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2015 CALENDAR INSIDE!

IRRI's new breeding factory

A bigger rice bowl
Rice in Mexico, the land of maize
Adding value to Africa's rice
Women who moved mountains for heirloom rice

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contents

About the cover. Another revolution in rice breeding is under way. Inspecting some of the source material in IRRI's new breeding factory for irrigated rice are team members of the Transforming Rice Breeding project. This multi-environment trial testing system is designed to identify elite lines with broad and specific adaptation to irrigated areas in Asia. Read the cover story beginning on page 14. (Photo by Gene Hettel)

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Rice Today is published by the International Rice Research Institute (IRRI) on behalf of the Global Rice Science Partnership (GRiSP).

IRRI is the world's leading international rice research and training center. Based in the Philippines and with offices located in major rice-growing 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. It is one of the 15 nonprofit international research centers that are members of the CGIAR consortium (www.cgiar.org).

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From the editor's desk

Extreme poverty in decline, but much more to do

As pointed out in this issue's *Grain of Truth* (page 47) by eminent economists from the Food and Agriculture Organization (FAO) and World Bank, the decline in poverty in Asia has been historically unprecedented in human history. Worldwide, the number of hungry people has dropped by more than 100 million over the last decade and by 209 million since 1990-92, according to a new report, the *State of Food Insecurity in the World 2014*[1] published by FAO, the International Fund for Agricultural Development, and the World Food Programme.

Unquestionably, significant progress is being made. However, more than one billion people are still poor and 805 million of them are still hungry. More work needs to be done. Rice will play a continuing role in reducing these numbers. This is so because rice is the staple food of more than three billion people on the planet and 600 million of them are living in poverty. Indeed, around 60% of the world's undernourished live in Asia, where 90% of the world's rice is produced and consumed.

With these numbers, it is comforting to know that, according to Robert Zeigler, director general at the International Rice Research Institute (IRRI), a second Green Revolution in rice is already under way (see *A bigger rice bowl* on pages 32-35). IRRI and the Global Rice Science Partnership (GRiSP) have a clear view on what it will take to fill this bigger rice bowl that will take another 150 million people out of extreme poverty by 2035, only 20 years from now.

Part of the blueprint, with marginal farmers in mind, involves the transformation of IRRI's rice breeding pipeline into a demand-driven, lean, mean machine. This new breeding factory, outlined on pages 14-17, is being targeted to respond directly to farmers' needs.

As part of this process, it is very important to know more about the farmers themselves, particularly women farmers. What is their role on a rice farm? How much is their input in producing the world's staple food? IRRI's Sam Mohanty looks at these issues on pages 42-43.

As the International Year of Family Farming winds down, we look at family farms in the remote areas of the Cordillera Mountain region of the northern Philippines. Until just recently, these farms were dying, with family members dispersing to lowland cities to look for livelihood. Then, two determined women, Mary Hensley and Vicky Garcia, arrived on the scene to make the connection between the indigenous heirloom rice produced in the region and consumers around the world. IRRI is now working with them to help farm families conserve and sustainably produce their heirloom rice and make it part of the mainstream market (see *Women who moved mountains* on pages 22-23).

Restaurateur Amy Besa is helping to make the world aware of the Cordillera's heirloom rice—one plate at a time—at her Purple Yam restaurants in New York and Manila. The sous chef at the Manila branch uses Ominio, a tasty heirloom rice, in a popular recipe in our *What's Cooking?* installment on page 28. And what might you read while waiting for your heirloom rice dish to be served? How about a fable (on pages 26-27) about the origin of Tinawon, a beloved heirloom rice of the Philippines' Ifugao tribe?

In Africa, similar work is being done to help farmers add value to their rice and eventually raise their income. For the first time, researchers are looking at improving not just the quantity of Africa's locally produced rice (pages 30-31).

Mexico, too, is on the verge of a second rice revolution as it seeks to revitalize its rice industry (see *Rice revival in the land of maize* on pages 20-21). Also in Latin America, scientists at the International Center for Tropical Agriculture are wielding big data tools to help farmers deal with changing weather patterns through better management of crops (see *Harnessing big data for climate change* on pages 40-41).

Speaking of climate change, IRRI's geographic information systems team and partners are using data showing that rice farmers in India and China are very dynamic and can adapt to changing economic, technological, and climatic factors (see *Rice on the move* on pages 36-37).

Indeed, we need movers and shakers in rice research and development to help farming families increase their yield and income. In fact, five innovative ones (IRRI's outstanding alumni) are being recognized at the upcoming 4th International Rice Congress (IRC2014) being held in Bangkok, 27 October-1 November (see pages 18-19).

Held under the patronage of the Royal Government of Thailand, IRC2014 is being organized by IRRI and Kenes MP Asia Pte. Ltd. With a theme of *Rice for the World*, this "Olympics of Rice Science" is bringing together about 2,000 top rice scientists and researchers from all over the world to present and discuss the latest breakthroughs in R&D on rice, striving to make a difference in the vital issues of poverty and hunger alleviation and stewardship of the environment. Read about the six renowned IRC plenary speakers and their important topics on pages 12-13.

Happy reading!

Lanie Reyes
Rice Today managing editor

[1] www.fao.org/publications/sofi/en

African rice sequenced


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Researchers have sequenced the complete genome of *Oryza glaberrima*, which will enhance the understanding of scientists and agriculturists of the growing patterns of African rice. This will also help develop new rice varieties that can better cope with increasing environmental stresses such as drought, flooding, and soil salinity.

