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Rice Today

International Rice Research Institute
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Rice in the mountains
A new green revolution

Thailand special
The restless rice breeder

Improving jasmine rice

The genome sequence
Making waves in rice research

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IRRI

contents

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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 11 other countries, IRRI is an autonomous, nonprofit institution focused on improving the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes, while preserving natural resources. IRRI is one of 15 centers funded through the Consultative Group on International Agricultural Research (CGIAR), an association of public and private donor agencies. For more information, visit the CGIAR Web site (www.cgiar.org).

A TIME OF REVOLUTION

The last revolution in rice research and production is close to 40 years old. The now-famous Green Revolution began in the 1960s with the release in Asia of the first modern high-yielding rice variety, developed at the Philippines-based International Rice Research Institute (IRRI). This advance, and the regional food security it guaranteed, laid the foundations for the economic revolution that transformed Asia in the 1980s and 1990s. Never have more people been lifted out of poverty in such a short period of time.

Now, the international rice industry stands on the threshold of not one but multiple revolutions in rice production and consumption. First and foremost is the gene revolution sparked by the recent sequencing of the rice genome — meaning that scientists, for the first time ever, have the chance to truly unmask the genetic secrets that dwell inside the rice plant and determine how it grows and produces its grains. Most exciting of all, this new knowledge is only the beginning; intertwined with this looms a revolution in rice nutrition. Researchers are on the cusp of developing rice that is rich in essential nutrients such as vitamin A, iron and zinc, and which has the potential to improve the lives of millions of malnourished poor across the globe.

Next is a global upheaval in rice consumption. As economic growth and development in Asia lead to more diverse diets, consumption patterns are changing. But, as population growth continues, so demand will grow. Meanwhile, the crop's popularity in other parts of the world — particularly Africa — is steadily increasing.

And that's not all. Rice production in Asia faces challenges not seen since the population explosion in the 1950s brought about the first Green Revolution. The region is staring at the prospect of massive land and water shortages as increasing urbanization and industry compete for dwindling resources. And as rice farmers put down their tools to look for better lives in the cities, there may soon be too few farmers to grow enough rice for people to eat. Hovering behind these problems is climate change. Its effect on rice production is yet to be seen, but the signs are ominous.

Finally, there is an ongoing revolution in intellectual property and plant variety rights. Ten years ago, few countries had laws to protect their unique rice varieties; now, almost every nation in Asia has introduced such legislation and some are already firmly enforcing it.

This is a time of enormous change for rice — the food that helps feed almost half the world each and every day. In the face of these formidable challenges and an ever-growing avalanche of information, how can anyone hope to stay informed?

As the pace of change accelerates, it is our hope that *Rice Today* will help its many readers stay in touch with the rice revolutions that are already transforming the world's most important food supply.

Duncan Macintosh
Publisher

PS: *Rice Today* welcomes letters and articles from its readers, but makes no commitment for their return or publication. Please send correspondence to Adam Barclay.

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More rice on the Web

In its last issue, *Rice Today* offered readers a glimpse of the literally millions of Web sites that mention, in one form or another, rice. (A quick check on Google.com just before this issue went to print brought up more than 100 million results—up from around 40 million a few months ago.) We continue the theme here, so read ahead for more on where to satisfy your hunger for knowledge about the world's most important cereal crop.

In 1949, at a time when global rice production was stagnating at dangerously low levels, the Food and Agriculture Organization of the United Nations established the International Rice Commission in an effort "to promote national and international action in matters relating to the production, conservation, distribution, and consumption of rice." Almost 60 years later, the commission continues to play a vital role on the world rice stage. Its Web site (www.fao.org/ag/irc) includes pages on technical cooperative networks and partnerships, rice news and events, publications, and even a database of rice-related photos.

The Agricultural Research Service is the U.S. Department of Agriculture's main in-house scientific research agency. Entering "rice" into the service's search tool (at www.ars.usda.gov) brings up a host of information on rice breeding and pathology, rice quality, genetic characterization of rice traits, and tools and technologies for breeding improved rice.

The International Rice Research Institute (IRRI) is one of 15 centers that are part of the Consultative Group on International Agricultural Research (CGIAR). The CGIAR's home site offers information on the impact of rice research (www.cgiar.org/impact/research/rice.html), while IRRI adds impact information of its own (www.irri.org/media/impact). Two of IRRI's sister centers, the International Center for Tropical Agriculture (www.ciat.cgiar.org) and the Africa Rice Center (www.warda.cgiar.org) are also full of information on rice research in, respectively, Latin America and Africa. IRRI itself recently launched BETA versions of its Environmental Agenda Web site, GreenRice.net (www.greenrice.net), which provides communication tools and access to information about rice and the environment, and Rice News Worldwide (http://ricenews.irri.org), which keeps readers up-to-date with the latest news and features about rice from Web sites around the globe.

The Consortium for International Crop Protection (www.ipmnet.org), which works "to implement effective and environmentally sensitive crop protection worldwide," offers a range of freely available resources that focus on integrated pest management, including a monthly newsletter, a resource database, and an event calendar.

The Asia Rice Foundation is, according to its Web site (www.asiarice.org), a "nonprofit organization that works for an Asia that can feed itself, treasures the rich heritage of its rice cultures, cares about the well-being of both its rice consumers and producers, and values its rice-growing land as a precious commodity to be shared with future generations." The foundation aims "to mobilize and provide support for research, educational, cultural, and advocacy movements that promote public appreciation of the role of rice in the diverse culture of Asia." The site offers information on a range of rice-focused topics, including science, cultural heritage, and cooking.

And, speaking of cooking, with all the research and development happening in the name of rice, it's easy to forget that this indispensable grain for millions actually tastes good. Every day, all over the world, people are creating mouthwatering dishes using rice. Unsurprisingly, myriad sites and pages offer methods for cooking rice. For example, www.ricegourmet.com offers "delectable rice recipes from countries all over the world," www.congocookbook.com/index_4.html contains African rice dishes, www.mex-recipes.com/mexican-rice-recipes.html offers recipes from Mexico, and www.theitaliantaste.com/italian-cooking/riso/index_rice_eng.shtml tempts the taste buds of Italian food lovers. The California Rice Commission lists a range of dishes plus nutritional information (www.calrice.org/b_cuisine.htm; *pictured*) and the Rice Knowledge Bank carries the favorite recipes of IRRI's staff members and friends at www.knowledgebank.irri.org/recipes.

Just make sure you don't drool on your keyboard.

Agricultural ministers support IRRI proposals

JUANITO GOLOYUGO

IRRI Director General Robert Zeigler (*left*) welcomes H.E. Dr. Chan Sarun, the Cambodian Minister of Agriculture, Forestry, and Fisheries, at the IRRI environmental exhibit, which ran concurrently with the ASEAN meeting in Tagaytay, Philippines.

IRRI sought and received the Association of South East Asian Nations' (ASEAN) endorsement for two major proposals at the 27th ASEAN Ministers of Agriculture and Forestry (AMAF) meeting in Tagaytay City, Philippines on 27-29 September 2005.

The proposals, presented by Director General Robert Zeigler and Deputy Director General for Partnerships William Padolina, called for a regional meeting on the future development of IRRI's Rice Knowledge Bank (RKB) to provide farmers with direct access to the latest rice-farming strategies and technologies, and a meeting or workshop focusing on the future training and education of a new generation of rice scientists.

IRRI will organize and hold the RKB meeting at its headquarters in Los Baños, Philippines, and the training and education workshop will possibly be held in Singapore, to be organized jointly by IRRI and other partners in the ASEAN region. The institute also called for the adoption of the RKB as an ASEAN project.

In his presentation, *From endorsement to action: a new generation of rice farmers and rice scientists for ASEAN*, Zeigler said, "The RKB could become an increasingly important tool for rice farmers all over Asia, providing them with direct access to the very latest rice-farming strategies and technologies."

Zeigler warned that rice farming in ASEAN may be losing the skills and the knowledge it needs. "The challenge," he stressed, "is how to show that rice farming has an exciting future in ASEAN with new technologies and new opportunities that will attract those with a good education and managerial skills."

Zeigler and Padolina also reported to the AMAF about the progress made on the 3-point ASEAN-IRRI 10-year plan focusing on water, climate change, and human resource issues endorsed by the same gathering in Myanmar in 2004.

Zeigler said that IRRI would like to see the institute's Environmental Agenda and corresponding Web site, Greenrice.net, "adopted by the nations of ASEAN to ensure that the benefits of ongoing research and the new technologies that will be developed are fairly and efficiently shared by everyone in the region."

The ministers agreed to develop agriculture to secure a stable supply of safe food for their peoples; conserve the natural environment and the socio-cultural traditions of rural communities; make permanent the East Asian Emergency Rice Research project to speed up responses to food needs following disasters; and mobilize existing national stockpiles earmarked for the Asian Emergency Rice Reserve under the ASEAN Food Security Reserve Agreement.

The 6th AMAF meeting will be held in Singapore in 2006, while the 8th ASEAN and People's Republic of China, Japan, and Republic of Korea Summit will be held on 13 December 2005 in Kuala Lumpur, Malaysia.

IRRI's Agricultural Engineering Unit helped organize and conduct a hands-on training workshop on *Grain-Drying Systems and Dryer Fabrication* with Dr. Phan Hieu Hien at Nong Lam University in Ho Chi Minh City, Vietnam. Seven participants from Myanmar, Lao PDR, Cambodia, and Vietnam—seen here assembling a fan rotor—were taught the importance of grain drying in reducing paddy losses and maintaining seed and grain quality. They learned to identify suitable dryer types for their countries, perform cost-benefit analysis of drying, manufacture critical components such as fans and rice hull furnaces, and conduct fan and dryer testing and evaluation. The 10-22 October course was an Irrigated Rice Research Consortium activity with support from the IRRI Training Center and the Lao-IRRI Rice Research and Training Project.

MARTIN GUMMERT

Debate over basmati

A protracted "aromatic" debate is going on among India's scientists and exporters on whether or not to label their new varieties of aromatic long-grained rice as basmati. The National Commission on Farmers, in its "Crisis to Conflict" report, called on the agriculture ministry and the Indian Council of Agricultural Research to develop a policy that would use the basmati label only for "traditional fine grain aromatic rices of antiquity of a specific geographic origin," *The Indian Express* reported.

Crop scientists and exporters, on the other hand, wanted a more accommodating basmati definition. "It should be based on quality characteristics and not insist on immediate parentage," A.K. Singh, senior scientist in the genetics division of the Indian Agricultural Research Institute, was quoted as saying.

Dr. Singh feared that programs for improving basmati would end because exporters of improved varieties don't get the same advantages as basmati exporters. The paper reported that the European Union (EU) gives a subsidy of US$200 per ton for imported basmati rice, but not for other aromatic long-grained varieties.

As the debate continues, India's *Financial Express* published a series of articles on the issue, reporting that Pakistan and India are considering registering basmati rice in the World Trade Organization's Geographical Indication System.

ARIEL JAVELLANA

GRAINS of basmati rice.

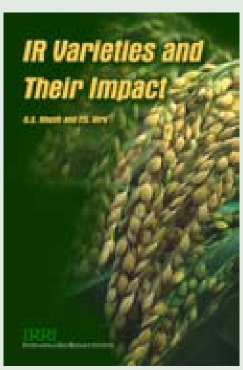
In the face of reports of several cases of fraudulent exports, the paper reported that the EU—whose definition of basmati insists that a variety should contain at least one parental strain from traditional basmati—has insisted on DNA testing of basmati rice exported from India and Pakistan and that "the EU is prepared to lower its high tariff barrier by Euro 250 a ton to facilitate imports of true basmati rice."

In 1999, the EU contested the claims of India's Pusa Basmati-1 and Pakistan's Super Basmati varieties, asserting that they were developed, rather than traditional, and denied duty derogation for their import. "Following this, India in 2000 decided to categorize basmati under two heads—one for traditional varieties and the other for developed varieties," reported the newspaper.

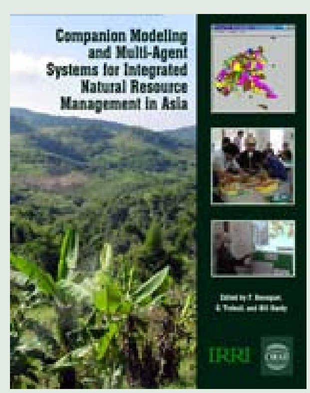
In February 2004, the EU reversed this decision. However the paper quoted R.S. Seshadri of rice exporter United Riceland as saying this was a political decision that could be reversed at any time. Seshadri was reported as insisting that "only traditional varieties should be entitled to be called basmati and that developed aromatic varieties should be marketed under a different brand." Nonetheless, the paper reported, Anil Mittal of exporter KRBL believes that "the developed varieties have a yield advantage and should be considered as basmati."

New books

IR Varieties and Their Impact, by Ghurdev Khush, former IRRI principal plant breeder and 1996 World Food Prize Laureate, and Parminder Virk, IRRI senior plant breeder, is a comprehensive list of all the high-yielding "IR" rice varieties released by the institute. The book includes information on 34 IR varieties as well as 328 IR breeding lines that were released as 643 varieties in 75 countries. In a foreword to the book, IRRI Director General Robert Zeigler says, "Rice scientists, journalists, and historians often search for information on Green Revolution varieties of rice. This information is buried in plant breeders' field books and records of plant pathologists and entomologists. [...] I hope that this publication will serve as a source of information on varieties that had such a significant impact on food security and poverty alleviation and fostered economic development."



Companion Modeling and Multi-Agent Systems for Integrated Natural Resource Management Systems in Asia, edited by François Bousquet, Guy Trébuil, and Bill Hardy, examines the relatively new research approach of companion modeling, which covers spatial modeling and adaptive management of renewable resources. The book follows a joint effort in 2001-04 by IRRI and the French Agricultural Research Center for International Development (CIRAD) that led to the implementation of a Thailand-based companion modeling project with a regional mandate. The goal was to create and train a regional network of national agricultural research and extension systems (NARES) practitioners of companion modeling in Southeast Asia and to support these practitioners in the development of their own applications and case studies. This volume is one of the first collective outputs and its various contributions show work in progress. Its production benefited from strong support from the NARES involved in the project activities, particularly in Thailand. For more on companion modeling, see *The game of life* on pages 25-27 of Rice Today Vol.4, No.1.



Council discusses genetic resources treaty

Plant variety protection rights and the continued implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture have aided the development of new rice varieties and the exchange of plant genetic resources between countries. This was a key message to emerge from the 9th annual Council for Partnerships on Rice Research in Asia (CORRA) meeting in Bali, Indonesia, on 9-11 September, hosted by the Indonesian Agency for Agricultural Research and Development (IAARD).

CORRA Chair Seong-Hee Lee told senior representatives of the major rice-producing countries: "It's very important that rice-producing and -consuming nations continue to develop new varieties to combat problems such as pests and diseases, and to have this collaboration is crucial."

Under the treaty, all ratifying countries must agree to facilitate access to their plant genetic resources (including rice) for food and agriculture. In turn, those involved will share—in a fair and equitable way—the benefits arising from the use of these plant resources.


IRRI/IAARD

INDONESIAN Minister of Agriculture, H.E. Anton Apriyantono.

Lee said that most of the CORRA members, however, are still not parties to the treaty because of its complex requirements when it comes to national governments.

Lee, who is also director general of the National Institute of Crop Science of South Korea's Rural Development Administration, told the CORRA meeting that, as the concept of national sovereignty over rice varieties was developed by each country, sharing and collaboration became more challenging. "There's no doubt that we must collaborate to develop the best new rice varieties," he said.

He cited the International Network for Genetic Evaluation of Rice (INGER), which has provided material for the development and release of 667 new rice varieties in 62 countries around the world during the last three decades. "It's very important for food security and rice production in Asia that INGER be able to continue its work," Lee said.

