early 2008, rice prices on the world market increased every year from 2001 to 2007. Never before in the post-World War II period had they increased for more than 3 consecutive years. Even after adjusting for inflation, average prices in 2007 were 64% greater than in 2001. There were many factors that contributed to this rise in prices, including the depreciation of the US dollar, falling real interest rates, and rising oil prices that led to higher fertilizer prices.

One very important factor that has been much overlooked, however, is the slowdown in rice yield growth in Asia, where about 90% of the world's rice is produced and consumed. Although rice yields are still growing, the rate of growth has been declining steadily for many years (see figure). Fortunately, population growth in rice-producing Asia has been steadily declining for even longer. Since population growth is the main source of rice demand growth, this trend helped to keep rice prices in check for a time.

But since the mid-1990s, population growth has exceeded rice yield growth and the gap has been growing steadily larger, creating a significant imbalance between supply and demand. This trend is evident for Asia as a whole, but also separately for East Asia, Southeast Asia, and South Asia. Part of this gap was filled for a time by increasing the area harvested, but rice area peaked in Asia in 1999.

To be sure, some of the slowdown in yield growth may be due to lower world prices leading to reduced supply. However, world prices were relatively constant from 1986 to 1998, when rice yield growth declined substantially. Thus, the major decline in yield growth preceded the decline in world prices from 1999 to 2001, suggesting that prices are far from the whole story.



ANNUAL AVERAGE percentage increase in rice yields and population between successive rolling 5-year periods in rice-producing Asia.

Source of raw data: USDA for yields, FAO for population.

Further, world corn prices have followed a broadly similar pattern to world rice prices during the past two decades, but, unlike rice, corn yield growth was much higher during the past 10 years than during the 1980s. And, it is domestic prices, not world prices, that affect farmers' decisions, and domestic prices in many countries have been quite stable when viewed from a longer term perspective (excluding events in 2008).

The widening imbalance between population growth and yield growth points to the need for more agricultural research. The funding of the International Rice Research Institute, for example, after adjusting for inflation, has declined nearly 50% since its peak in 1993.

Furthermore, the share of agricultural research funding to the Consultative Group on International Agricultural Research (an association of donor agencies that funds IRRI and 14 other centers) devoted to the core task of increasing productivity has declined over the past 15 years, as research goals have diversified toward other objectives. These declines are unfortunate, especially in light of research by Shenggen Fan and colleagues at the International Food Policy Research Institute that shows that, among various public goods, agricultural research has made one of the largest contributions to poverty reduction in developing countries.

Fortunately, agricultural research funding has not declined everywhere. In fact, agricultural research intensity (the ratio of agricultural research expenditures to agricultural gross domestic product) increased in most Asian countries between 1991 and 2002. While the increase is welcome, research intensity is still below 0.5% in nearly all Asian countries—less than half the optimal ratio suggested by experts.[1] This suggests that more spending on agricultural research at both national and international levels can reduce poverty and increase economic growth.

[1] Beintema N and Stads G-J. 2008. Agricultural R&D Capacity and Investments in the Asia-Pacific Region. International Food Policy Research Institute Research Brief 11 (www.ifpri.org/pubs/ib/rb11.pdf).

grain of truth

A lesson from nineteenth-century naturalists

BY PETER JENNINGS

As we grapple with the world rice crisis, I think of Alexander Humboldt, Henry Bates, Alfred Russel Wallace, Charles Darwin, and Richard Spruce. These extraordinary naturalists wove their exceptional powers of observation into the bases of the modern sciences of biogeography, meteorology, geology, tropical biology, and evolution. Their wide interests and insight contributed to our concepts of the origin of species, natural selection, mimicry in animals, continental drift, and the Wallace Line. Spruce, for example, was responsible for the introduction of chinona trees to India for the extraction of quinine. These explorers were supreme generalists.

Scientists today are specialists who focus ever deeper into specific research areas. The continuing shift from the general to the specific is exacerbated by institutional policies, funding agencies, publication standards, and peer pressure. This specialization has also contributed massively to knowledge with immense benefits to society. This essay is not to debate the merits of each but, rather, to suggest that we might learn from past masters to address current problems.

Agronomy's time has come to lift farm productivity out of stagnancy—will it respond to the challenge?

Rice scientists likewise have become narrowly specialized and, thereby, increasingly isolated from their clients, the rice farmers who are consummate generalists. Extension agents, the conduit of information from laboratory to rice field, are often sequestered from researchers, treated as second-class workers, and reduced in number and institutional support. Further, within the scientific community, basic research is often favored over the applied, widening the gap between researchers and farmers.

If one research area should be exempt from overspecialization, it is agronomy, the study of field crop management. It is not. Agronomists rank somewhere between extension agents and biotechnicians in the elitist hierarchy of agricultural research. They are relatively few in number compared with breeders and geneticists of all sorts and their contributions are inadequately recognized. Perhaps to compensate, they, too, have become specialists: experts in soils, weed control, land and water management, plant nutrition, planting systems, crop rotation, and so forth. They are infected with a guild consciousness. Yet, specialized agronomic knowledge applied singly to the multiple management deficiencies of farms is inadequate to the task.

It is now widely recognized that rice yield gaps result from agronomic failings, and that future yield increases depend heavily on this science. Agronomy's time has come to lift farm productivity out of stagnancy. Will it respond quickly and efficiently to the challenge?

Perhaps it is an insult to pose the question; yet, the answer is not evident to me. The issue is not lack of knowledge—agronomists have good answers to individual yield constraints. Nor is the problem ignorance of the need to bundle together solutions to interrelated management deficiencies. Farm yield is always constrained by several management deficiencies. Alleviation of one may increase yield modestly; simultaneous reduction of all narrows the yield gap substantially.

This integrated approach has resulted in spectacular productivity gains in Latin America through the Latin American Fund for Irrigated Rice (FLAR) agronomy program, and in several countries in Asia through integrated crop management.

Although modifications must be made continually for local conditions, it is evident that integrated agronomy works and has the power to balance Asian and Latin American rice supply and demand. Compared with seed-based technology, bringing agronomic improvements to millions of farmers is slow, difficult, and costly, and requires many more agronomists able to unite specialist knowledge into comprehensive solutions. But, it is the best alternative to repeat the success of the Green Revolution.

What, then, is the problem? I suggest it concerns agronomic overspecialization wherein pitifully few agronomists apply on-farm, holistic solutions to multiple yield limitations. The lesson from Humboldt, Darwin, *et al.* for research directors and project managers is to reward, not penalize, a generalist approach to solving farm problems. The greater the impact on yield, the greater should be the reward. This attitude could convince young, bright scientists to discard their lab coats and head to farmers' rice fields as generalist agronomists. Rice farmers and consumers sorely need more of them.

Dr. Jennings was principal scientist at the International Center for Tropical Agriculture and FLAR after founding the breeding program at IRRI (1961-67), where he helped develop IR8, the variety that ignited the Green Revolution in rice. See his IRRI pioneer interview *at www.irri.org/publications/today/Jennings.asp.*