In analyzing the 33,000 genes that make up the African rice genome, researchers discovered that during the process of domestication, Africans and Asians independently selected for many of the same genetic traits in the two species (the Asian species being *Oryza sativa*), such as higher nutrition and traits that make harvesting the crop easier.

"Rice feeds half the world, making it the most important food crop," said Rod Wing, director of the Arizona Genomics Institute at the University of Arizona and AXA-endowed scientist at the International Rice Research Institute, who led the effort. "Rice will play a key role in helping solve what we call the 9 billion-people question."

The 9 billion-people question refers to predictions that the world's population will increase to more than 9 billion people by the year 2050 and concerns that have existed since the 1960s that food will become a luxury for the rich. America alone can feed the world but not at a reasonable cost so the question lies in how to scientifically optimize plants so local people can control their own food.

With the completely sequenced African rice genome, scientists and agriculturists can search for ways to cross Asian and African species to develop new varieties of rice with the high-yield traits of Asian rice and the hardiness of African rice.

African rice already has been crossed with Asian rice to produce new varieties under a group known as NERICA, which stands for New Rice for Africa.

Source: www.science20.com

Nigeria to receive US$79 million to help boost rice production

The Bank of Industry is currently in talks with the Federal Ministry of Agriculture and Rural Development to provide a $79 million intervention fund to boost rice production in the country. The fund is aimed at establishing 10 integrated rice mills and six cassava mills across Nigeria and provide five-year loans at an interest rate of 9% per annum to farmers to establish small scale plants or mini mills to process rice.

The fund is useful for Nigeria, which is a net importer of rice and imports nearly half of its rice consumption demand. The government has been aiming to increase the country's rice production and ban imports by 2015. The government has also been encouraging farmers to increase rice production and thereby contribute to food security in the country.

Source: www.thisdaylive.com

US$75 million facility to boost rice production in Ghana

The SNV Netherlands Development Organisation has secured $75 million from the USAID's Financing Ghanaian Agriculture Project to boost the capacity of local rice producers in the three northern regions.

The facility is expected to allow rice farmers access the necessary funds and logistics to increase yields and produce quality grain that will meet international standards in order to attract investors, and improve the economic lives of farmers.

Source: www.ghanaweb.com

California drought could claim quarter of rice crop


©BRIAN BAER

Nearly 25% of California's US$5 billion rice crop will be lost this year due to lack of water, experts say. And while analysts say the loss is not a crisis just yet, at least one rice producer is ready to call it a day.

With surface water sources drying up from lack of rain, the problem for rice producers is having enough water available to fill rice paddies, said Jim Morris, communications manager for the California Rice Commission. It's not a case of the crop being damaged, he said, so much as it's been reduced as farmers cut back on planting.

Source: www.nbcnews.com

Flood-tolerant rice for food security

Expanded farming of flood-tolerant rice varieties could increase rice production substantially and ensure national food security despite adverse impacts of climate change according to speakers at the *Climate change and cultivation of flood-tolerant rice for food security* workshop held in Lalmonirhat district town, Bangladesh.

The speakers said farmers of Lalmonirhat have been successfully cultivating flood-tolerant rice with assistance of the Stress-tolerant Rice for Africa and South Asia project (STRASA). They have had good yield even after floods in recent years.

A number of farmers testified that their yields from flood-tolerant rice were between 4.5 and 5 tons per hectare last cropping season despite 15-18 days of submergence.

Source: www.thefinancialexpress-bd.com

Kellogg pledges support for 15,000 smallholder farmers worldwide

Kellogg Company announced its commitment to support the livelihoods of 15,000 smallholder growers around the world at the UN Climate Summit held in New York in September. The commitment will enable smallholder farmers in Kellogg's agricultural supply chain, with a focus on rice, to improve their productivity and reduce greenhouse gas emissions.

"Climate change threatens agriculture and food systems in many regions, making it more difficult to achieve food security," said John Bryant, chairman and CEO, Kellogg Company. "As a food company, it's our responsibility to help ensure the long-term sustainability of key grains, including rice, and enable those who help grow and supply it."

Source: http://money.cnn.com

ASEAN photo contest

To celebrate the opening of the ASEAN Economic Community in 2015, the Thai Rice Foundation under Royal Patronage, the Royal Photographic Society of Thailand, and others are sponsoring a photo contest. The organizers are looking for striking and meaningful digital images that depict people and events representing key rice-based cultural aspects in ASEAN countries: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Vietnam, and Thailand. Entry deadline is 10 January 2015. For more information, go to www.asiariceusa.org/asean-photo-contest.html or contact rpst.info@gmail.com.

TRAINING COURSES AT IRRI

Course title	Date	Venue
Basics of Rice Production (2nd offering)	21-23 October	IRRI, Philippines
Basic Scientific Writing Course	10-14 November	IRRI, Philippines
Advanced Applications of ORYZA V3 in Rice Research	10-14 November	IRRI, Philippines
Research Data Management	18-20 November	IRRI, Philippines

For inquiries, contact IRRITraining@irri.org, m.maghuyop@irri.org, or a.aquino@irri.org. Phone: (63-2) 580-5600 ext 2538 or +639178639317; fax: (63-2) 580-5699, 891-1292, or 845-0606; mailing address: The IRRI Training Center, DAPO Box 7777, Metro Manila, Philippines (Attention: TC Course Coordinator); Web site: www.training.irri.org.
Note: Fees and schedules are subject to change without prior notice.