Bangladesh, Cambodia, China, India, Indonesia, Japan, Korea, Laos, Myanmar, Pakistan, the Philippines, Sri Lanka, Nepal, Thailand, and Vietnam are the current CORRA members.

IAARD also held the International Rice Conference on 12-14 September. Indonesian Minister of Agriculture H.E. Anton Apriyantono opened the conference in Bali. IRRI Director General Robert Zeigler gave the conference keynote speech on *Rice research and development: supply, demand, water, climate, and research capacity*.

Sequence of rice genome finalized

The final sequencing of the japonica rice genome announced in the 11 August issue of the journal *Nature* was reported across the globe. The unscrambling of the genome, described in the Online edition of BBC News by Robin Buell of The Institute of Genomic Research as "the Rosetta Stone for crop genomes," is a milestone development that could one day help mitigate hunger around the world.

According to the United Nations, rice provides 20% of the world's dietary energy supply. But, in coming decades, more rice will be needed to feed the world's hungry as current consumption trends point to 4.6 billion people relying on rice by 2025.

IRRI Senior Plant Pathologist Hei Leung said that the successful mapping of the rice genome "sets a gold standard" for sequencing other cereals with similar genetic makeup—maize, wheat, barley, rye, sorghum, millet, and sugarcane—and speeding up the search for genes that will guard these crops against diseases and pests and improve their productivity.

According to *Nature*, scientists estimate that rice contains 37,544 genes, in contrast to humans' 20,000 to 25,000 genes. Knowledge of the 389 million-base-pair genome will help crop researchers develop improved rice varieties with traits such as higher yield, improved nutritional content, and resistance to pests and diseases.

As rice is closely related to the other cereal grasses, "this has transformed the way we study the UK's main crops—wheat and barley," Professor Michael Bevan of the John Innes Centre told *The Telegraph*.

"The delineation of the genome is a milestone for rice improvement programs that translate genetic information into improved varieties," says Leung." The pathway from sequence to on-farm use is actually happening gradually over the years, but now we can look at the whole, which is important for understanding more complex biological problems, such as drought tolerance."

Established in 1998, the International Rice Genome Sequencing Project (IRGSP) was funded by The Rockefeller Foundation. Japanese researchers led the program, along with teams of scientists from Brazil, China, France, India, Korea, Taiwan, Thailand, the United Kingdom, and the United States.


ADAM BARCLAY

The first draft of the genome sequence of the indica subspecies of rice, widely cultivated in China and in tropical Asian countries, was achieved by the Beijing Genomics Institute (BGI) in collaboration with 10 other Chinese institutions and the University of Washington.

India's Minister for Science and Technology, Kapil Sibal, told *The Indian Express*, "It's a revolutionary landmark that could ensure India's food security ... since India now has complete access to the entire rice genome with no encumbrance related to intellectual property rights."

While the international research community has unrestricted access to the Chinese and IRGSP data, *The Christian Science Monitor* points out that "for all the enthusiasm about the drafts, plant biologists acknowledge that sequencing is only a first step in using the tools of biotechnology to improve cereal crops. The genes in the sequence must be mapped to specific chromosomes, their functions must be identified, as well as the processes they trigger."

But, as Johnjoe McFadden, professor of molecular genetics at the University of Surrey, pointed out in *The Guardian*, "the release of the rice genome sequence places a powerful toolkit in the hands of researchers eager to improve crop yields."

For more on the significance of the rice genome sequence, see *The gene revolution* on pages 14-18.

Media focuses on Asian drought

Drought across Asia dominated the headlines again in recent months. As drought continued to create havoc for the poorest around the globe, Agence France Presse (AFP) picked up the *Rice Today* story *Dreams beyond drought* (September 2005, Vol. 4, No. 2, pages 14-21).

The 17 October AFP story, *Rice research turns to Asia's chronic drought*, was subsequently reported by major newspapers and Web sites around the world. As well as running on page 1 of the 18 October *Philippine Daily Inquirer*, the article was carried by online news services, including TODAYonline.com and Yahoo! News, which reported that "IRRI said a study this year concluded that dry spells, more than floods or typhoons, are the primary recurring threat in Asia, where around a fifth of all the rice-growing areas are drought-prone."

The *Kathmandu Post* reported on 13 August that, following a drought-induced price rise, some 2,500 metric tons of cheaper Indian rice has illegally entered the Nepali market, prompting rice entrepreneurs to fear for the survival of local rice mills.

A story from online rice news service Oryza.com reports that the Thai government plans to ban rice sowing in drought-hit areas to conserve water resources and prevent farmers from suffering losses due to damaged crop.

From not enough rain to too much, *The Rising Nepal* reported on 7 August that Nepal's Ministry of Agriculture and Cooperatives has implemented reforms and offered subsidies to monsoon-affected regions of the country, including the provision of seeds in wet areas where cultivation is possible and an awareness campaign to use pesticides to protect cultivated rice from diseases.

Hurricane Katrina hits rice

Meanwhile, Oryza.com reported on 2 September that, in the wake of Hurricane Katrina, which hit Louisiana on 29 August, Mississippi rice farmers could experience yield drops of at least 20%. The farmers' biggest concern was the time it would take to harvest lodged (fallen) rice, which, according to them, means "triple the time, triple the diesel fuel and labor expenses."

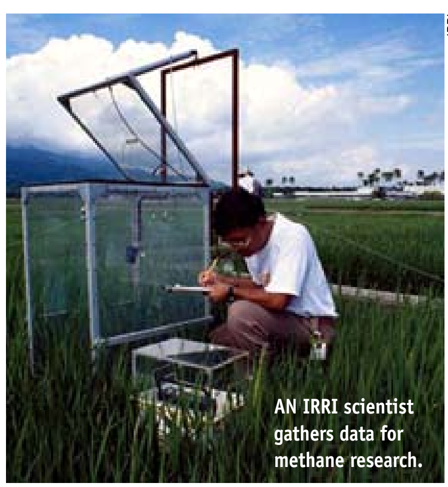
Oryza.com also reported on 6 September that His Majesty King Bhumibol Adulyadej of Thailand donated an unspecified quantity of rice to help feed people in hurricane-hit areas of the U.S. The King also sent a note to President George W. Bush, expressing his sorrow for the tragedy.

WITH OVER 8 million hits since its launch in September 2002, the IRRI Rice Knowledge Bank (www.knowledgebank.irri.org) has become the world's premier repository for rice-related training and extension material. Now, a revamped Knowledge Bank is set to make information that helps feed half the world even more accessible. The new-look Rice Knowledge Bank is more intuitive, allowing people to easily locate information to solve their rice-farming needs. Associated with the impressive volume of visitors to the site is a growing realization that the RKB is now a major tool with which the institute communicates its rice science and rice-farming messages to the rice community across Asia.

Climate change and methane

An AFP story, *Climate change to reduce rice yields*, which quoted IRRI senior scientist John Sheehy, was carried by Yahoo! News on 18 October. The article reported that increasing emissions of carbon dioxide would "drive yields down by 0.15 tonnes per hectare (2.47 acres) in 50 years."

AFP likewise quoted Deputy Director General for Partnerships William Padolina as saying that rice yields must increase by 30–40% by 2030 to match population growth, which is greater than the increase in production over the past 15 years.



IRRI

AN IRRI scientist gathers data for methane research.

The Voice of America, a U.S.-government-funded international multimedia broadcasting service, also ran a 19 October report on the need to improve world rice production to keep pace with population and climate change. Padolina was again quoted, saying that "if the present trend of population growth continues, rice production must increase by 30–40% to match demand."

The 11 August issue of the journal *Science* published a study by Yahai Lu of China Agricultural University and Ralf Conrad of the German Max-Planck-Institute for Terrestrial Microbiology, who have identified the microorganisms responsible for using carbon released by rice plants' roots to make methane, which is consequently released through the soil into the atmosphere.

Asian rice farms are one of the world's largest sources of methane—the most important greenhouse gas after carbon dioxide—and emit 50–100 million tons of the gas each year. The study was reported on the SciDev.net Science and Development Network Web site, which quoted Andrew Whiteley of the U.K. Centre for Ecology and Hydrology as saying that, "Once scientists know which organisms are involved in a particular process, they can focus right down on them and design experiments to work out how important they are."

Coping with drought


JOSE RAYMOND PANALIGAN

Two important meetings—Interdrought II and the Annual Research Meeting of the Generation Challenge Program—were held in Rome on 24-28 September. During the Interdrought II meeting, IRRI senior scientists Sushil Pandey and John Bennett made presentations on, respectively, *Coping with drought in developing countries' agriculture* and *Monitoring changes in the proteome and metabolome under drought*. Postdoctoral fellow Jill Cairns talked on *The use of deletion mutants in identifying candidate genes for drought tolerance*. The Interdrought symposia provide a platform for presenting, discussing, and integrating results of both basic and applied research into crop production under drought conditions.

Good and bad tsunami news

As part of its Post-Tsunami Initiative following the disastrous Indian Ocean earthquake and tsunami of 26 December 2004, the Future Harvest centers of the Consultative Group on International Agricultural Research have set up a Web site "to serve as a common platform for CGIAR information on relevant research and development information on restoring livelihoods and on integrated natural resource management in areas directly and indirectly affected by the tsunami and earthquake disasters, particularly in Indonesia."

The Jakarta Post reported on 25 August the promising news that "Fears that the most fertile agricultural land in the Indonesian province of Aceh has been wrecked by seawater that swept inland from the December 26 tsunami are unfounded." The Indonesian daily quoted a *New Scientist* article on a study that had shown that that salt from the tsunami did not penetrate far into the coastal rice-farming soils, and that irrigating with salt-free water has removed most of the excess salt. However, according to the story, "Some rice fields remained slathered with thick sea sediment, and in parts of Aceh's flood plain, changes in drainage patterns wreaked by the tsunami mean that once-rich agricultural land is regularly inundated by seawater that rushes up tidal creeks. Such problems may take as long as a decade to fix."

BRIEFLY

Arsenic-tolerant rice

IRRI is looking to mitigate the effect of contamination by breeding rice varieties tolerant of arsenic-contaminated water and soil in Bangladesh. Social Sciences Division Head Mahabub Hossain, irrigated rice breeder Parminder Virk, and IRRI-Bangladesh staff members M.A. Hamid Miah, M.A. Ghani, and Noel Magor recently met with officials of the Bangladesh Rice Research Institute to initiate collaborative research that attempts to solve this major health problem.

Salt-tolerant seed varieties

The International Crops Research Institute for the Semi-Arid Tropics and the M.S. Swaminathan Research Foundation are screening crop varieties that have salt tolerance, selecting varieties through community participation, establishing local seed banks, and rehabilitating soil and water systems. Six varieties of rice found on the east coast of Tamil Nadu, India, have potential in flood-prone areas. IRRI also provided seeds of salt-tolerant rice varieties. Fifteen agricultural research institutes under the alliance of the Future Harvest centers of the CGIAR are helping to rehabilitate agriculture in 47 developing countries in Asia, Africa, Latin America, and the Pacific through the Healing Wounds initiative.

Managing tungro disease

About 80 farmers and Department of Agriculture personnel from Iloilo Province, Philippines, learned about *Mixed planting of resistant and susceptible varieties for tungro management* during a farmers' forum on 1 September. Results from field trials conducted by IRRI and the Provincial Agriculture Office in the 2002-04 planting seasons showed that mixing 75% tungro-resistant Matatag 9 seeds and 25% disease-susceptible IR64 produced higher rice yields with good eating quality. Tungro devastated thousands of hectares of rice crops in Iloilo from 1999 to 2000.

International Rice Congress 2006

India is scheduled to hold the second International Rice Congress (IRC2006) in New Delhi on 9-13 October 2006. IRC2006 will feature the 26th International Rice Research Conference and will be co-organized by IRRI and the Indian Council of Agricultural Research.

IRRI-Korea collaboration

The Rural Development Administration (RDA) of the Republic of Korea and IRRI have agreed to a five-year extension of the memorandum of understanding signed in 2000 for further collaboration involving biotic and abiotic stress tolerance of temperate japonica rice. RDA Administrator Jeong-Soo Son and IRRI Director General Robert Zeigler signed the letter of agreement at a ceremony at the International Technical Cooperation Center (ITCC), RDA, on 29 August. Dr. Zeigler also presented a seminar, *Challenges facing rice-producing countries in Asia*.

IRRI's strategic planning

IRRI conducted a series of strategic planning workshops—which aimed to identify new science and technology, economic and political, environmental and ecological,

Transgenic rice as a vaccine

News agency Reuters and U.K. newspaper *The Guardian* have reported on the development of an edible vaccine produced in genetically modified rice that prevented the immune response that triggers allergies. The study, by Japanese researchers from the National Institute of Agrobiological Sciences and the University of Tokyo, was published in the 1 November issue of the *Proceedings of the National Academy of Sciences*.

The team created the vaccine using parts of allergy-related proteins found in Japanese cedar pollen, a trigger of hay fever. Genetic material that coded for the allergen proteins was inserted into the rice genome. The resultant rice grains then carried the proteins, thereby exposing the rats to small amounts of the allergy-causing agent—the same idea behind injected vaccinations. *The Guardian* explains that the team "fed the rice to a group of mice allergic to the pollen for four weeks. Compared with mice not receiving therapy, they sneezed less and had fewer antibodies to the cedar pollen."

Senior author Fumio Takaiwa was cited as claiming that as well as being potentially cheaper, food-based allergy treatments would be more efficient and avoid the chance of anaphylactic shock. Takaiwa was further cited as saying that a human version of the rice vaccine had been developed and should be ready for safety testing in a few years.

ARIEL JAVELLANA

IRRI hosted 300 local farmers on 27 September. The farmers, seen here examining IRRI's rice mill, also toured the IRRI farm, the Agricultural Engineering Unit, and the breeding warehouse.

Keeping up with IRRI staff

Fangming Xie, former director of line development and hybrid rice breeder of RiceTec, Inc., USA, recently joined Plant Breeding, Genetics, and Biotechnology (PBGB) as a senior scientist.

Grant Singleton, previously at Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), Sustainable Ecosystems, joined the Entomology and Plant Pathology Division (EPPD) as coordinator for the Irrigated Rice Research Consortium.

Cristine Kreye joined Crop, Soil, and Water Sciences (CSWS) as an international research fellow after serving as a junior research fellow at the University of Kiel in Germany.

Xiaochun Lu, **Yuka Sasaki**, and **Michael Thomson** joined CSWS as postdoctoral fellows. **Endang Septiningshi** of the Indonesian Agency for Agricultural Research and Development joined PBGB as a postdoctoral fellow.

New Philippine Department of Agriculture Secretary **Domingo Flores Panganiban** has replaced **Arthur C. Yap** as an *ex officio* member of IRRI's Board of Trustees. Panganiban was also secretary of the Department of Agriculture (DA) from January to March 2001, and undersecretary of the DA from in 1996-2001.

Edith Yalong, who worked as executive secretary to IRRI's directors general from 1974 to 1985, died on 20 August after a battle with cancer. She was 62.

and institutional trends—in August in its effort to develop a clear perspective of the challenges and opportunities over the next 10–20 years. From these workshops, management will produce a new strategic plan, a business plan, and a new medium-term plan for presentation to the Board of Trustees at its April 2006 meeting.

GM rice commercialization?

A 29 September Reuters report suggested that China could become the first country to approve large-scale planting of genetically modified (GM) rice. The State Agricultural GMO (genetically modified organisms) Crop Biosafety Committee, the technical body that evaluates GM rice for research and marketing, would likely meet in November with four varieties of GM rice on the agenda, the report said, adding that three varieties resistant to insects and one variety resistant to bacterial blight had been under production safety evaluation since last December. The committee's decision would determine their commercialization. Jikun Huang, a scientist at the China Academy of Sciences, was quoted as saying that, "The government is serious about examining GMO rice safety issues or the impact on the environment and they want to make sure everything is fine. Given this situation, I personally think it [a decision in November] is not very likely."