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Theme 4: Extracting more value from rice harvests through improved quality, processing, market systems and new products
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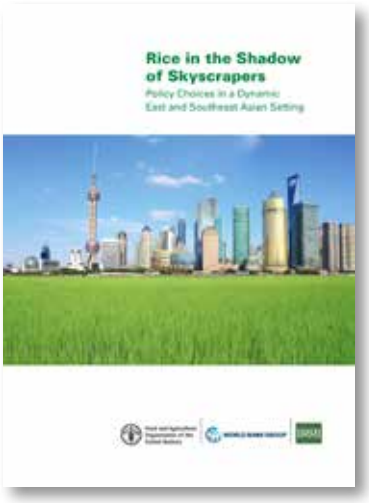
Rice in the shadow of skyscrapers: Policy choices in a dynamic East and Southeast Asian setting

Edited by David Dawe, Steven Jaffee, and Nuno Santos

Published by the Food and Agriculture Organization (FAO), World Bank, and International Rice Research Institute (IRRI). 149 pages



This compendium of policy notes is the result of cooperation among FAO, the World Bank, and IRRI. Across Asia, rice as food plays an important part of the human family. These policy notes seek to contribute to the ongoing policy dialogues and debates about rice and food security in East and Southeast Asia and make decision-making better informed (see the *Grain of Truth* on page 47).

This compendium aims to synthesize and reframe a large body of recent literature into a readily-accessible format for public officials, business leaders, civil society, and other stakeholders involved in policy-making. Although this publication focuses on the rice sector in East and Southeast Asia, many of its key findings and conclusions will also be of interest to policymakers who are finding solutions to similar challenges that have something to do with staple foods in other regions.

The role of rice in East and Southeast Asia is shifting along with broader societal changes, including what is going on in economic structures, demography (including rapid urbanization), rising incomes, and changes in food consumption patterns. Just the same, the political economy of rice remains exceedingly complex within the region. Rice is still closely tied to food security imperatives, but increasingly also to improving the income of rice producers, realizing commercial trade objectives, and, more recently, lowering the environmental footprint of agriculture in major rice-growing areas.

As this compendium seeks to support and nurture a learning process, it also aims to contribute to more effective and efficient policies and programs. This is part of the ongoing efforts of the three sponsoring organizations to win the fight against poverty and improve food security in East and Southeast Asia through research, sharing of knowledge, strategy development, technical assistance, and boosting investments in rice-related infrastructure and management systems.

Collaboration on this policy note series involved 20 authors from the three sponsoring organizations and other partner institutions. The work was initiated and led by Steven Jaffee, lead rural development specialist, Global Agriculture Practice in the World Bank, and David Dawe and Nuno Santos, senior economist and economist, respectively, in FAO. They worked together in identifying the major themes and contributing authors and they edited this publication. ■

The PDF of the book can be downloaded free at http://irri.org/resources/publications/books/item/rice-in-the-shadow-of-skyscrapers.

Plant biotechnology: Experience and future prospects

Edited by Agnes Ricroch, Surinder Chopra, and Shelby J. Fleischer

Published by Springer International. 291 pages.

By 2050, there will be more than 9 billion people in the world—around 2 billion more than today. This means the world's population will increase substantially—much of it in regions that are already in a food deficit. How can governments ensure a secure and stable food supply for their citizens? Can current agricultural production practices and technologies provide for an expanding population in a sustainable way? Innovations through biotechnology have played crucial roles, and will continue to do so in the future. Students of many disciplines and the general public who are interested in examining the development and adoption of these innovations that are applied in agriculture in the world's largest economies and in developing countries will find this book valuable.

Even with almost two decades of experience in deploying transgenic crops in agroecosystems, we are still very much in the early stages of technological development, deployment, and adoption of the resulting plants (cereals, vegetables, and trees). In relation to this, this book would like to answer several important questions. What are these biotechnologies that are aimed at enhancing agricultural productivity? How are they being deployed now? What are some short-term realistic expectations? And, ultimately, will they be a part of the sustainable agriculture required for the future?

The book contains 20 chapters, including one by Robert Zeigler, director general of the International Rice Research Institute, who explores biofortification in general and vitamin A deficiency and the case for Golden Rice specifically: http://link.springer.com/chapter/10.1007/978-3-319-06892-3_19. ■

To buy copies of the entire book (US$149) or individual chapters online, go to www.springer.com/life+sciences/agriculture/book/978-3-319-06891-6.

XII International Rice Conference for Latin America and the Caribbean

Horizons for competitiveness

The **XII International Rice Conference for Latin America and the Caribbean** will be held in Porto Alegre, the rice capital of Brazil, on 23-26 February 2015. The Conference will once again be the gathering place to review scientific and technological advances, identify new challenges and opportunities, and share knowledge and experiences around rice.

The 2015 conference theme is *Horizons for competitiveness* and we invite the rice sector from the region to join us, along with leading rice researchers and experts from all over the world, as we discuss the state of the art and the contribution of key areas such as plant breeding, crop management, climate change, market opportunities and partnerships to make the rice sector competitive in Latin America. The Conference will also have a field day at the *Instituto Rio Grandense do Arroz* (IRGA-Brazil) Rice Experiment Station in Cachoeirinha, 15 minutes away from Porto Alegre.

Since 1976, the International Rice Conference for Latin America and the Caribbean has been the prime international forum for the rice sector in the region. The conference will also be a great opportunity to celebrate the 20th anniversary of the Latin American Fund for Irrigated Rice (FLAR), a public-private partnership that has served as an engine for research, development, and alliances of the region on rice.

The XII International Rice Conference for Latin America and the Caribbean is organized by the IRGA- Brazil, FLAR, the International Center for Tropical Agriculture (CIAT), and the Global Rice Science Partnership (GRiSP).

For more information, please visit www.conferenciaarroz2015.com.br.

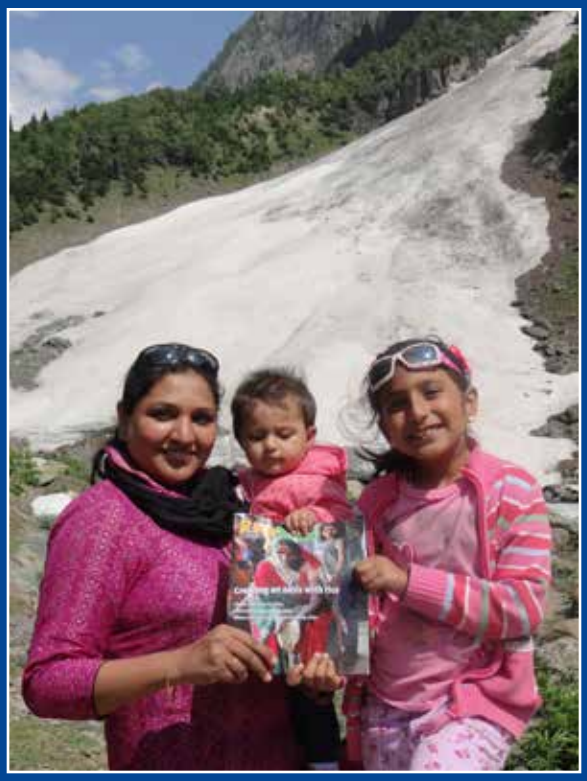
XII International Rice Conference for Latin America and the Caribbean
23-26 February 2015, Porto Alegre, Brazil

Organizers: IRGA Instituto Rio Grandense do Arroz; FLAR; CIAT International Center for Tropical Agriculture Since 1967 / Science to cultivate change; CGIAR Research Program on Rice Global Rice Science Partnership

HORIZONS FOR COMPETITIVENESS

www.conferenciaarroz2015.com.br

Rice Today around the world



◀ NAJAM WARIS Zaidi and her daughters, Mysa and Myra, visit a hill station in the Sonamarg alpine valley of Kashmir State, India, which is a popular tourist destination. Dr. Zaidi is a postdcotoral fellow at IRRI. The photographer is her husband Manzoor Hussain Dar, senior associate scientist for STRASA based in India.

▲ MAKING WAVES in science and sports. *Rice Today* shares a ride with Matty Demont, IRRI senior economist, in one of his wakeboard adventures on Caliraya Lake in Laguna, Philippines.

IRRI ALUMNI (international and national staff) gather in Woodland, California (near U.C. Davis), at the home of Lito and Amy Real on 4 July. This event was held in advance of the 15th annual trustees meeting of the Asia Rice Foundation USA. See the article about ARFUSA on pages 44-45 and a video at http://youtu.be/nl-seOCk_NE in which the persons in the photo identify themselves.

Helping to solve the 9-billion people question

AGI
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12th International Symposium on Rice Functional Genomics

Among the most pressing concerns facing our world today is how to grow enough food to feed a human population that will expand by more than 2 billion in the next 35 years. Rice will play an essential role in our quest to feed 9 billion people in 2050. Now feeding around half the world, rice will continue to be the primary source of calories in many rapidly growing regions.

On 16-19 November 2014, the University of Arizona in Tucson is hosting scientists from around the world at the 12th International Symposium on Rice Functional Genomics (ISRFG). It was at this meeting 10 years ago (during the 2nd ISRFG in Tucson) where the International Rice Genome Sequencing Project celebrated the completion of the rice genome, which to date remains the highest quality reference genome for any crop plant.

The 2014 symposium will cover recent breakthroughs in structural, functional, and evolutionary rice genome biology—pushing current scientific knowledge to address the need for sustainably increasing crop yields and global food security.

There is still time to plan coming to Tucson in November! Please join us for an exciting meeting to discuss cutting-edge science with many of the world's top scientists. Meet old friends, make new ones, and forge novel collaborations in the setting of scenic U.S. southwestern desert. Together, we can make new discoveries in rice biology and breeding to improve the world for our and future generations.

- Standard registration through 1 Nov. 2014 is $495 (Students, $395).
- Late registration after 1 Nov. is $525 (Students, $425).
- On-site registration is $575 for all.

For more information, go to http://www.isrfg12-tucson.org

Plenary speakers provide grist for discussion at IRC2014

Games changers in agriculture, transformations in the rice value chain, rice pricing and politics, beyond the rice genome, and GMOs are the issues

Five experts with wide-ranging knowledge—serving as the plenary speakers during the 4th International Rice Congress (IRC2014)—will be flagging cross-cutting issues for discussion among the attending rice scientists and industry players. All will be gathering in Bangkok during the last week of October. Their topics are critical to assuring that there will always be *Rice for the World*, the Congress's overarching theme.

Enhancing the 6-day gathering throughout the week will be:

Ms. Marie Haga, executive director of the Global Crop Diversity Trust. She joined Global Crop Diversity Trust as executive director in March 2013.