GM rice study questioned

In a 14 October letter to *Science*, IRRI Scientists K.L. Heong *et al.* questioned the methodology of *Insect-resistant GM rice in farmers' fields: assessing productivity and health effects in China*, published in the journal's 29 April issue. The study claimed "farmers growing insect-resistant GM rice obtained higher yields with less use of insecticides than farmers growing conventional varieties." The IRRI letter suggested that farmers might have been using less pesticide for the GM rice crops because they had decided beforehand that they would need fewer chemicals, not because they saw fewer insects. The authors of the original paper, Huang *et al.*, responded by saying that they had taken into account the effects of farmer perception and that this was small relative to the pesticide reduction due to using the GM rice.

Human gene in rice plant

A study, conducted by a team of Japanese scientists and published in the 20 October issue of the *Journal of Agricultural and Food Chemistry*, showed that transgenic rice plants carrying a human cytochrome P450 gene become more tolerant of various herbicides than nontransgenic plants of the same variety. Cytochrome P450 genes produce proteins involved in breaking down toxins in the body. The team contained scientists from the Plant Biotechnology Department, National Institute of Agrobiological Sciences, Fukuyama University, and Agriculture, Forestry, and Fisheries Research Council Secretariat.

Gates grant for Philippine rice

The Philippine Rice Research Institute (PhilRice) has received a US$800,000 grant from the Bill and Melinda Gates Foundation's Grand Challenges in Global Health program to develop multinutrient

Achievements

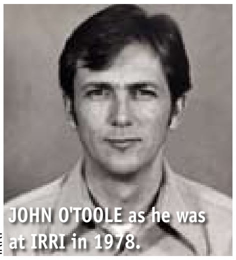
Hei Leung, IRRI plant pathologist, is this year one of 376 members of the American Association for the Advancement of Science (AAAS) to be awarded the distinction of Fellow. Leung received the honor in the Agriculture, Food, and Renewable Resources section for "distinguished contributions leading to improvement of rice varieties, including the dissection of rice disease resistance, and to understanding rice-pathogen interactions and pathogen population biology."

Former IRRI agronomist **Ken Cassman**, now at the University of Nebraska–Lincoln Institute of Agriculture and Natural Resources, also became an AAAS Fellow for his work in crop ecophysiology and agroecology and research in natural resource conservation and global food security.

The Yunnan Academy of Agricultural Sciences (YAAS) conferred the title of Visiting Professor in Agricultural Economics on **Sushil Pandey**, IRRI senior scientist, agricultural economics. He received the award at a 9 October ceremony in Kunming, Yunnan. The title recognizes Pandey's contribution to the development of close partnership between YAAS and IRRI on the assessment of economic and environmental impacts of upland rice technologies in Yunnan.

IRRI Board of Trustees member **Emerlinda R. Roman** was conferred the *2005 Outstanding Citizen of Los Baños Award* by the Municipal Government of Los Baños, Philippines, on 16 September.

Agricultural leader to retire


JOHN O'TOOLE as he was at IRRI in 1978.
IRRI

John O'Toole, who joined IRRI in 1974 as an agronomist, is set to retire this year, capping a stellar career of more than 30 years in international agricultural research. In his ten years at IRRI, O'Toole investigated soil and plant water relations of the rice crop with a focus on genetic improvement for drought-prone environments. His original and influential research on upland and drought-prone rainfed lowland rice laid the foundation for understanding the ecophysiology of water deficits in rice cultivation.

After leaving IRRI, O'Toole spent four years as a professor at Texas A&M University before joining The Rockefeller Foundation. He was posted to Asia with the aim of bringing ten South and Southeast Asian countries into the foundation's *International Program on Rice Biotechnology*. Dr. O'Toole helped to design and implement the international competitive grants program that provided training for more than 400 Asian rice scientists.

In 1998, he began work on the *Resilient Crops for Water-Limited Environments* program that focused on genetic improvement of drought tolerance of rice in Asia and maize in Africa. From 2000, he helped oversee the program, which invested more than $20 million in the generation of new knowledge, capacity building in plant breeding, and development of drought-tolerant rice and maize varieties.

Dying crop diversity?

The *International Herald Tribune* (IHT) in its 18 August issue reports that "The loss of food plant species is directly related to the 20th century Green Revolution, in which farmers adopted streamlined agricultural techniques to increase production of food."

IRRI Director General Robert Zeigler, in a response letter to the IHT on 22 August, pointed out that, although it is true that the widespread adoption of modern crop varieties caused many traditional varieties to disappear from farms, "it is also true that the instigators of the green revolution, which helped many millions of people avoid starvation, were well aware of this problem and had the foresight to collect samples of many of the old varieties before they completely vanished. These samples are now conserved in 'gene banks,' where they are carefully kept alive and available for use by current and future generations."

Zeigler adds that "The judicious use of crop biodiversity will contribute to a reliable, environmentally sustainable agriculture that can help the poor feed themselves with a nutritionally rich diet and offer a light at the end of the tunnel of poverty."

BRIEFLY

rice through conventional breeding and genetic transformation. PhilRice acquired the grant by collaborating with a team of German scientists working on improving the nutritional quality of rice. Part of the grant will be used to upgrade the institute's biotech laboratories, establish a bioisotope laboratory, and improve screenhouses for testing genetically modified rice.

Robust Indian rice exports

Indian newspaper the *Financial Express* reported on 6 September that India's rice exports are expected to increase to 4.5 million tons in 2005. Official statistics showed that exports reached 2.5 million tons for the period January through May. Shipment data from private sources indicated large exports in June and July, mostly to African countries and Saudi Arabia, with likely exports to Bangladesh in the coming months. Also, trade data showed strong exports in May at 425,000 tons (100,000 tons of basmati and 325,000 tons of non-basmati), mainly to Nigeria, Saudi Arabia, South Africa, Côte d'Ivoire, and other African countries.

U.S. rice shipments to Cuba fall

A 26 August report on Oryza.com stated that American rice shipments to Cuba declined by about 50%, from 172,000 metric tons in 2004 to 90,000 metric tons in 2005, because of stringent U.S. export restrictions. Cuba buys the bulk of its rice from Asian countries. The report added that the USA Rice Federation signed a memorandum of understanding with Alimport, a Cuban food import firm, to lobby for an end to U.S. sanctions against Cuba and the resumption of two-way trade.

Philippine rice self-sufficiency

The Philippines Department of Agriculture is confident of meeting a 95% rice self-sufficiency target for 2005 as the government adopts measures to limit rice importation. The Philippines needs about 900,000 tons of imported rice annually. The country is confident of this year reaching 14.47–14.5 million tons of rice production nationwide, against last year's target of 14 million tons. Meanwhile, Oryza.com reported in August that the Philippine National Food Authority is intensifying its campaign to promote hybrid rice in Mindanao to ensure rice sufficiency in the region over the next decade. Increased planting of hybrid rice is viewed as the most viable option for reducing the Philippines' rice imports.

Vietnamese rice exports

Oryza.com reported in August that Vietnam expects to increase its rice export earnings in 2005 to $1.15 billion due to increased world demand and higher prices. Farmers in the Mekong Delta expect to harvest between 8 and 9 million tons of paddy on more than 1.47 million hectares under this summer-autumn rice crop. The price of high-quality rice has increased 15% over the same period last year.

A strong supporter of agricultural research

by Anne Germain and Barbara Shaw

Canadian International Development Agency | Agence canadienne de développement international | Canada

CIDA

Ms. Germain (*right*) is policy analyst and senior development officer, Multilateral Development Institutions, in the Canadian International Development Agency (CIDA). Ms. Shaw (*left*) is policy adviser on CIDA's Agricultural Team.

In April 2005, the government of Canada launched an integrated *International Policy Statement* (IPS) in an attempt to bring together the various components of its international relations, including development. The IPS provides the policy framework for Canada's international development assistance, including the work of the Canadian International Development Agency (CIDA).

This framework focuses Canada's contribution to poverty reduction on the Millennium Development Goals and articulates five priority sectors for Canadian development assistance: promoting good governance, private-sector development, health, basic education, and environmental sustainability. Gender equality will be systematically and explicitly integrated across all programming within each of the five sectors.

Agriculture is regarded as an important means to achieve development results in four of the five priority sectors in the IPS. Food security is identified as a target outcome under the health priority. Because small farmers should be recognized as entrepreneurs and their associations as key economic players, rural entrepreneurship and market issues are areas for support under the private-sector development component. Natural resource management challenges underpinning agriculture, such as water scarcity and land degradation, are highlighted under the environmental sustainability component. Good governance also plays a role in facilitating agricultural growth—the presence of strong national agricultural research systems, appropriate policy frameworks, and the ability to play an active role on the international scene, particularly as it relates to trade, are strategically important for all countries.

We should also not forget that increased income from rural livelihoods directly affects children's ability to access and benefit from basic education and, conversely, that better basic education helps farmers become more productive.

Promoting gender equality in the agricultural sector is both a condition for and an element of success. Any policy or intervention should recognize from the onset the large number of women involved in agriculture, particularly in sub-Saharan Africa, and the gender-based nature of agricultural production. In many cultures, there are "men's crops" and "women's crops"—each with consequent specialized knowledge, practices, and rituals. Certain roles, such as seed preservation and food processing, marketing, and preparation, are often traditionally performed by women.

Additional factors, such as the devastating effects of HIV/AIDS in many African societies (and projected elsewhere), are resulting in a rapid increase in the number of farms managed by older women and orphans in rural areas, and have strong implications for agricultural productivity. Yet, in several countries, women's access to and ownership of land—to name a key challenge—remain an issue. It is thus imperative that support for agriculture, from policy to extension, take these realities into account.

This imperative also holds for agricultural research if it is to continue to play its role in contributing to food security, poverty reduction, and environmental sustainability. Canada is a founding member of the Consultative Group on International Agricultural Research (CGIAR) and has remained a strong supporter of the group's 15 international agricultural research centers—including IRRI—since their creation. CIDA has been a strong proponent of core funding to the CGIAR, as a means to ensure ongoing resources for long-term scientific undertakings. In addition to its regular contribution, over the course of the past three years, CIDA has provided CAD$40,000,000 (US$34,000,000) in core funds to the CGIAR through the Canada Fund for Africa to support specific research. We are very pleased with IRRI's recent decision to augment its activities in Africa, in close collaboration with the West Africa Rice Development Association (WARDA, also called the Africa Rice Center) and other CGIAR centers.

A small grant fund, the Canada-CGIAR Linkage Fund, managed through CIDA, was created ten years ago to contribute to the CGIAR's goals of reducing poverty and food insecurity through strengthened collaboration between the CGIAR system and Canada's university and science community. Under the Linkage Fund, IRRI has most recently been working with Montréal-based McGill University, advancing the application of bioinformatics to plant genetics, in the hope of accelerating the development of drought tolerance in rice. CIDA is proud to contribute to this research and looks forward to agricultural research helping to further improve the lives of the poor in developing countries.

The gene

by Duncan Macintosh,
photography by Ariel Javellana

IRRI SENIOR plant pathologist Hei Leung, seen here examining gene markers linked to disease resistance, says the rice genome sequence will help researchers find useful genes in not only rice but also related cereals such as maize and wheat.

revolution

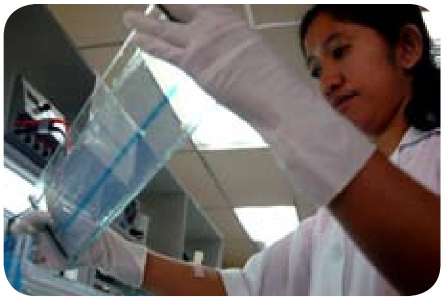
The recent sequencing of the rice genome ushers in an exciting new era in public rice research

Despite the historic significance of this year's "final" sequencing of the rice genome, few in the international rice industry—excepting rice researchers—could be expected to fully understand the huge potential impact of this major scientific breakthrough.

The news was confusing to the layperson for several reasons. First, this latest rice genome sequencing was just the most recent of a series of rice sequencing announcements since the first one by the agricultural corporation Monsanto in 2000. In each case, the published sequence was more and more precise, culminating with the 2005 announcement in the 11 August issue of the journal *Nature* by the International Rice Genome Sequencing Project (IRGSP) of the most detailed, complete sequence yet.

Second, while many agreed the sequencing breakthrough had major implications for rice production—especially exciting in the context of rice being the staple food for almost half the planet's population—

UBON RATCHATHANI RICE RESEARCH CENTER



most also agreed that it would be several years before there were any tangible benefits for rice farmers or consumers and especially in helping the poor improve their lives.

In short, it was a little like the Apollo space missions that put humans on the moon—the science and technology were brilliant and exciting, but had little impact on the life of ordinary people. The research and technology development, however, led to many new consumer products and benefits, including medical techniques such as computer-aided tomography (CAT) scans, magnetic resonance imaging (MRI), kidney dialysis, and cordless power tools. In the world of rice research, though, the implications of the sequencing of the rice genome are perhaps more clearly foreseen. Like the ripples from a stone dropped into a pond, the impact will spread far and wide.

"The rice-growing world will benefit from this international scientific undertaking because it provides a 'dictionary' for future understanding of rice genes and using them in rice improvement," explains IRRI Senior Plant Pathologist Dr. Hei Leung. "I say 'future' because what we have now is a dictionary with accurate spelling. The huge task ahead is for the world community to work together to assign meanings to these strings of characters—the 'words.'"

One of the most important implications of the sequencing effort is for public rice research. Not only did large multinationals such as Monsanto and Syngenta decide for the first time to share their sequencing data publicly, but the idea of keeping such information freely available in the public domain also became increasingly accepted.

Monsanto launched its *rice-research.org* public database in June of 2000 to provide access to its draft rice genome sequences to publicly funded, public researchers. Almost 800 researchers registered

THIS CARABAO can't understand all the fuss about the new sequence as it carries a farmer through a rice field in Camarines Norte, Philippines. But farmers—like Ahd and Saboo Sriwong from Thailand (*top left*)—will ultimately benefit from the new tools and technologies that emerge from the encyclopedia of genetic information held in the genome, including improved varieties such as disease-resistant jasmine rice (*top center*). The finalized sequence will also help scientists like Sheila Quilloy (*top right*), from IRRI's Plant Breeding, Genetics, and Biotechnology Division, find useful genes in range of different rice varieties (*opposite*).

to use these data. When more than 90% of the sequences contained in the Monsanto draft rice genome sequence data could also be found in the public databases, the company closed the site.

Another important outcome from the availability of the private-sector data was the formation of another international effort, which also included the private sector, to turn the available sequence into thousands of new useful molecular markers—segments of DNA that are linked to an allele (version of a gene) that controls an important trait and are easily detected in the lab—and to ensure that these important tools remain available to public research.

"It's very important that we keep such information in the public domain," says IRRI Director General Dr. Robert Zeigler. "In that way, research that is conducted in developed countries and in countries where gene patents are recognized is opened up to researchers in poorer developing nations."

The IRGSP sequence—which is

all freely available to the public—provides an indispensable road map to agricultural researchers using both biotechnology and conventional breeding to develop hardier rice varieties. This new genetic map of the world's most important cereal is already accelerating the hunt for genes that increase yield, protect against diseases and pests, or provide drought tolerance in rice and other cereal crops.

A very useful side benefit of all this is that rice is genetically similar to other important crops such as maize, wheat, barley, rye, sorghum, and sugarcane. Hence, the rice genome can be used as a base for genomics studies, being largely colinear with these other genomes. In other words, similar genes in the other plant species should pop up in roughly the same spots as their rice counterparts. With the finished sequence, rice researchers gain a kind of genetic street directory, while other cereal researchers inherit a hand-drawn map with some important landmarks.

According to Leung, the high-quality sequence is exactly what researchers of functional genomics—the science of discovering genetic structure, variation, and function, and the interrelationships among these—were waiting for, in that it acts as a template for related sequences.