Dr. Thomas Reardon, a professor in the Department of Agricultural, Food, and Resource Economics at Michigan State University. He has extensive research experience on food industry transformation, in particular the "supermarket revolution.

Mr. Vichai Sriprasert, honorary president of the Thai Rice Exporters Association and President and CEO of Riceland International Ltd. He is an expert on parboiling rice and was the first to introduce this processing technology from the United States to Thai rice mills in 1978.

Prof. John Colbourne from the School of Biosciences at The University of Birmingham. He regularly works with industry and advises government agencies and professional societies, aiming to transform practices at monitoring and protecting the environment.

Mr. Mark Lynas, environmental campaigner, journalist, and author. He has written several books on the environment, including *High Tide*, *Six Degrees*, and *The God Species*.

Agriculture—including rice—needs game changers

Ms. Haga will point out that, in the 1960s, agriculture flourished under the Green Revolution. Now, in light of climate change, she believes that agriculture needs a "Gene Revolution" to feed the world.

"Agriculture is probably facing its biggest challenge ever, and rice is not immune," she says. "We need game changers in the way we do agriculture," Ms. Haga says. "The diversity contained within plant genetic resources provides a universe of untapped possibilities.

"Crop diversity is the biological base of all agriculture, she points out. "But as the diversity of rice is being lost through genetic erosion, supply of this staple grain becomes more vulnerable."

In her presentation, Ms. Haga will explain why conservation of genetic resources of rice and other crops is critical to agriculture and the world's future food supplies, particularly under rapidly changing climate patterns.

Transformation of Asia's rice value chain

"There is a rapid transformation afoot in the rice value chain in Asia," says Prof. Reardon. "The 'upstream' is changing quickly—farmers are undertaking capital-led intensification, and participating in burgeoning markets for land rental, fertilizer and pesticides, irrigation water, and seed. And at midstream, in wholesale and milling, there is a 'quiet revolution' underway, with thousands of entrepreneurs investing in equipment, increasing scale, and diversifying into higher quality.

"Farmers, with better access to improved varieties and technologies, are producing more rice with better quality and are moving beyond their village markets," says Prof. Reardon. "Instead they are starting to sell their produce directly to mills and wholesale market traders for better prices. Meanwhile, millers and traders, especially in China, with the help of better technologies, have started selling branded, labeled bags to retailers.


Marie Haga


Thomas Reardon


Vichai Sriprasert


John Colbourne


Mark Lynas

"The transformation appears to be improving food security for cities, by reducing margins, offering lower consumer rice prices, and increasing quality and diversity of rice." He bases this on extensive data from unique "stacked surveys" of all value chain segments, in seven zones, more or less developed, around Bangladesh, China, India, and Vietnam. He will flesh out the situation further during the IRC.

Why rice pricing and politics don't mix

Thailand had been the world's largest rice exporter for decades," says Mr. Sriprasert. "The country owed its success to the free trade policy initiated 150 years ago by King Rama IV."

However, that all changed when the Pheu Thai Party made a key promise during the 2011 election to buy rice from local farmers at a generous price—about 50% above the market rates—to boost incomes for rural farmers. It backfired because rice traders promptly switched their purchases from Thailand to other rice suppliers, particularly India which lifted its four-year-old rice export restrictions in the same year and stabilized the rice market and prices.

"Farmers were not told that, at such high prices, not all the surplus crop could be exported," he says. "Soon government warehouses bulged with an equivalence of two years unsold rice, and no cash to meet farmer obligations."

Under the Rice Pledging Scheme, exports dropped to third place behind India and Vietnam. "The lesson: prices must not by the government," says Mr. Sriprasert who will explain why it is best to let the markets play a decisive role in determining rice prices in his presentation.

Beyond the rice genome

The rice ecosystem isn't just about the rice plants—it's the whole landscape that includes a wealth of biodiversity, much of it beneficial to rice agriculture, but some rather harmful. For example, Prof. Colbourne asks what secrets lie in the genome of the water flea? "They could be the key to fighting invisible health threas such as chemical pollutants," he exclaims!

"The genomes of agricultural and ecologically relevant species can reveal how animals respond to chemical threats that are found in our water supply," he explains. "The goal is to measure the changes that happen in their genes that would then lead to technologies that may be able to tell us about the presence and effects of those chemical pollutants."

Rapid technological improvements to access this "memory" encoded within genomes of populations promises to transform how the health of the environment is monitored and protected.

In his presentation, Prof. Colbourne will clarify how the application of 21st century technologies towards environment and health protection can promote not only public well-being, but also the economy, job creation, and global competitiveness of industrial, agricultural, and service sectors.

Where's my GM rice?

Finally, Mr. Lynas, will point out that it's high time to discuss genetically modified crops using scientific facts instead of muddling the issue with baseless fear tactics. He believes that ignoring scientific evidence about genetically modified crop safety and benefits is a threat to food security and the health of hundreds of millions of people.

"Rice remains locked out of the two-decade-old biotechnology revolution," he says. "Largely because of political activism motivated by superstition and anti-science attitudes, there is up to now no GM rice available to consumers anywhere in the world."

Mr. Lynas hasn't always been a supporter of biotechnology. "In 2008, I was still penning diatribes in *The Guardian* [a UK broadsheet] attacking the science of GM," he admits.

He will discuss why he is now critical of organizations that ignore scientific facts about the safety and the benefits of genetically modified crops such as Golden Rice. "If the industry self-imposed de facto moratorium on genetically improved rice is allowed to become a permanent fixture, the options for plant breeders will be constrained, and humanity will be denied the use of a major tool to feed the world more sustainably." he says.