"This 'gold standard sequence' will let us efficiently determine the sequence of other genomes in many other rice varieties used by farmers," he says. "Knowing the variation in many varieties will be the key to using them in breeding. This is exactly what people do with the human genome sequence. They look for variation in many people,

Facts and figures

The analysis of the rice genome by the International Rice Genome Sequencing Project (IRGSP; http://rgp.dna.affrc.go.jp/IRGSP), reported in the 11 August issue of the journal *Nature*, revealed the location and sequence of over 37,500 protein-encoding genes in 389 million base pairs of DNA. (Each base pair is represented by a pair of the "letters"—A, T, C, and G—that make up a DNA sequence; C pairs with G and A pairs with T.) It was finished three years ahead of schedule.

Rice now holds the distinction of being the first crop plant whose genome has been sequenced. Scientists around the world will use this wealth of new information in efforts to improve yields in not only rice but also other closely related grass crops such as barley, maize, rye, sugarcane, and wheat.

The IRGSP used the japonica subspecies of rice, which is cultivated in temperate countries such as Japan, Korea, and the United States.

Established in 1998, the Japanese-led IRGSP consortium includes the United States, China, Korea, India, Thailand, France, Brazil, and the United Kingdom.

The group made public a draft sequence of the japonica genome in late 2002. Since then, IRGSP scientists have increased the quality of the sequence to 95% complete at greater than 99% accuracy. By comparison, the 3-billion-base-pair human genome, with its 25,000 genes, reached that quality level in 2004, some three years after its draft sequence was completed.

The IRGSP used a time-consuming procedure in which the researchers created libraries of small bits of rice DNA and then sequenced them piece by piece. *Science* magazine reported that this "map-based" approach came under fire a few years ago after two teams not in the consortium published draft sequences of the rice genome based on a different technique. That approach, called whole-genome shotgun sequencing, busts the entire genome into different-sized bits, sequences them, and then uses supercomputers to put the data in order.

IRGSP researchers feared that their funding agencies would assume the job was done and pull the plug. But IRGSP leaders successfully argued that the drafts had too many gaps and errors to do justice to the world's most important cereal. There has been no complete estimate of the total project cost, but Japan spent roughly US$100 million to sequence 55% of the genome.

The group finished ahead of its 2008 target date because of help from the U.S.-based agricultural corporation Monsanto, which had announced in 2000 that it would make its rice sequence data available to researchers. Syngenta, an agribusiness firm based in Switzerland that had published a draft rice sequence in 2002 based upon the whole-genome shotgun approach, also contributed its data to the IRGSP.

The other draft rice genome was of indica, a strain widely cultivated in tropical regions and China. The Beijing Genomics Institute, a publicly funded Chinese institution that also published its draft genome in *Science*, says it is now finishing a second indica variety. These two are the parental strains of a hybrid rice variety increasingly important in China. The data will help identify which genes are dominant in the first-generation crosses, which produce from 15 to 30% more grain than either parent.

based on the first template, and then associate the variation with diseases or behavior. One can imagine similar applications to find genes useful for disease resistance or drought tolerance, for example, in rice as well as in other related plants."

Zeigler describes the formation of the IRGSP in 1998 as a major milestone in international collaboration to accelerate the discovery of important genes in the rice plant. Both the public and private sector contributed substantially complete draft sequences from two rice subspecies—japonica and indica—in 2002 but it took the IRGSP to complete the job and to make sure that all of the important genetic information was publicly available.

The international rice research community realized that a dedicated group would be vital in the postsequencing "functional genomics" era of rice research. Thus, following completion of the draft sequence in 2002, an International Rice Functional Genomics Consortium (www.iris.irri.org/IRFGC) grew out of the existing IRRI-coordinated International Rice Functional Genomics Working Group. The consortium, formed in 2003, featured an interim steering committee of scientists representing 18 institutions from

10 countries and two international agricultural research centers.

The goals of the original working group—which essentially aimed to enhance rice functional genomics by building a global research community and sharing new knowledge, tools, and resources—were consolidated by the consortium objectives. Along with the development of specific genomics tools, these include an integrated online global network of rice functional genomics databases by the end of 2006, and characterization of the function of 60% of rice genes by 2010.

The goals of the original working group were to build a research community with a shared vision of rice functional genomics; create a common resource platform to broaden access to and promote sharing of the new genetic and genomics knowledge, tools, and resources of functional genomics; and gain efficiency and accelerate application of functional genomics to rice improvement.

"There's no doubt the private sector has a very important role to play in this exciting new era of rice research," Zeigler stresses. "But the role of this consortium, and the way it has been set up, means the gains achieved will be available to those who need them most—poor rice farmers and consumers."

Leung concurs that the public nature of the sequencing will ultimately be a huge boon to those who most need help.

"The publication of the high-quality sequence—making it fully public—is not only scientifically significant but symbolic of international collaboration," he says, "although we shouldn't jump to the conclusion that it will solve all problems in rice production. I think the 'harvest' will come later when we use the information to discover gene function. But having an important agricultural crop like rice as a model for international collaboration is a boost to agriculture."

Duncan Macintosh is the spokesperson for IRRI and publisher of Rice Today.

RUARAIDH SACKVILLE HAMILTON, head of IRRI's Genetic Resources Center, peers through shelves of some of the more than 100,000 types of rice stored in the institute's International Rice Genebank. The genetic treasures held therein will be easier to find with the new sequence information. An IRRI scientist crushes rice leaves to extract DNA (*top*).

SURAPONG and Saneh Rurkwiree, former director of the Ratchaburi Rice Research Station, examine rice plants in a screenhouse at the Thailand Rice Research Institute's headquarters in Bangkok.

BOB HILL

All in the GENES

by Bob Hill

Like the plants they produce, plant breeders seem to be strong, healthy, and productive. Thailand's renowned rice breeder Surapong Sarkarung confirms that it takes more than retirement to keep a good breeder down

There seems to be something about plant breeding that leads to a long and productive life. Dr. Norman Borlaug, wheat breeder and Nobel Peace Prize laureate, is still working in his 90s. Dr. Gurdev Khush, rice breeder and World Food Prize laureate, is traveling the world long after his "retirement." Whatever the secret, plant breeders just keep on going.

Now, one of Thailand's most renowned rice breeders, Dr. Surapong Sarkarung, is having second thoughts about his own retirement, despite a lifetime working to improve rice varieties for the difficult and vastly variable rainfed lowlands.

He packed his bags as the International Rice Research Institute's (IRRI) resident plant breeder in Thailand in

2002, content in the knowledge that his last big project would provide an important boost for rice production in his native country—a new variety of the famously fragrant Thai jasmine rice resistant to a fungal disease known as blast. Capable of badly damaging Thai rice crops, a blast attack leaves farmers little choice but to use pesticide on one of the world's most popular rice varieties or simply accept the loss of their livelihood.

However, after an impressive career that left its mark in rice fields around the world—from West Africa to the plains of Latin America—Surapong is, at just 60 years old, feeling restless and in need of a new challenge. He regularly laments what he calls the "tragic mistake" of agricultural scientists in failing for decades to learn from the experience of ordinary farmers, and the consequent years of wasted effort.

It was his closeness to farmers that led Surapong to begin the breeding program seven years ago that resulted in the new blast-resistant variety *Khao Dawk Mali* (KDML), the Thai name for jasmine rice (see *Improving the sacred* on pages 24-29). He wanted to reduce farmers' risks by giving them alternative varieties and he knew they wouldn't accept anything of lesser quality than their traditional variety, known as KDML105.

Following that success, Surapong has remained concerned with helping small-scale poor farmers to garner a better standard of living from their inadequate plots of land. He's teaching about 50 farmers at Chaiyaphum, in Thailand's northeast, how to improve the purity of their crops by culling off-type plants from their fields and rejecting poor-quality seeds before planting. He's also teaching them how to make organic fertilizer. Using these techniques, he hopes they'll make a better living.

"We're very close," he says. "They're like my friends. We have lunch and dinner together. I listen to what they have to say as much as they listen to me. No matter what we do, we've got to get farmers involved."

He hopes the farmers he trains will pass their new knowledge on to their neighbors and, in this way, his lessons will eventually reach more than 100,000 rice growers in the area.

Surapong, whose parents owned

SURAPONG PRIVATE COLLECTION

a rubber plantation in Thailand's eastern province of Rayong, was the oldest of six children. He gained a bachelor's degree in agronomy from the University of the Philippines, Los Baños, before returning to work for three years in the Thai Agriculture Ministry's Rice Department. It was there that he met his wife, Prat, an entomologist working for the department in the northeastern city of Khon Kaen. They were married in 1973.

Surapong gained his Ph.D. in agronomy, specializing in plant breeding, at the University of Arkansas in the U.S., where his final years of study coincided with the emergence of molecular breeding. His only son, Patrick, was born in his last year at university. But the excitement of the academic environment and the tidiness and order of Fayetteville, Arkansas, made his first career appointment something of a culture shock, taking him literally and figuratively to the other side of the world.

He accepted a postdoctoral position with the International Institute of Tropical Agriculture in Nigeria, West Africa. Surapong remembers being reassured about any trepidation he might have had on moving to Africa. He and his family nevertheless found the shift very difficult, confined as they were to the institute complex for security reasons.

Despite the difficulty of the living conditions, Surapong claims the research was to have a very strong influence over the rest of his career. The leader of the institute's cereal improvement program was a legendary figure in agricultural research, Dr. Ivan Buddenhagen, who was involved in introducing disease resistance genes from native rice varieties into high-yielding IRRI varieties.

After three years working for Buddenhagen's team, Surapong's next move was to Cali, Colombia, as a plant breeder for the International Center for Tropical Agriculture (CIAT by its Spanish acronym).

SURAPONG (*second from left*) **visits a field of upland rice in Thailand's Chiang Mai Province in 1995. With him are then-IRRI Director General George Rothschild (*third from right*) and Kwanchai Gomez (*third from left*), then an IRRI consultant and now executive director of the Asia Rice Foundation.**

SURAPONG PRIVATE COLLECTION (2)

SURAPONG (*above, at center*) with his team of research assistants and field workers at the International Institute of Tropical Agriculture, Ibadan, Nigeria, in 1981. Ten years later (*right*) in Colombia at the International Center for Tropical Agriculture (*CIAT*), Surapong opens a gift presented by current IRRI Director General Robert Zeigler (then head of CIAT's rice improvement program) upon winning the institute's Best Scientist Award in 1991. Surapong chats with workers tending experimental rice fields at the Thailand Rice Research Institute's Bang Khen station in Bangkok (*below*) where, 35 years earlier, he began his career in rice breeding.

Far from abandoning his earlier work in Africa, he took much of the breeding material with him, and was the first scientist to introduce African rice varieties into South America. He was to work for ten years on upland rice varieties grown on the vast acid-soil plains of Latin America and Brazil, under the leadership of Dr. Robert Zeigler, who is now IRRI's director general.

Surapong recalls that rice crops in Latin America were grown like wheat, without standing water, and were harvested mechanically. "They had quite good yields, maybe two or three tons per hectare," he says, "but the eating quality was awful, and the plants were prone to disease."

New upland rice plants developed by Surapong came to cover much of the rice-cropping land of Colombia, and spread into other countries. They have both good eating quality and disease resistance. But they're chronically low-yielding varieties and he has one enduring conviction, arising from his years with upland rice: "I believe it will be very difficult to breed improved, high-yielding varieties of upland rice. The only chance of increasing productivity is to improve agronomic practices."

In the course of his efforts in Latin America, Surapong also began to realize the value of closeness to farmers. Unlike many of his colleagues, he moved out of the scientific enclave in Cali to live in a small village and learned to speak Spanish so he could communicate directly with the people on the land.

In 1991, Surapong joined the world's premier rice breeding team at IRRI headquarters in the Philippines to concentrate on the awesome task of breeding improved varieties for the multitude of rainfed lowland environments from India and Bangladesh through Thailand to Vietnam and the Philippines. Once again, he was under the leadership of Zeigler, who at the time was leader of IRRI's rainfed lowland program.

BOB HILL

With the majority of the world's rainfed lowland rice grown in India, Bangladesh, and Thailand, that's where Surapong's emphasis fell.

"Thailand was looking for grain quality, India wanted higher yields, and Bangladesh wanted higher yields and pest resistance, although they were all keen on pest resistance," he says. "And the rice-growing environment was hugely diverse."

So he concentrated on setting up and strengthening what soon became known as the shuttle breeding program.

"We brought in breeding materials from all the countries, crossed them with IRRI varieties having resistances to pests and diseases as well as good grain quality, and sent them back," he explains. The good sense of bringing national breeding programs together in a common purpose, and a thorough sharing of newly developed plant lines showing desirable characteristics, soon became obvious. "Before that, there was no interaction, no interchange," he adds.

Surapong organized meetings and visits among breeders from different countries to enlist involvement in the new international process. Shuttle breeding was not a hard concept to sell. Despite early difficulties in financing the program, national programs soon swung their support behind it. The entire effort was held together by the IRRI rainfed lowland team. The program is now broadly accepted as having been a major contributor to rice improvement in many countries.

Because his rainfed lowland research concentrated on India, Bangladesh, and Thailand, Surapong found himself constantly traveling. In 1995, he was able to convince IRRI that he should be based in Thailand and, after working abroad for 15 years, he at last returned home.

Having seen the failure of earlier efforts to breed new varieties for Thai rice farmers, Surapong was among the first of Thailand's rice scientists to urge the participation of farmers in the breeding and selection processes.

"We would develop new varieties and, at the experiment station, they would look beautiful," he recalls. "But the farmers would reject them all, for reasons that hadn't even been considered. Scientists were getting the selection process wrong; they weren't recognizing the desirable traits. Entire breeding programs were wasted.

"So we had the idea of taking new varieties out and letting the farmers judge them. That was the start of farmer participation."

The experience left Surapong with a clear feeling for the limitations of biotechnology in efforts to breed new rice varieties.

"Scientists will make a big mistake if they depend on biotechnology without the support of traditional breeding because they'll fall into the same old trap," he says. "Molecular markers and related technologies are wonderful tools. But it's all very well being able to say, 'Yes, the genes are there.' The selection process is perhaps the most important aspect of purpose-oriented plant breeding and, without a traditional breeding program, how are they going to select the correct lines? How will they know that the genes are doing what they hope? And how will they get farmers involved?"

In 1999, in a new atmosphere of farmer involvement, Surapong launched his backcrossing program to perfect the new blast-resistant jasmine rice variety that will be introduced to farmers' fields in 2006. He is gratified that, in this project, he was able to deliver a potentially big benefit to the farmers of his native Thailand.

Following his retirement, Surapong was determined that he, too, would become a farmer. He turned his full attention to developing 300 hectares of rolling uplands overlooking the Mekong River at Chiang Saen, in Thailand's far north. He concentrated on orchards of oranges, lychees, pomelo, and dragon fruit, as well as organic cropping of baby corn for the European export market. The farm also had 16 hectares of ginger, along with other herbs and medicinal plants, intercropped with pomelo trees. One hundred cattle provided manure for organic fertilizer.