IRRI's new breeding factory

by **Lanie C. Reyes**

Transforming from research-driven to product-oriented breeding processes

THE CORE TRB team members take a break in one of their multi-environment trial plots. Foreground: Eero Nissilä; middle row (*left to right*): Glenn Gregorio, Bert Collard, Richievel Ibanez; background (*left to right*): Rafiqul Islam, Gina Vergara, Michael Thomson, Alice Laborte.

ISAGANI SERRANO

The road toward global food security is not without challenges. The population will balloon to 9 billion in 2050. The signs of climate change have never been so real—frequent floods, droughts, and storm surges. Storm surges make farmland in coastal areas too salty for most crops to grow. Also, pathogens and pests evolve. Therefore, a rice variety may lose its resistance to new strains of pathogens or insects.

"With so many challenges that we are facing now, we can't just continue with what we are doing," said Eero Nissilä, head of the Plant Breeding, Genetics, and Biotechnology Division (PBGB) at the International Rice Research Institute (IRRI). "There need to be changes in the way we do breeding at IRRI."

IRRI plant breeder Bert Collard agrees. "A revolution in rice breeding is what we need now," Dr. Collard said. "Not much has changed for the last 50 years. The methods used today in Asia are generally the same as the ones used in the 1960s-'70s. More importantly, the rate of yield increase or genetic gain for irrigated varieties is less than 1% per year."

Doubling genetic gains

Thus, Dr. Nissilä and his team are now restructuring IRRI's entire breeding operations. Transforming Rice Breeding (TRB), a project funded by the Bill & Melinda Gates Foundation, is one important component of this new breeding factory, which focuses on irrigated rice. IRRI is aiming to double the rate of genetic gains—the increase in crop performance that is achieved through genetic improvement programs per unit time of breeding—or even make it higher (more than 2%).

"To make breeding more efficient, we need to change how we organize our breeding operations," Dr. Nissilä said. "We need to restructure the overall breeding pipeline."

A shorter cycle

Traditional breeding takes 8 to 9 years to develop a variety and even longer for the variety to reach farmers. Now, the breeding process has been shortened to about 6 years (See *How a modern variety is bred* on pages 11-12, Vol. 9, No. 1 of *Rice Today*).

"In breeding, one year is significant," said Dr. Nissilä. "Investments in plant breeding with costs incurred during the phase of developing varieties are only realized when farmers grow the varieties. A longer breeding cycle means economic opportunity cost to farmers of losing the chance to grow better varieties earlier."

A 1999 study conducted by IRRI shows that reducing a breeding cycle by 2 years has an economic benefit of about US$18 million over the useful life of the variety.[1]

[1] Pandey S, Rajatasereekulb S. 1999. Economics of plant breeding: the value of shorter breeding cycles for rice in Northeast Thailand. Field Crops Research 64:187-197.

Breeding by demand

Taking a cue from breeding in the private sector, IRRI's breeding pipeline should run like a business operation—production by demand. For Dr. Nissilä, this should be the underlying philosophy of the new breeding pipeline.

"That's why the TRB team is working closely with IRRI's Social Sciences Division to better understand the needs of farmers," said Dr. Collard. "This will help guide us in 'must have' traits as well as 'good to have traits' in our breeding objectives."

The team recognizes that national programs have different needs. It could be a breeding line, a gene donor, or a gene marker. If a researcher needs only a gene marker and wants to do the breeding in a lab himself or herself, IRRI will provide some help on how to use that marker. If a national program is interested only in salinity tolerance, the team will use its trait pipeline to provide the best package of salinity tolerance for the national program's breeding. On the other hand, if a national program needs a new rice variety, then the team will use its product development pipeline.

"We can help organize a national program's overall product development and product profiling when needed," Dr. Nissilä said. "We will not only give a trait, say, salinity tolerance, but, it can be combined with many traits that one needs in one's 'market,' so to speak. We can fit their needs.

"But, our aim in the future is that we won't be doing the 'job,'" he added. "We want them to do it themselves. Our role will be more of a consultant and provider of training. Then, we exit when they are already able to do the work."

The role of hubs

"But, if national programs want us to do this in the first round, we will breed the variety itself," said Dr. Nissilä. "This is where our regional breeding hub system comes into the picture. Our hubs in India, for the South Asian region, and in Burundi, for East and Southern Africa, allow us to localize the breeding process—we select and produce the material in the region where it will be used."

IRRI now has many modern breeding options for a more efficient and cost-effective process than the conventional pedigree method. The conventional breeding way goes like this: choose plants with the desired trait, cross-pollinate them, wait for the offspring to reach maturity, select the best performers, and then repeat the process to the n^{th} degree until one obtains a plant that fits farmers' need.

Today, these modern methods include marker technology, multilocation trials, and rapid generation advance (RGA). RGA produces fixed lines or plants that no longer segregate. Scientists call them "homozygous" or "genetically stable." "In RGA, plants are grown at high density with low nutrients in greenhouses or screenhouses so that they flower and mature earlier, thus shortening their life cycle," said Dr. Collard. "Therefore, several generations (e.g., three to four) can be advanced in one year." In addition to time savings, this method also saves labor and resources, and costs considerably less than other methods.