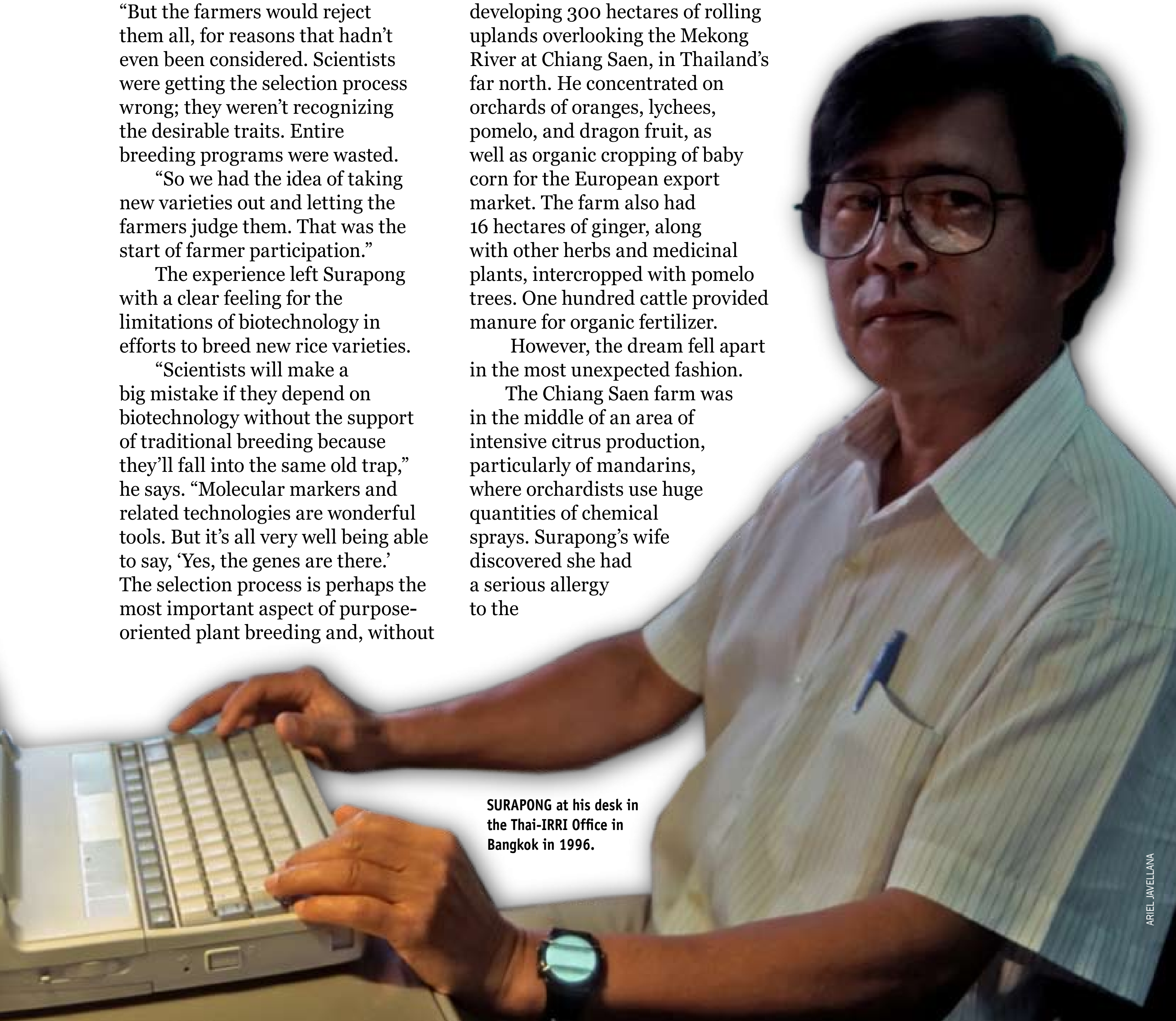
However, the dream fell apart in the most unexpected fashion.

The Chiang Saen farm was in the middle of an area of intensive citrus production, particularly of mandarins, where orchardists use huge quantities of chemical sprays. Surapong's wife discovered she had a serious allergy to the chemicals that were constantly drifting in the air. She couldn't live at Chiang Saen, and they had to move back to suburban Bangkok.

Early retirement has therefore come too early for a man whose career has taken him around the world. Surapong is restless.

"I still need a challenge," he says at his home in the Bangkok suburb of Min Buri. Thoughtfully, he adds: "I would like to try again in Africa. There are a lot of poor people there. A lot of people are dying of hunger. I would like to try to help them."

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



SURAPONG at his desk in the Thai-IRRI Office in Bangkok in 1996.

ARIEL JAVELLANA

THE NEW blast-resistant jasmine rice shortly before harvest and (*opposite*) piles of traditional jasmine rice ready for milling in Ayutthaya, north of Bangkok.

UBON RATCHATHANI RICE RESEARCH CENTER

Who says the sacred can't get any better? Thai scientists show that even their revered jasmine rice can benefit from an occasional helping hand

Improving the sacred

by Bob Hill

ARIEL JAVELLANA

Rice improvement efforts supported by the International Rice Research Institute (IRRI) have recently proven their worth in what is virtually sacred territory: they have led to the development of a new disease-resistant variety of Thailand's famous long-grained jasmine rice—arguably the finest and most popular rice in the world.

Thai jasmine rice comes from a traditional plant that is commercially viable only when it is grown in its home soil, on the poor rainfed farms of Thailand's north and northeast. It goes by the name KDML105, short for *Khao Dawk Mali*—in Thai, "jasmine flower rice."

It is a tall, weak-strawed plant that is prone to lodging, is vulnerable to climatic stresses in an environment notorious for both flood and drought, and falls easy victim to pests and diseases. It is particularly vulnerable to the destructive fungal disease blast, which is an endemic problem in Thailand (and many other countries; see *Beating blast* on pages 36-37). On top of all this, it is a low-yielding variety.

Yet, its long translucent grains, incomparable fragrance, and distinctive cooking quality make it one of the world's most sought-after varieties.

It was first offered to Thai farmers in 1959 after a research effort in the mid-1950s to find the "best" of the country's jasmine rice varieties. For almost half a century, small farmers with plots averaging little more than 1.5 hectares have fatalistically shouldered the huge risks of growing a weak monocrop in an environment laden with threats. Since the 1970s, the vast majority of farmers have grown only two other varieties of rice, RD6, a glutinous variety that they use for home consumption, and RD15, another jasmine variety of slightly lesser quality than KDML105. All are equally prone to climatic stresses and diseases.

The new variety will do away with much of the risk because it has strong resistance to blast—the bane of Thai rice farmers.

But the "sacred" nature of the traditional crop and the prospect of a successful newcomer have sparked an intriguing controversy in a country where the government has announced wide-ranging plans to modernize both its farm production and the marketing of agricultural produce.

Millers and exporters, the middlemen in Thailand's tradition-bound marketing system, have complained that their orders are based solely on the name KDML105. They say nothing else should take its place or the country will risk squandering its reputation for quality on the world rice market.

Their reaction comes at a time when Thailand's Commerce Ministry has warned the country's rice marketers against "blending" the premium KDML105 with grain of lesser quality. The ministry was referring to a known practice of

THIRTY-FIVE DAYS after having been sprayed with a normally lethal dose of the blast fungus, seedlings of the new jasmine rice variety thrive while seedlings of the traditional variety, KDML105 (*right*), are devastated.

AFTER ARRIVING direct from the farm, traditional jasmine rice is unloaded by a mill worker in Ayutthaya.

ARIEL JAVELLANA (2)

BOB HILL (2)

adding a percentage of irrigated rice, such as Pathum Thani 1, to shipments of jasmine rice, to boost financial returns. Pathum Thani 1 has grain almost identical in appearance to KDML105, but with an inferior fragrance. The Commerce Ministry has threatened to revoke exporters' licenses if they're caught blending.

The related clamor over the new blast-resistant jasmine variety means it has not yet been given a name. Millers and exporters suggested that it should also be called KDML105 to overcome marketing problems, but this is impractical from the viewpoint of researchers and farmers. Researchers, who fear the millers will offer a lower price for grain from the new variety, thereby dissuading farmers from growing it, say the official naming may have to wait upon the Department of Agriculture.

Agriculture Minister Khunying Sudarat Keyuraphan announced in June 2005 that the government wanted the country's jasmine rice crop to have a new brand name to boost its reputation and value on the export market. Her proposal was part of a range of government initiatives to modernize agricultural production, including a heavy emphasis on organic farming methods, which, the minister says, will give priority to the interests of farmers.

Meanwhile, the new variety, which is in its final season of experimental trials at the Department of Agriculture's Ubon Ratchathani Rice Research Center in the country's northeast, languishes under its awkward development label, IR77924-62-71-1-2.

Highlighting the pressing need for an alternative variety, the Thai government, millers and exporters, and the governors of the northern and northeastern provinces have all been urging farmers to lift their production of KDML105. The mounting pressure to force poor farmers to accept the risks of monocropping what is now a potentially lesser species has scientists deeply worried.

"They can't realize what they're suggesting," one senior scientist said recently. "They have no idea of the dangers involved. They've learned nothing from the past."

In October 1993, just as the country's jasmine rice crop was flowering, the weather suddenly produced optimum conditions for the blast fungus. It was a few degrees cooler than usual, but the humidity was high. It rained just a little—enough to keep the rice leaves wet for maybe 10 days—but there was no standing water in the fields. Carried in the air, the blast spores settled and grew in countless billions. Because the entire area was growing just one main variety, the disease was unstoppable. It raced like wildfire through nearly 200,000 hectares of rice. Within a few short weeks, more than 100,000 farming families had lost their entire crop, and were destitute.

Had the disease struck at the seedling stage, or even later, the farmers might have been able to replant and salvage something from the disastrous season. But their crops were flowering, and nothing could be done to save the rice.

The 1993 disaster was not an unusual event. It is commonplace for blast to destroy 5% to 10% of the Thai jasmine rice crop, and losses can sometimes climb to 60% and more in individual fields.

Apart from the determination of a handful of Thailand's top rice scientists, little work has been done to overcome the problem. The farmers are poor, and are reluctant to spray expensive fungicides as a preventive measure onto crops that don't already exhibit the symptoms of blast attack.

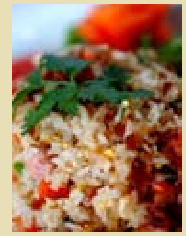
Development of the new variety began in 1999 when IRRI's resident plant breeder in Thailand, Dr. Surapong Sarkarung (see *It's all in the genes* on pages 19-23), crossed KDML105 with a rice variety drawn from the institute's huge genebank in the Philippines. The "international" variety was chosen for its strong resistance to blast disease.

From that first cross came a rice variety that was blast-resistant, but had lost a lot of KDML105's quality characteristics. So, Surapong embarked upon a lengthy and painstaking process known as backcrossing. This involved crossing and re-crossing the developing variety with its own KDML105 parent, so that, as well as holding onto the blast resistance, the jasmine rice quality was regained.

Joining the effort were Thailand's leading expert on blast,

Rice in Thailand: the facts

Rice is the most important crop in Thailand, occupying about 55% of the arable land in 2001. The country's northeast is the main rice-growing region and home of the famous Thai jasmine rice. The main surplus production is from the central region and the north, where the average farm size is three times larger than in the northeast, and the production environment more favorable. Rice is the staple food of the entire population regardless of income. Average per capita rice consumption, which has been declining since the mid-1980s, was around 100 kilograms per year in 1999.



Over the first two decades of the Green Revolution, area planted to rice grew rapidly from 6.9 million hectares in 1968 to 9.9 million hectares in 1988, and has remained around 9.0 to 10.0 million hectares depending on the relative price of rice in the world market. Rice production increased from around 12.4 million tons in 1968 to 21.2 million tons in 1988. Over the past five years, production has settled at around 26 million tons.

Rice yields have increased slower than in other Asian countries—from 1.79 tons per hectare in 1968 to 2.15 tons per hectare in 1988. The slow increase is largely due to the predominance of the rainfed (versus irrigated) rice ecosystem and farmers' preference to grow high-quality but low-yielding traditional varieties that fetch a premium price in the domestic and world markets. The 2004 average rice yield of 2.57 tons per hectare remains relatively low.

plant pathologist Dr. Poonsak Mekwatanakarn, and senior rice breeder Dr. Boonrat Jongdee, who would take over leadership of the project after Surapong's retirement in 2002. Both work at the Ubon Ratchathani Rice Research Center.

Poonsak says that, to ensure the developing variety would have the broadest possible resistance to blast, researchers set about gathering as many pathotypes of the blast fungus as they could find. Their search revealed that, of all rice-growing countries, Thailand had one of the most complex blast populations in the world. They gathered 1,766 samples of the disease and later classified them into no fewer than 485 pathotypes. Of these, 145 were regarded as common, 340 as rare.

"The fungus mutates very easily," Poonsak explains. "We get different pathotypes every season, so we had to equip our new variety with genes to resist as many as possible."

This took three backcrossing procedures, involving literally hundreds of thousands of plants. Surapong modified normal breeding and selection procedures to suit the purpose of the project because cooking and eating quality is not normally a principal consideration in developing new plants. Every new generation was grown to the

ARIEL JAVELLANA (2)

seedling stage, then inoculated by spraying the plants with a blast fungus "soup" containing most of the blast pathotypes. The surviving plants, having proven their resistance to the disease, were then transplanted and grown to maturity and their grain was tested for the precious qualities of KDML105.

The qualities of Thai jasmine rice, once intangible, can today be accurately measured. Its grain should be long and thin and its amylose content should be low—from 12% to 18%—making the cooked rice slightly sticky and soft. The temperature at which its starch gelatinizes should also be low—from 55 to 69 degrees Celsius—and its cooking time should be from 12 to 18 minutes. On top of this, its characteristic fragrance should register a clear superiority over all other varieties.

During the development of the new variety, an abbreviated analysis of these characteristics was applied to the grain from all plants that survived the blast trial. In charge of the quality evaluation side of the project was Dr. Duangjai Suriya-aroonroj. Eventually, after about five years, a small selection of varieties was proving its quality in the field and performing well in laboratory testing. It was time to take the testing a step further.

But Thailand's development of new rice varieties has been historically hobbled by a distinct lack of contact between scientists and farmers. Many varieties have been developed at high cost, only to be totally rejected by farmers.

Over the past five years, Thai scientists have accepted the error of ignoring the opinions of farmers and, these days, selected groups of farmers participate at all levels of research and development. In particular, a procedure developed by IRRI and adapted to Thai conditions is being used to answer the ultimate question in a farming community known to be obsessive in its regard for quality: "Do you like this new rice, or not?"

The researchers organize meetings of farmers, both men and women, in the communities they hope will adopt the new variety. The farmers are asked to judge three unnamed varieties of rice. Although they are not told this, the three include their most popular variety and the new variety, plus one other. They first handle, smell, and crack open the unmilled grain from each. Then they examine the milled grain, cupping it to their noses to measure its fragrance. Finally, they taste samples of each variety after it has been expertly cooked. Tasting is performed on both hot and cold samples. At each of the four stages, farmers vote by choosing a round piece of paper showing either a smiling face or a frowning face. The votes are placed in a ballot box, blue faces for men and pink faces for women. After casting their votes, they are asked to explain why they voted as they did on each occasion.

The new blast-resistant variety of jasmine rice has won its way through this exacting process. As well, Poonsak says proudly

PLANT BREEDER Boonrat Jongdee (*center*), plant physiologist Poonsak Mekwatanakarn (*right*), and a field worker examine specimens of the new jasmine rice variety growing on the experimental farm at the Ubon Ratchathani Rice Research Center. Traditional jasmine rice (*top*) is unloaded in preparation for drying at a rice mill in Ayutthaya.

UBON RATCHATHANI RICE RESEARCH CENTER

RICE FIELDS stretch out into the distance at Kanchana Buri, northwest of Bangkok.

that it has resistance to more than 90% of the blast pathogens he dumped on the new plants.

It has also performed better than the old KDML105 in field trials. Although the new variety is not a heavy yielder, its resistance to blast means that farmers can use nitrogenous fertilizer to boost its performance. Such is KDML105's weakness to blast that farmers are advised not to use nitrogenous fertilizer because the subsequent boost in growth leaves the tissues of the plant softer than normal, increasing its vulnerability to blast attack. This is not a problem with the new variety.

In field trials so far, the new variety has produced 3.75 tons per hectare without fertilizer—about the same as the potential yield of KDML105. But, when boosted with fertilizer, it has delivered more than 5 tons per hectare, a significantly higher yield.

The new variety has two other advantages for farmers. Unlike KDML105, it is photoperiod-insensitive, meaning it can be planted just about any time and it will grow and yield without concern for the length of the day and the amount of daylight. KDML105, on the other hand, flowers around October, according to a specific daily exposure to sunshine. The new variety also matures in about two weeks' less time than KDML105, allowing farmers to harvest varying rice crops without paying for additional labor.