THIS GREENHOUSE facility employs RGA techniques to develop new irrigated breeding populations. RGA technicians (*from left*) Joseph Beredo, Rhulyx Mendoza, and Herman Hermosada grow the rice plants in small trays to quicken flowering and maturity. Tens of thousands of breeding lines can be advanced for 3-4 generations in a year in an area of less than 400 m^2.

BERT OLLARD (3)

New breeding pipeline model

The new structure of IRRI's breeding pipeline will hopefully be a model for the national programs to follow. Historically, the national partners have modeled their programs on IRRI's old system.

"We hope that the new processes of rice breeding at IRRI will help catalyze new thinking in the national programs so they can also restructure their own factory," Dr. Nissilä said.

"There is a great interest in Africa and Asia to do the same," said Dr. Collard. "There may be some reluctance about specific aspects because it is a 'big change' generally. But with the criteria of time and efficiency, it wins hands-down."

Breeding economics

To have an evidence-based comparison between the old and the new system, IRRI will conduct a benefit-cost analysis.

"IRRI has never put value to its costs until recently," Dr. Collard recalled.

In terms of full-cost recovery, IRRI's breeding pipeline is working to improve efficiency in three areas. First is the use of knowledge capital. The pipeline should maximize the use of expertise in the Division.

Second is the use of a running budget. Will it be split into a hundred small activities or put in a strategically based operation?

Third is the use of investment. "This is important since it is a technology-driven operation and this will ensure an efficient use of investment," said Dr. Nissilä. "This is where our cross-cutting strategy comes in. For instance, instead of adding seven more molecular labs, we will have one world-class lab!"

With one state-of-the-art facility servicing all breeding pipelines, the use of expertise will be more efficient because activities won't overlap or be duplicated compared to having several scientists working on their own in their respective small labs.

Moreover, Dr. Collard mentioned that the team is implementing computerized systems for data collection and exploring using mechanization in field trials to save on time and labor.

So, with efficient use of knowledge capital, a running budget, and investment capital coming into play, Dr. Nissilä concluded that there is no better way of organizing breeding operations.

Measuring success

In any business operation, one is usually asked how to be sure that the money is used efficiently for its intended purpose. According to Dr. Nissilä, the new breeding pipeline has put in place some indicators of success.

The first is cost-efficiency. What costs what? The second is progress. Have we increased the genetic gain as promised? The third is impact. What products are used in the national programs? How many farmers' seeds were produced? How much income did these products make for farmers?

"And, of course, one more measure of success is making our national partners more independent and their breeding activities more sustainable," Dr. Collard said.

MECHANIZED HARVESTING of direct seeded breeding trials greatly increases the efficiency of field operations. This is old news for developed country or private company breeding programs, but novel for rice breeding in Asia. Research technician Luisito Caracuel (*left*) watches closely as the first direct seeded irrigated field trial (2014 dry season) is harvested using the combine harvester.

A never-ending story of service

Will there be a time when IRRI's new breeding pipeline will no longer be needed in the future? "Breeding is a never-ending story of service, because the technology upstream is developing," Dr. Nissilä explained. Things that are not normal today will be routine tomorrow. To stay alive in this business, we need to have a very wide product portfolio and diverse expertise.

"Besides, the needs are very wide. For example, in Rwanda, they will need our lines while in India we need collaboration in genomics and biotechnology applications."

The story has started

But, even before the funding of the foundation arrived in November 2013, Dr. Nissilä and his team had started carrying out some changes in IRRI's rice breeding pipeline (See *The pipeline grows stronger* on pages 14-15, Vol. 12, No. 2 of *Rice Today*). They restructured the breeding activities from research-centric to a product-oriented pipeline. Now, the TRB project brings the resources as the fuel to propel the new factory of irrigated variety pipelines.

Many examples of change are brewing in IRRI's new breeding factory. One is the modernization of IRRI's data collection and analysis and the organizing of a load of information on rice breeding.

In fact, the Institute has come a long way in terms of its baseline. In IRRI's classic book on breeding called *Rice Improvement* by Jennings, Coffman, and Kauffman,[2] which was published in 1979, data or analysis was not even mentioned, Dr. Collard said. "During that time, plant breeders decided whether a plant was good or bad 'by eye assessment,'" he added.

Today, decision-making strongly depends on data collection and analysis. "After field work, we spend a significant time in our office analyzing data," said Dr. Collard. "Modern techniques such as the use of new statistical analysis, computerized data management, and molecular breeding approaches may be small things. But, the sum of all these spells a great difference in streamlining high-quality data for a more efficient way of breeding."

A significant improvement of IRRI's breeding program in the last 2 years has been its testing of breeding materials at multilocations much earlier than before. With this multilocation trial system and regional hubs, the effectiveness of the development of new varieties will improve. Furthermore, decentralized breeding in hubs allows easy seed transfer of IRRI breeding material to the region.

With the TRB project, Dr. Nissilä and his team in the PBGB Division are looking forward to a future when farmers need not wait long to plant an improved variety apt for the challenges of the time.

"The TRB project aims to accelerate the current breeding pipeline in developing varieties, shorten the breeding cycle, and dramatically increase the efficiency of breeding operations," said Dr. Collard. "But, the big picture of this project is to help resource-poor farmers in Asia and Africa improve their food and income security."

Ms. Reyes is the managing editor of Rice Today.

A COMPUTERIZED STATIONARY thresher is used to dramatically reduce the time for processing data from field trials. Threshing and yield data are generated in minutes per sample and electronically recorded.