Boonrat says the aim of the breeding program was not to replace KDML105. Rather, it sought to reduce farmers' risks and give them a range of varieties of jasmine rice from which to choose, according to their own priorities.

He adds that the new variety has two sister varieties that emerged from the seven-year backcrossing project. Both were being developed for release to farmers. One is identical to KDML105 in all respects—including its photoperiod sensitivity—but it has the blast resistance of the new variety and it matures a couple of weeks earlier. The other is also an identical match for KDML105, including its photoperiod sensitivity and its time to maturity, but it has blast resistance.

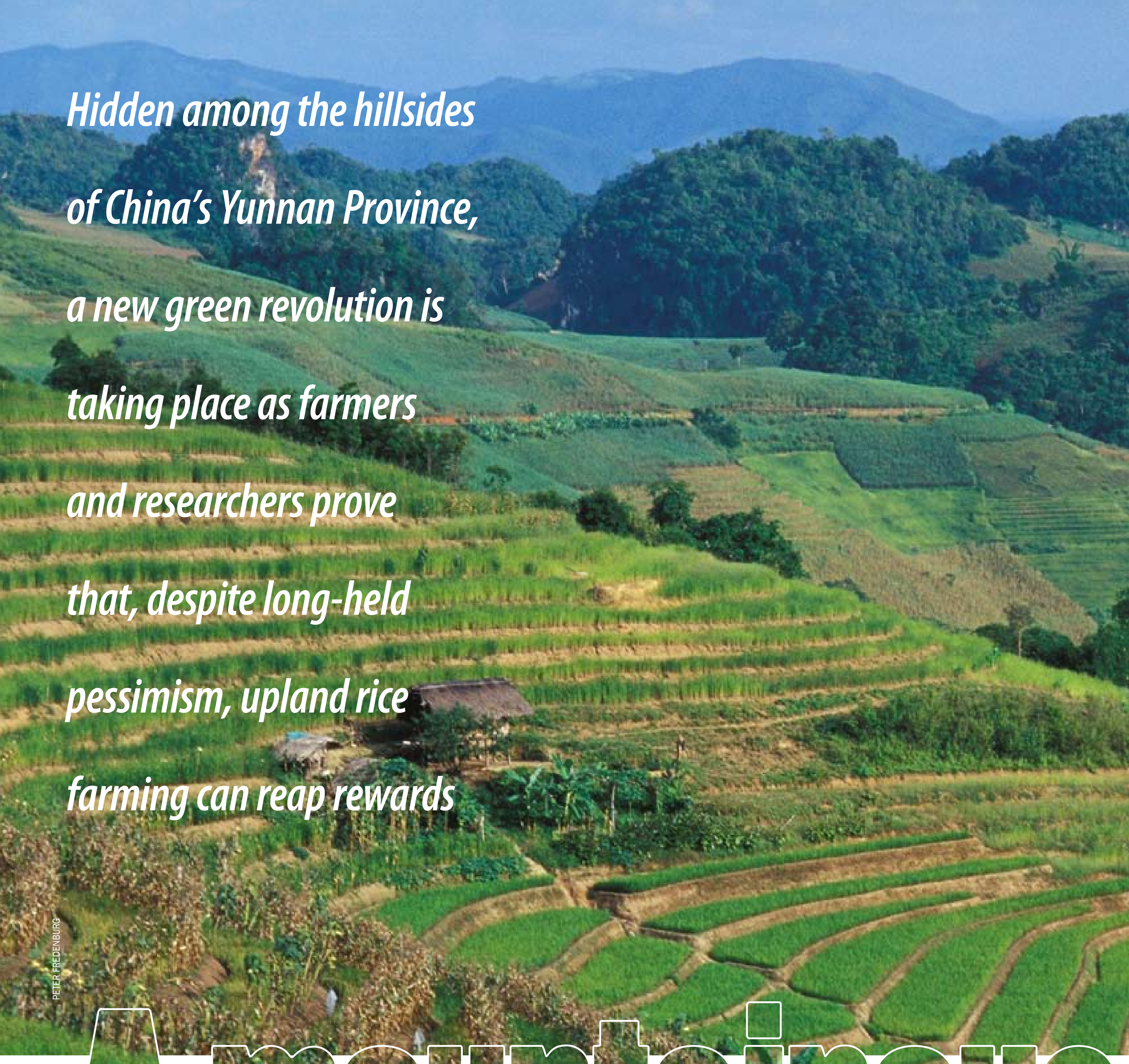
Boonrat says researchers at Ubon Ratchathani were in the late stages of field testing new jasmine rice varieties with tolerance of both soil salinity and submergence, and a blast-resistant matching variety was being developed for RD6, the most popular glutinous (sticky) variety among the country's northern and northeastern farmers.

Rice science in the world's leading rice-exporting country now looks to all links in the chain of the rice production industry in an effort to achieve a common purpose, from farms to export shippers. Quality, once again, is at the heart of the issue, and the new blast-resistant jasmine rice variety seems to have helped bring the matter to a head.

"Thailand should be selling rice on the basis of its quality, and not according to the name of one well-known variety," says Boonrat. "We will soon have three varieties capable of delivering premium jasmine rice, as well as KDML105, and nobody in the marketing chain without a quality evaluation laboratory is capable of saying 'yes, that's top stuff,' or, 'no, this is not good enough.' The millers and exporters test for physical qualities, and not for eating quality. They can't judge the quality that they're demanding from farmers. They simply demand KDML105 because they've come to depend upon it."

Boonrat is in a good position to know the importance of quality. Not only has the issue dominated his research for the past decade, his wife, Supanee, is a quality evaluation specialist at Ubon Ratchathani. And now that Thailand's researchers and farmers have forged a fledgling working relationship, he sees an urgent need to involve the rest of the industry.

"Something has got to come out of the hat," he says. "We want an exchange of ideas among millers, farmers, and researchers, and we want to involve the country's policymakers."



PETER FREDENBURG

Hidden among the hillsides of China's Yunnan Province, a new green revolution is taking place as farmers and researchers prove that, despite long-held pessimism, upland rice farming can reap rewards

A mountainous

by Bob Hill

Li Kan is a warm, convivial man. He welcomes guests with a genuine pleasure, shooing the dogs and chickens from the concrete courtyard of the neat collection of brick-and-tile buildings that make up his home before offering chairs in the

IRRI

BOB HILL (2)

RICE TERRACES and patchwork fields constitute a typically stunning Yunnan vista, which now—thanks to new high-yielding rice varieties that produce more rice on less land—increasingly includes the forest that for decades fought a losing battle with slash-and-burn agriculture (*inset*). Farmer Zhao a-Chi (*above right*) shows part of the rice surplus from his upland terraces while farmer Li Kan (*below right*) points to an area near his farm once cleared to grow upland rice, but which has now been returned to forest.

success

warm morning sun. At 52 years old, he is a thin, wiry figure with a lined face betraying both his years and the harshness of his youth. But it's a face that lights easily with laughter. His wife bustles happily about, pouring glasses of green tea for the guests, and his father, a tiny gnome of a man, hovers about with a toothless grin and clear, twinkling eyes.

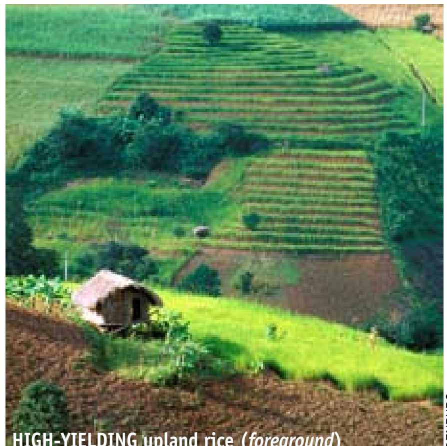
It wasn't always like this. A mere decade ago, Li Kan's family huddled in straw-thatched poverty, barely able to grow enough rice to feed themselves. They were completely without cash, without a future, and without hope, and the memories are too recent for comfort.

Li Kan's roller-coaster farm of 2 hectares lies at an elevation of 1,340 meters, in Lancang County, Simao Prefecture, in the endless mountains of China's Yunnan

Province. He was one of the first to be caught up in a new green revolution that is spreading across Yunnan's fragile mountain uplands, where an estimated 1 million people depend upon upland rice as a staple food. The revolution comes in the form of a new farming system, the key component of which is a collection of new upland rice varieties that have tripled yields, and more.

Already, the new system has lifted hundreds of thousands of farmers and their families out of poverty. Even more extraordinary is the fact that changes to upland farming systems on the scale being witnessed in Yunnan have rarely, if ever, been achieved before. The theory behind the transformation has long existed, but its practical application has frustrated agricultural authorities and scientists alike in many countries of the Asia Pacific region.

For thousands of years, the farmers of minority ethnic groups living in the highlands of countries such as China, India, Myanmar, Thailand, Lao People's Democratic Republic (Lao PDR), and Vietnam have grown traditional varieties of upland rice in shifting cultivation systems. They cleared forest from mountainsides, grew their rice and other crops until the soil was exhausted or competition from weeds became intolerable, and then they cleared a new plot and moved, leaving the old one fallow. This system was sustainable while



HIGH-YIELDING upland rice (*foreground*) sits next to other crops in the new—and more diverse—agricultural system.

PETER FREDENBURG

the need for food was limited by a small population and cleared fields were able to lie idle for long enough to recover. But the population grew rapidly. Vast forested mountainsides were stripped bare with the need to grow more food and nature was not given enough time to rejuvenate them from the depletion wrought by food crops and tropical sun and rain.

As this "slash-and-burn" agriculture deprived the soil of its ability to deliver enough food, vast and increasing numbers of people were unable to feed themselves. The majestic forested mountains of the Asian uplands became endless vistas of patchwork fields, rising from muddy ribbons of rivers. Reversing the situation became a universal imperative when the environmental devastation made itself felt downstream—because the uplands of Asia provide water for the rest of the region's teeming humanity.

Most efforts to create socially and environmentally sustainable agricultural systems in the Asian uplands have been unsuccessful. The incidence of poverty in the uplands of Lao PDR, Vietnam, and Nepal is much higher than the respective national averages. In remote parts of many countries, inadequate production can leave up to one third of the people short of rice, although their countries may be rice exporters.

Li Kan's example is typical. Ten years ago, he struggled to harvest enough upland rice from 4 hectares to feed his family. There was no room for other crops, no cash for the many needs of a growing family, and no hope for a better future. Today, the area of his farm is halved. Some of the land has been allocated to others, some has been returned to forest. Yet the harvest he reaped in October gave him enough rice for his family of six as well as a surplus of 6.4 tons of unmilled rice that he will sell. He also grows maize, buckwheat, soybeans, and peas, and he owns cattle, pigs, and goats. Life is good. Better, in fact, than he ever dreamed it might be.

Lancang, Li Kan's home county, is where it all began. Only about 6% of Yunnan Province is flat, and Lancang is typically mountainous. More than 106,000 farmers live in the county, and agricultural extension workers—the people responsible for moving improved technologies from the research institute to farmers' fields—estimate that about 60% of

them already practice the new system, with many more joining each season.

Yunnan's quest for sustainable agriculture in its uplands began nearly 20 years ago. After decades of frustrating effort, it had become a common belief among rice breeders that traditional varieties of upland rice, or rice grown on dry soil like wheat and maize, were unable to be "improved." Nevertheless, a team from the Food Crops Research Institute at the Yunnan Academy of Agricultural Sciences (YAAS) set about finding and creating new plants for the upland environment.

The Institute's deputy director, Professor Dayun Tao, says that in the late 1980s it was decided the new plants had to be shorter and more robust, developing more tillers and panicles than traditional varieties, and they had to be responsive to fertilizer and resistant to the fungal disease known as blast. Significantly, because of the vast diversity of the upland environments, the search was for a range of new varieties, and not just one.

The breeding process for the first new variety began in 1989. Named Yunlu 29, its parents were local upland varieties. The first crosses for a sister variety, Yunlu 52, were made in 1991. The painstaking breeding process took 11 years for Yunlu 29 and 13 years for Yunlu 52.

At the same time, two suitable, newly developed upland varieties were found in other countries. The first, IRAT104, was created in Africa by scientists from the French Agricultural Research Center for International Development. The second, B6144F-MR-6, which became known in Yunnan as Luyin 46, was bred in Indonesia and supplied to YAAS by the International Network for Genetic Evaluation of Rice (INGER), based at the International Rice Research Institute (IRRI).

THE BUMPER rice crop of October 2005 seen here allowed farmers to plant more land to other crops, such as maize (*below*). Prof. Tao (*below left*) contemplates the the new green revolution; IRRI Director General Robert Zeigler (*second from bottom*) shakes hands with a happy Yunnan farmer.

SUSHIL PANDEY (3)

PETER FREDENBURG

PARTICIPANTS in a 2003 study tour survey a Yunnan farm.

YUEH KWONG LEONG

Prof. Tao now proclaims a new scientific regard for dry-soil upland rice: "People should no longer regard rice in the uplands as a low-yielding, hopeless crop. It is a high-yielding crop with the ability to change the livelihoods of whole communities."

"Smart" farmers—those most likely to succeed—were chosen at the beginning. They were given seed for one of the varieties as well as enough fertilizer to support their first few seasons of production. Importantly, the government not only granted them long-term leases for their land but also promoted and financially supported the construction of cropping terraces on sloping uplands. Then, with extension workers carefully guiding the efforts of the early participants, all involved encouraged other farmers to join.

Within the first or second season, farmers were harvesting an average of 300 kilograms per mu, or 4.5 tons per hectare (15 mu make up 1 hectare), of rice from fields that earlier struggled to produce less than one-third of that with the old traditional varieties. Suddenly, food security was no longer an issue. The burden of the constant, debilitating struggle by farmers to feed their families was lifted.

With the guiding advice of extension workers and with transportation and marketing assured by government agencies, the farmers began to diversify. Since their staple crop could be grown on much less land, they branched out

BOB HILL (3)

into maize, sugarcane, buckwheat, soybeans, peanuts, oil-seed crops, and, if they had enough water, vegetables. They were soon able to manage their own cropping systems and buy their own fertilizers and herbicides. Li Kan, for example, uses three judicious applications of nitrogenous fertilizer—along with around 20 tons of organic fertilizer (mainly animal manure)—on his upland rice crops each year. The farmers are also buying chickens, goats, pigs, cattle, and buffaloes.

More recently, they've been able to build new houses and buy tractors, motorcycles, home appliances—luxuries that were unthinkable just a decade ago. However, lifting entire communities out of poverty was not the authorities' singular purpose.

Prof. Tao says the fundamental aim was to feed more people from less land—precisely the motive that drove the original Green Revolution in the world's lowlands—and to stop encroachment into the few remaining forested areas. In the area currently covered by the new farming system, the figures speak for themselves. Ten years ago, 10 mu (two-thirds of 1 hectare) of land was needed to feed one person. Now, that area is down to a mere 2 to 3 mu per person.

IRRI senior economist Dr. Sushil Pandey, lead author of the recent report *Upland rice systems and farmer livelihoods in Yunnan: recent changes and impact*, points out that the environmental benefits are also significant. Cropping has been concentrated in pockets of good land, and many of the unfavorable patches have been set aside for forest regeneration.

"It's really made a big difference to the government policy of returning steep, sloping agricultural lands to forest," he says.

IRRI Director General Dr. Robert Zeigler, who visited the Yunnan uplands in October 2005, came away convinced that something momentous is taking place. "I really think the Yunnan experience can serve as a model for other upland areas in the region," he says.

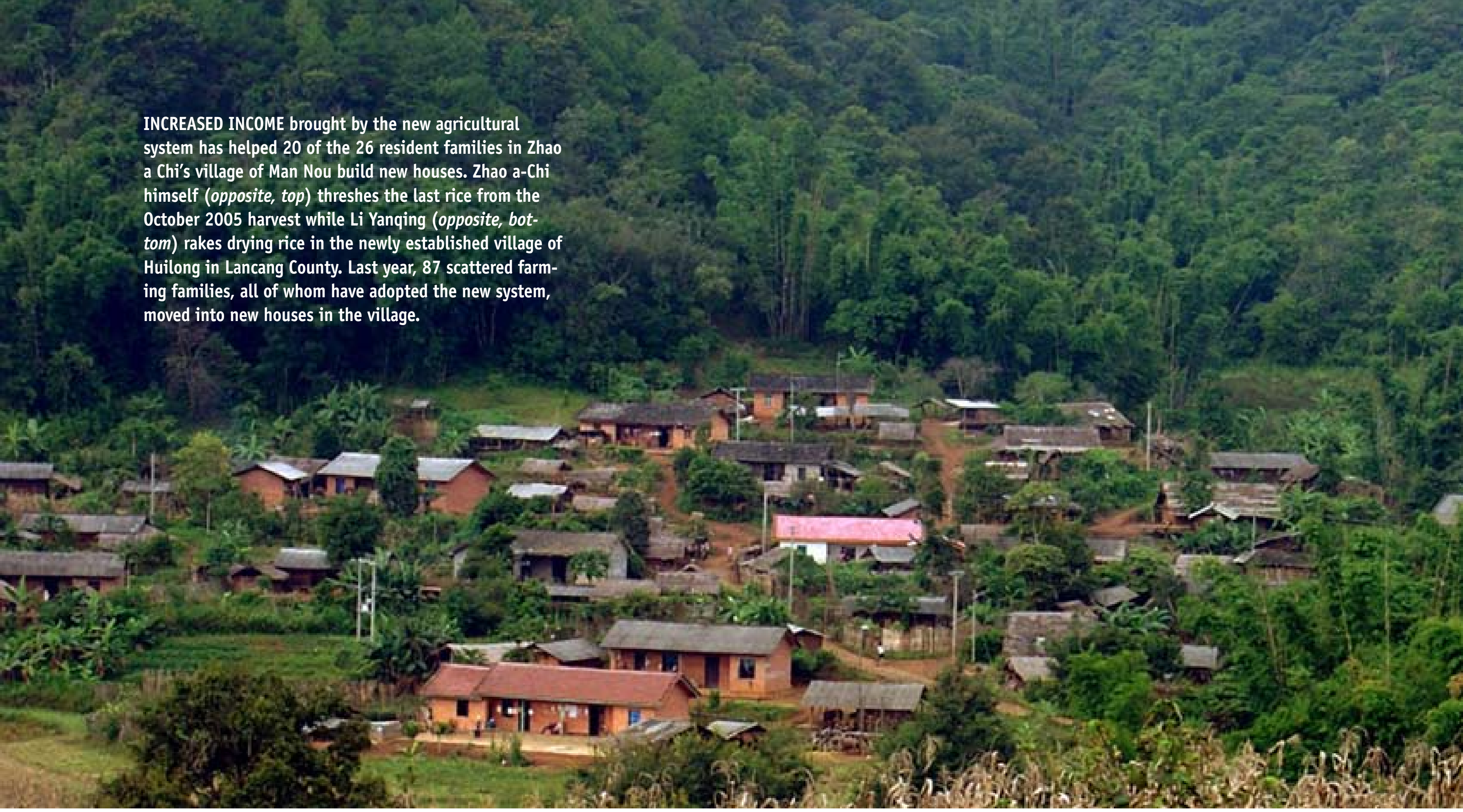
Zeigler emphasizes that YAAS has shown that the pessimism regarding technological progress in the uplands is unwarranted. He hopes that the academy will join IRRI in promoting the new approach.

Meanwhile, in Lancang's neighboring Menglian County, the new farming system is not only widespread; it is sprouting its first farming entrepreneurs.

Zhao a-Chi, at just 30 years of age, is head of Man Nou village, which nestles in a wooded valley not far from Menglian City. Although he is not yet married, Zhao a-Chi supports a family of four. His farm covers 6 mu, less than half a hectare. Rather than selling his recent rice surpluses, he has traded the grain with other village families for the right to use some of their land allocations to grow more rice and cash crops in the following season.

Zhao a-Chi's harvest in October 2005 left him with a surplus of 2 tons of unmilled rice. He is also growing maize, soybeans, and peanuts as cash crops.

He remembers when there was not enough rice in Man Nou village to feed most of the people, when he labored all day to carry home 10 kilograms of rice in the evening, when 80% of his neighbors had no money at all. Twenty of the village's 26 families have recently built new



INCREASED INCOME brought by the new agricultural system has helped 20 of the 26 resident families in Zhao a Chi's village of Man Nou build new houses. Zhao a-Chi himself (*opposite, top*) threshes the last rice from the October 2005 harvest while Li Yanqing (*opposite, bottom*) rakes drying rice in the newly established village of Huilong in Lancang County. Last year, 87 scattered farming families, all of whom have adopted the new system, moved into new houses in the village.

houses and, working together, they have bought a rice-milling machine and another machine for making feed for the growing number of livestock.

Despite the growing success of the new system, Prof. Tao says his team is not yet ready to rest on its laurels. The breeding effort continues, particularly to produce better varieties for higher altitudes. Suitability for elevation tends to be a limiting factor for the new plants. Some are good only up to 1,200 meters. Others begin to fade at 1,500 meters.

"We want to continue to reduce the land needed per person," he says. "We're breeding new generations of upland rice varieties in the hope of reaching a yield of 500 to 600 kilograms per mu (7.5 to 9 tons per hectare)."

The senior scientists and extension workers in Yunnan readily concede that China's approach to land ownership and communal responsibility have contributed significantly to the success of the new system. Nevertheless, the concept behind high-yielding upland rice varieties is equally applicable to other countries, and YAAS is ready to help China's neighbors tackle their own upland agricultural problems.

In this light, IRRI is now leading a project that aims to achieve similar results in Lao PDR. Project leader Pandey agrees that the Yunnan experience has rejuvenated efforts to improve agriculture in the notoriously difficult upland environments of the Greater Mekong Subregion, which comprises Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam, as well as Yunnan Province.

"Now," he says, "IRRI is playing the role of catalyst by establishing a platform on which the range of collaborators involved, which include the Lao Ministry of Agriculture, the International Fund for Agricultural Development, provincial governments, and YAAS, can come together."

Already, the high-yielding varieties being tested in Lao PDR look promising. Initial yields are much higher than those of the farmers' traditional varieties, even in the absence of fertilizer—and even in the least favorable environments where people are most in need of help.

There's perhaps one final test for Yunnan's scientists and administrators in proving the new farming system. Is it sufficiently sustainable to hold on to the next generation of farmers, or will their new affluence see them scatter to the cities?

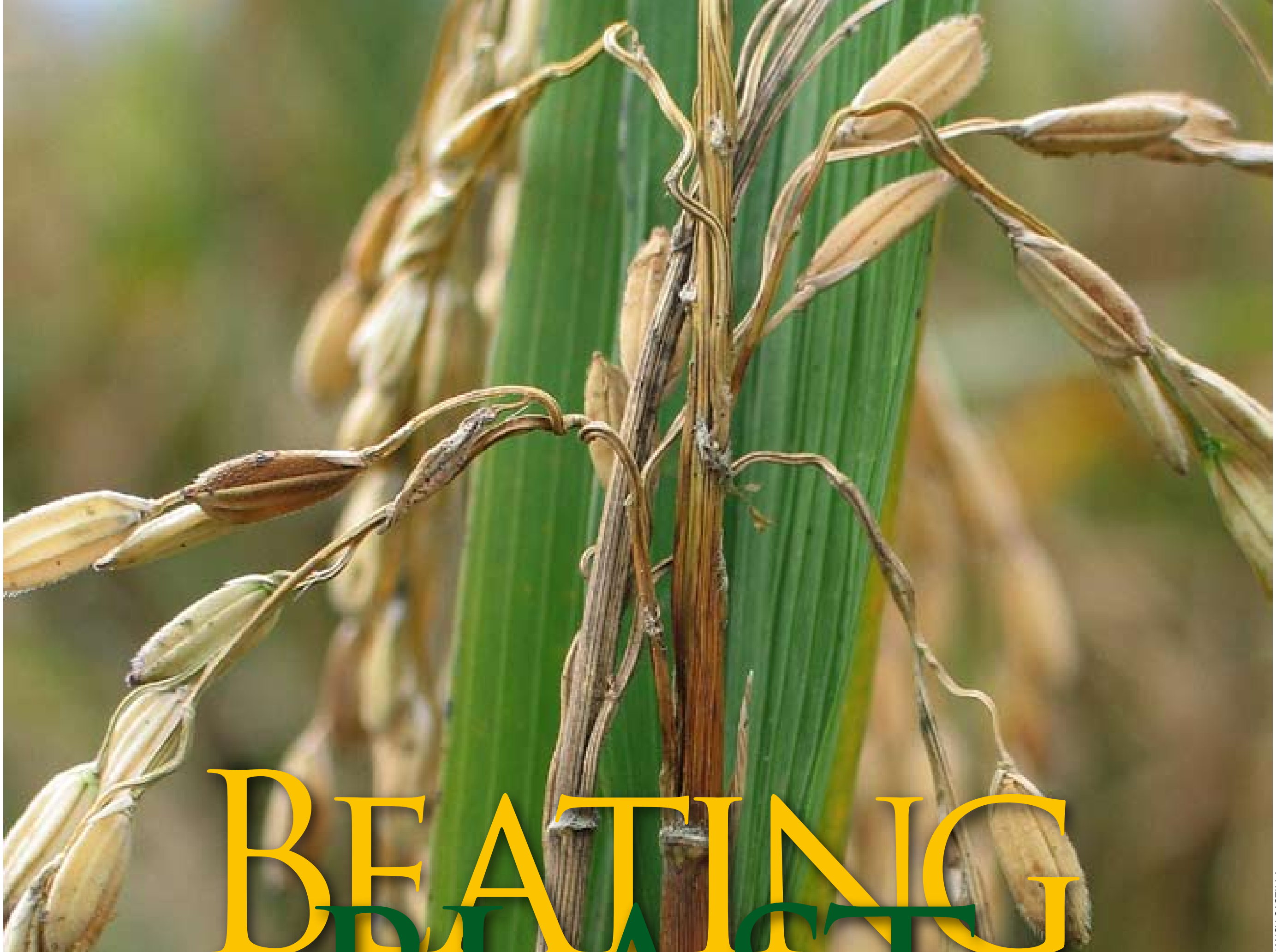
Li Kan's son, Kai, aged 24, dreamed of becoming a driver—any kind of driver—when he was younger, and the family had nothing. Now, he's Li Kan's enthusiastic right hand, driving their own farm vehicle and happy with a future on the family farm.

Zhao a-Chi's nephew, 20-year-old Zhao a-Jiao, however, has a different view. Despite the new affluence of his father and uncle, Zhao a-Jiao has a rather blunt vision for his future.

"We [young people in his age group] now feel that we can do anything we want," he says. "I want to do anything but work on a farm."

Potential loss of its younger farming generation is far from being a problem unique to Yunnan, but Prof. Tao is upbeat.

"This system can support a new generation of farmers," he says. "When farmers, both young and old, see the hope that this is bringing for their future, I think they'll stay."



NANCY CASTILLA

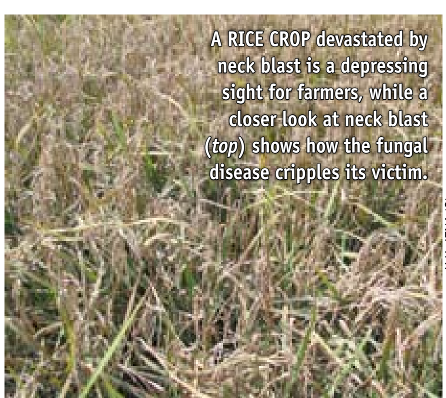
BEATING BLAST

BY K.K. JENA

Combining traditional and modern breeding techniques, researchers in Korea have succeeded in the perilously difficult task of making Korean rice varieties resistant to one of the crop's most destructive diseases

The rice fungal disease known as blast is a scourge to farmers across the rice-growing world. It has been estimated that, each year, the disease kills enough rice to feed 60 million people. An outbreak of blast can devastate rice fields, completely destroying crops in the most extreme cases. And, although it thrives in the humid tropics (see *Improving the sacred* on pages 24-29), blast is also a major problem in temperate countries such as Korea and Japan, and those in central Asia.

"South Korea suffered serious yield loss due to blast in the 1990s, primarily because of a lack of resistant rice varieties," says Dr. Moon Huhn-Pal, chairman of the Agricultural Advisory Committee of the South Korean Rural Development Administration (RDA).



A RICE CROP devastated by neck blast is a depressing sight for farmers, while a closer look at neck blast (*top*) shows how the fungal disease cripples its victim.

K.K. JENA (2)

In this light, a team at the International Rice Research Institute (IRRI)–Korea Office began in 2002 the search for a rice gene that offered blast resistance and could be used to develop japonica rice varieties resistant to a range of blast types. (Japonica rice is largely grown in temperate regions, as opposed to indica varieties, which tend to be grown in the tropics.)

The researchers knew from the outset that the project would

be a great challenge. Japonica rice germplasm (seeds and the genetic material they contain) has very narrow genetic diversity—finding a reliable genetic source of resistance to different types of the blast fungus *Pyricularia grisea* would prove difficult. Moreover, the complex life cycle of the fungus makes it necessary to develop rice varieties with durable resistance to blast that are appropriate for commercial cultivation but won't damage the environment.

Rice blast occurs in two forms: leaf blast and neck (or panicle) blast (*photos*). The first phase of the project was to find suitable germplasm that could donate reliable resistance genes into the resistance-gene-deficient japonica varieties. The researchers began by exposing a number of rice varieties—including traditional Korean varieties, breeding lines that had had genes from wild rice species bred into them, and other japonica varieties—to 15 types of blast that cause the disease frequently in japonica varieties.

Initially, the scientists inoculated 20-day-old seedlings with different blast types and, after seven days, studied the resultant blast-caused lesions. One indica rice variety was not affected by any of the types of blast, ultimately showing strong resistance to more than 30 Korean blast types and ten Philippine blast types and so proving itself the leading candidate as a new source of blast resistance. Next, the challenge was to get the blast resistance gene from the indica variety into Korean japonica rice varieties—something easier said than done.

"While incorporating the new gene for blast resistance into the Korean cultivars, we need to retain the grain quality characteristics of japonica rice that Korean rice consumers demand," explains Dr. Choi Hae-Chun, senior rice breeder at the RDA's National Institute of Crop Science.

The task, therefore, was to introduce a new blast resistance gene into a Korean rice variety and retain all the desirable japonica characteristics. Finding a source of blast resistance is hard enough; putting it into the genome of Korean varieties multiplies the difficulty again. In many cases, japonica genomes will reject a gene from an indica genome because the combination causes hybrid sterility.

The solution is to find a suitable japonica and donor indica combination. The researchers approached the challenge with both conventional breeding (crossing different varieties) and molecular breeding (examining and manipulating specific parts of the genome in the laboratory—although this can include genetic engineering, the IRRI-Korea team did not employ genetic engineering techniques). In this way, they introduced the gene into several japonica varieties and were able to pinpoint the gene's position in the rice genome.

One of the most important and difficult tasks is to link the resistance gene with a DNA marker—a segment of DNA that is linked to an allele (version of a gene) that controls an important trait and can easily be detected in the lab. Researchers can then perform a technique known as marker-assisted selection (see *On your mark, get set, select!* in *Rice Today* Vol. 3, No. 3, pages 28-29), which allows rapid screening of large numbers of plants. After several hundred crosses were made between the Korean japonica variety and the donor indica variety, marker-assisted selection was used to identify which of the crosses had inherited the blast resistance gene.

The researchers then studied the most resistant new japonica plants in more detail, evaluating their agronomic traits, grain quality traits, and the durability of their resistance. Suitable japonica breeding lines with strong blast resistance are now in the pipeline. Although these will initially be most useful in the temperate regions where japonica rice grows best, the prized new germplasm can also help researchers in tropical countries where rice blast is a problem.

Ultimately, the new breeding lines will allow the production of commercial rice varieties that give farmers the chance to cultivate high-yielding rice with good grain quality and remain confident that they can keep the scourge of rice blast at bay.

IRRI-KOREA OFFICE

EXAMINING THE REACTION to blast of newly developed resistant rice lines are (*from left*) Korean National Institute of Crop Science rice pathologist S.S. Han, IRRI plant pathologist C. Vera Cruz, IRRI plant breeder K.K. Jena, and IRRI–Korea Office scientist J.U. Jeung. A rice leaf (*top*) exhibits dreaded leaf blast symptoms.

Dr. Jena, IRRI country representative for Korea and senior scientist, plant breeding, led the IRRI-Korea team that developed the new blast-resistant japonica rice varieties.

It's not all about the research!

by Mark Bell

The International Rice Research Institute is, as its name suggests, renowned for its research. But, for more than 40 years, it has also trained scientists to make sure that ***research has impact***

Wiping the sweat from his eyes, the trainee thought, "Why have I come all this way to IRRI to plod through the mud in the name of training?" When training first started at the International Rice Research Institute (IRRI) in 1964, it aimed to meet the basic rice production knowledge needs. At that time, national agricultural research programs had few trained scientists. There was an urgent need for a combination of both scientific method and, in the face of rapidly increasing populations and an urgent need to increase rice yields, practical expertise. A generation of researchers had to be developed and developed quickly.

Key to success at that time was an understanding of the needs and a consequent clear focus. Research skills had to be developed but they had to be grounded in the reality of rice production. As a result, many if not most of the early courses involved considerable hands-on rice farming.

Jump ahead four decades to the present and you can see the impact that training has had. In the past 41 years, IRRI has seen trainees attend just short of 15,000 courses at its headquarters in Los Baños alone. Add this to the thousands of in-country participants and the extent of IRRI training has been remarkable. But do these numbers really represent impact? Anecdotal analysis, for a start, suggests there is little doubt as to the impact of IRRI training. Leaders of national agricultural research and extension systems (NARES)—often previous recipients of IRRI training themselves—regularly call for the continuation of training and highlight the importance of IRRI training in helping them achieve their national rice production and environmental goals.

IRRI offers four basic types of programs: degree scholarships (M.Sc. and Ph.D.); on-the-job training fellowships that allow participants to work alongside IRRI scientists and learn the latest techniques; group training courses, including study tours; and collaborative in-country courses.

A key concept in IRRI training is that it is integrated with research, not done as an activity on the side. In this way, the topics emerge from IRRI's collaborative research with national partners and, as a result, remain focused and relevant. Indeed, most participants come from collaborative projects. One great advantage in this is that these participants can return home and immediately apply the skills they have learned.

This integrated approach to course identification and development ensures that IRRI's training topics are diverse and dynamic. Courses range from the two-week Rice Production Course to courses on molecular engineering.

TERESA CLABITA

PARTICIPANTS in IRRI's rice production course learn how to prepare a seedling nursery, while trainees (*below*) share a joke in the Leadership Course for Asian Women in Research, Development, and Extension.

LAURO ATIENZA

Training at IRRI centers around the Training Center team, which has several roles: facilitating, providing management support, providing training method consultation, and capturing materials in an appropriate educational form. As part of this process, the Training Center employs innovative participatory learning methodologies and approaches. To keep trainees engaged, the Training Center team ensures that courses are interactive and that participants have a say in the day-to-day course organization. IRRI's training philosophy can be summed up by the old saying "Tell me and I forget, teach me and I learn, engage me and I remember."

NARES partners continually provide information on their needs. These requests are integrated with the perceptions of the individual IRRI scientists to produce an annual training plan. This plan builds on the traditionally strong courses while allowing flexibility to respond to new demands. For example, issues such as grain quality and intellectual property rights have emerged as major new topics.

The impact of IRRI training is currently undergoing formal documentation, but impact can be measured at different levels. For example, several IRRI alumni have gone on to become high-ranking agricultural officials in their countries such as ministers, secretaries, and directors, as well as leading scientists and influential figures. In general, though, the value of training is reflected in the development of NARES capacity, the consequent increase in rice yields over time, and the continued ability of IRRI trainees to respond to new challenges. It is also clear that, with the emergence of many top-class universities, especially in Asia, IRRI's role in training continues to evolve.

Today, IRRI's core training objectives are to develop competent rice professionals that make use of current best practices; to provide needs-driven training that is timely, is relevant, and uses appropriate teaching methodologies; and to collaborate with NARES to support and strengthen their training programs.

An effective training organization is able to position itself to benefit from new technologies and ideas. The emergence of information and communication technology was hailed as offering a revolution in training. IRRI was quick to see the possibilities of the technology and moved to capture the benefits. The result of this, IRRI's Rice Knowledge Bank (www.knowledgebank.irri.org), was launched in 2002 and offered what many were simply talking about—a repository of up-to-date information for practical solutions to the farming and research needs of the rice farmers, researchers, and extension agents of Asia.

The Rice Knowledge Bank rapidly established itself as a source of credible, focused, demand-driven material. It covered the entire rice spectrum, from "What is golden rice?" to "How to transplant and harvest your crop." Furthermore, all of IRRI's training course materials are captured and made available through the Rice Knowledge Bank.

The Internet is already playing a critical role in the timely delivery of knowledge to its target audience—and this is increasingly the case in developing, as well as developed, countries. IRRI's approach is to balance face-to-face approaches with online approaches. While the Internet is often excellent for finding specific answers to specific questions, more intensive education requires socialization and interaction. Thus, blended approaches that combine online media with person-to-person methods will play an increasing role in IRRI's training agenda.

Dr. Bell is a consultant to IRRI and former head, IRRI International Programs Management Office and Training Center. *For more on training, see* Training for greater impact *on page 42.*

Sowing seeds, reaping rewards

ARIEL JAVELLANA (2)

Dr. Achmad M. Fagi first arrived at IRRI in 1971 for three months as a 30-year-old rice field experimentation trainee. He returned in 1974 to embark on two years as a Masters' student enrolled at the University of the Philippines, Los Baños, and once more in 1977 for three years as a Ph.D. student, working under IRRI agronomist Dr. S.K. De Datta. Now, 25 years later, he sits on the institute's board of trustees. Following his time at IRRI, the Indonesian national followed a steadily rising career path. His work subsequently took him from junior through senior research positions to his current role as senior researcher for the Agency for Agricultural Research and Development in the Indonesian Ministry of Agriculture. His research efforts, especially on water reservoirs for the rainfed lowlands, the rice-fish system, and effective and efficient use of fertilizer, have made major contributions to integrated crop management, which now has national support in Indonesia.

Dr. Siene Sapanthong is another IRRI alumnus who has gone on to play an influential role in Asian agriculture. After spending almost a year at the institute in 1973 as a nondegree scholar, also under De Datta, he became head of the Soil Division at the Vientiane College of Agriculture. From there, Siene progressed steadily to his current position as minister for agriculture and forestry in Lao PDR, and he too sat on IRRI's board, serving two terms from 1996 to 2001. In his earlier role as vice minister, Siene strongly supported the Lao-IRRI Rice Research and Training Project in its early stages—a big factor in the project gaining momentum and ultimately having a huge impact on rice farming in Lao PDR.

A challenge...

Helping Africa produce more rice

IRRI

RICE FACTS

Rice in Africa

by Mahabub Hossain
Head, IRRI Social Sciences Division

Can rice help reduce hunger and poverty in sub-Saharan Africa?

Africa is labeled as a "poverty continent." While respectable progress has been made in reducing poverty in other regions of the developing world, the number of African people living on less than one dollar per day has increased, especially in sub-Saharan Africa. The region, which includes countries in central, eastern, western, and southern Africa, is now the main focus of overseas development assistance.

Rice is grown on 8.5 million hectares in sub-Saharan Africa (Figure 1), equal to 5.5% of global rice area. Almost all of the region's 38 countries grow rice, but two countries, Nigeria and Madagascar, account for 60% of the rice land. Nine other countries grow rice on over 100,000 hectares, including Guinea and Côte d'Ivoire. In most of these countries, more than 40% of the population lives in poverty.

A shift in consumer preferences—driven by rapid urbanization and women's growing participation in the formal labor force—away from traditional staples of cassava, sorghum, millet, and maize toward rice and wheat, combined with high population growth, means that rice demand is increasingly outstripping supply. And, while per capita rice consumption in Asia is declining, it is growing in sub-Saharan Africa—where, in 1990-2003, rice consumption grew 3.2% per year compared with annual production growth of only 2.4%.

As a result, rice imports have grown rapidly. The share of imported rice relative to total rice consumed grew from 32% in 1990 to 45% in 2003, and the volume of imports increased 5.6% per year. Sub-Saharan Africa now accounts for a quarter of the global import market and hosts some of the world's largest rice-importing countries. In 2003, 11 sub-Saharan countries imported more than 200,000 tons of rice, with Nigeria importing 1.64 million tons, up from 224,000 tons in 1990.

The consequently large expenditure on rice removes financial resources that could otherwise be used to fund much-needed infrastructure development. Therefore, many African governments are now looking to increase rice production, to both enhance food security and save foreign exchange (or currency).

However, efforts to increase rice production and productivity have had limited success, despite many governments protecting their domestic rice industries with high import tariffs. The area planted to rice increased from 3.5 million hectares in 1970 to 8.5 million hectares in 2004, but the average rice yield remains low at 1.5 tons per hectare (t/ha)—40% of the average yield in Asia. Yields have barely increased over the past three decades—a period when the Green Revolution contributed greatly to food security in Asia with minimal expansion of cultivated area.

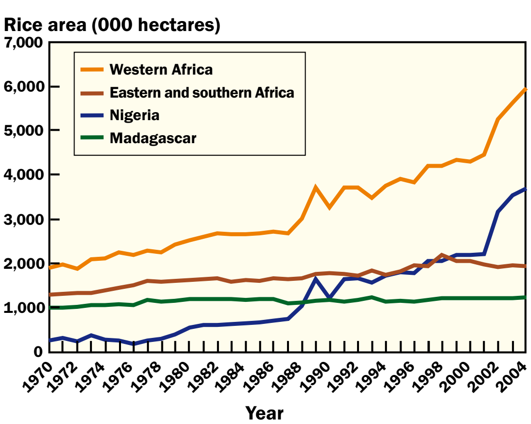


Figure 1. Trend in rice area, Africa, 1970-2004.
Source: FAO, 2005

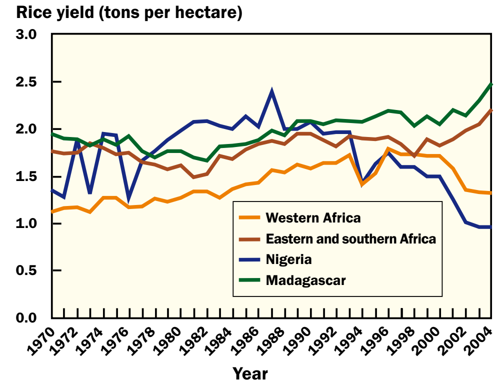


Figure 2. Trend in rice yield, Africa, 1970-2004.
Source: FAO, 2005

Average yield increased marginally from 1.33 t/ha in 1970 to 1.64 t/ha in 1990, but in many areas has since stagnated or even declined (Figure 2). Nigeria's dramatic yield decline, from 1.75 t/ha in 1996 to 0.96 t/ha in 2004, occurred despite the successful release of the drought- and weed-tolerant NERICA (New Rice for Africa) varieties.

The main constraint to increasing rice productivity in Africa is the dominance of unfavorable rice-growing environments. Just over half of Asia's rice is grown in irrigated conditions, whereas only 10% of Africa's rice area is irrigated. In African countries where rice is grown mostly in irrigated lowlands, yields, at more than 4.5 t/ha, are comparable with those of Asia. But the predominant ecosystem in Africa comprises uplands with infertile and toxic soils—an ecosystem in which Asia, too, has failed to significantly increase productivity.

Rice is uniquely adapted to flooded lowland ecosystems where soils are less fragile and crops respond to improved management, particularly the optimized application of nutrients. The development of profitable lowland rice technologies should therefore be a central element in increasing African rice productivity and production. There is vast potential for expansion of lowland rice cultivation in inland river valleys in sub-Saharan Africa. This should be explored if rice is to contribute to reducing African hunger and poverty.

David Shires

Training for greater IMPACT

Rice research can play a major role in achieving many of the eight United Nations Millennium Development Goals (MDGs), particularly those that call for the eradication of poverty and hunger, and for environmental sustainability. The International Rice Research Institute (IRRI) conducts research that regularly leads to validated technologies that have the potential to improve rice farming and so contribute to the MDGs.

The argument for rice research goes something like this: as more farmers use improved technologies, their communities achieve better food security while their income increases, thereby improving the livelihoods of those farmers and their communities. A sound argument indeed, but to realize the potential of the research, the effective transfer of these new technologies onto farms is vital. "Effective," in this sense, means that farmers understand both the new technology and the technology's effect on their farms. Crucially, farmers must feel compelled and sufficiently skilled to implement the technology. At this point, a training agenda—as opposed to a research agenda—becomes key to the successful transfer of the new technologies and a requirement for maximizing their impact.

Researchers and trainers who implement new technologies should teach management and communication skills as well as technical knowledge. Only when these are learned together and in context can we be sure of effective and sustainable adoption of technology

To obtain sustainable impact from the results of a research agenda, technical knowledge, although vital, is not enough. "Training for greater impact" must incorporate not only technical knowledge but also the range of associated skills needed for implementing the new technologies. These skills include personal attitudes, project design and management, time management, and effective communication. Often, these additional skills are overlooked or forgotten because science communities such as IRRI's—where such skills are part and parcel of everyday life—sometimes take them for granted. But these attitudes and skills form a "hidden" agenda that should be incorporated into technology transfer.

Validated scientific content, which forms the basis of new technologies, is created by IRRI scientists working with their partners from the national agricultural research and extension systems (NARES). The challenge of "training for greater impact" is to expand training from individual technical events to training that includes the necessary personal, management, and communication skills in concert with the requisite technical skills. Only when these skills are learned together—and in the context of farmers' needs and community circumstances—can we be sure of effective, sustainable implementation.

This type of encompassing approach can only be achieved by a new and enhanced relationship between the IRRI science community and the available training expertise. We need to develop approaches that allow training participants to interact with the technical content and discuss, debate, and discover ways to incorporate it into their own environments. Once participants have determined how the new knowledge fits into their environment, additional training and support can provide the detailed technical and general skills required for implementation.

This does not mean that the existing range of technical seminars and training events are not useful—on the contrary, they will continue to give NARES scientists the opportunity to dip into the pool of scientific knowledge within the IRRI scientific community. But, when a new technology needs to be delivered to farmers, a different form of training is required if it is to achieve its potential impact. This training is based on the learning theory of constructivism, which allows learners to integrate new information into their own existing framework of knowledge, in their own time.

As a research institute, IRRI is expected by its donors to do just that—research. IRRI does not have a mandate to focus on the extension process of training farmers to incorporate new technologies into their farming systems. This is a job for the NARES, whose staff understand the issues on the ground in their own countries. Where IRRI can play a role, however, is in training the people who will themselves carry out the extension and training.

By rigorously addressing the form and structure of training, IRRI can increase the impact of its vast store of research results and further justify an expanding research agenda.

David Shires is a training consultant for IRRI's Training Center and International Programs Management Office.

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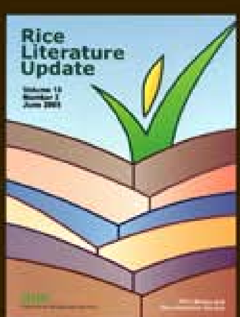

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