[2] See http://sn.im/rice-improvement

Innovators in rice science

by **Alaric Santiaguel**

The 2014 IRRI Outstanding Alumni awardees

The International Rice Research Institute (IRRI) is recognizing another crop of Outstanding Alumni during an upcoming quadrennial ceremony. They are Amitha Bentota, Pham Van Du, Meas Pyseth, Ganesh Thapa, and Chay Bounphanousay. They are truly innovators in rice science.

The Outstanding IRRI Alumni Awards, presented every four years in conjunction with the International Rice Congress (IRC), this time on 30 October at the Bangkok International Trade and Exhibition Center in Thailand, acknowledge the international contributions of these alumni who have conducted their research at IRRI as part of their graduate and postgraduate degree programs.

The awardees were selected because of their contributions in one of five categories: rice research management (Dr. Bentota), management of the rice crop and its environment (Dr. Du), rice technology delivery and extension (Dr. Pyseth), social science and rice policy (Dr. Thapa), and rice crop improvement (Dr. Bounphanousay). At the same time, their contributions have advanced IRRI's mission to reduce poverty and hunger, improve the health and welfare of rice farmers and consumers, and ensure the sustainability of rice production.

Rice research management

Amitha Priyadarshani Bentota
Director, Rice Research and Development Institute
Department of Agriculture, Sri Lanka

Amitha Bentota, head of the Rice Research and Development Institute (RRDI), presently leads in formulating and carrying out all collaborative rice R&D plans in Sri Lanka. These include all research programs across the country managed by RRDI, Batalagoda, seven satellite R&D centers in Sri Lanka, and productivity enhancement programs with stakeholders in the country and abroad.

One of Dr. Bentota's key achievements is increasing the productivity of problem soils in the low and wet zone of Sri Lanka, particularly iron-toxic rice soils, by developing appropriate varieties. Under her direction and leadership, the Regional Agricultural Research and Development Center, Bombuwela, successfully developed five high-yielding, iron-toxicity-tolerant rice varieties with acceptable grain quality and resistance to major pests and diseases. The cooking and eating qualities of these varieties are the preferred choice of consumers in the region.

Rice varieties with tolerance of iron toxicity allow farmers to cultivate once unproductive rice lands continuously. These varieties help increase rice yield in the country's problem soil areas from 1–2 tons per hectare to 3–4 tons per hectare. Because of the nonlodging trait of these varieties, machinery for harvesting can be used and can reduce the farm labor shortage in the country. One of these varieties has been recently released in Bangladesh as a high-yielding variety.

Management of rice crop and environment

Pham Van Du
Deputy director general for crop production
Ministry of Agriculture and Rural Development
Southern Region, Vietnam

A rice plant pathologist, Pham Van Du has made messages on how to manage a rice crop easy to understand and farmer-friendly. Dr. Du's messages have been mainstreamed by Vietnam's Ministry of Agriculture and promoted nationwide. An example, among many, is the *Ba Giảm, Ba Tăng* (*Three Reductions, Three Gains*) program, which motivates farmers to reduce seed rates and use less fertilizer and pesticide.

The best of his achievements is the Small Farmer, Large Field (SFLF), a contract farming scheme that links big companies with individual rice growers. The companies provide farmers with technical support, including dryers, storage facilities, and milling, to ensure the quality of their produce. The companies also buy and export the rice. Because the model encourages linkages among small farmers, agricultural product dealers, traders, and exporters. SFLF also gradually improves the value chain.

Launched in March 2011 by the Department of Crop Production, Ministry of Agriculture and Rural Development, the SFLF model spread throughout the northern region a year later. After 3 years, the model has been applied in 13 provinces and 150,000 farmers' handbooks have been distributed through extension services and the agriculture department.

Rice technology delivery and extension

Meas Pyseth
Director, Department of International Cooperation
Ministry of Agriculture, Forestry and Fisheries, Cambodia

Meas Pyseth pursued a career in postharvest technology to ease the plight of the Cambodian people, especially the farmers, who rely on rice as their main source of food and livelihood.

Dr. Pyseth believes that Cambodia cannot rely on manual labor if it wants to be a major rice exporter someday and the use of machinery is a need for its rice sector development. He is a staunch advocate for the importance of proper handling of the grain. He helped raise awareness on the losses incurred during rice postharvest activities.

Working closely with government agencies, the private sector, development partners, millers, and farmers, Dr. Pyseth ushered in an era of modern and mechanized agriculture in Cambodia. This resulted in improved harvesting, drying, storage, and milling, with lower physical losses and higher quality grain and seeds. His efforts resulted in the adoption of and investment in new technologies, strategies, policies, programs, and projects. Today, around 6,000 combine harvesters and hundreds of grain dryers are used by farmers across the country. Although the equipment is mostly imported, Cambodian manufacturers have started producing it locally, thus giving farmers access to more affordable units.

In 2009, the United States Department of Agriculture reported that Cambodia aims to double its rice production in 2015. According to Dr. Pyseth, the country already has a surplus for export even if its average rice production is only 2.9 tons per hectare and it has poor irrigation infrastructure. Dr. Pyseth confidently predicts the country may even triple its present rice production if it continues to use modern varieties along with improved irrigation and postharvest technologies.

Social science and rice policy

Ganesh Thapa
Consultant/former senior economist, International Fund for Agricultural Development (IFAD)

Ganesh Thapa served as a senior economist for IFAD and earlier as a senior economist for Nepal's Ministry of Agriculture and program leader of Winrock International. As an economist, he has conducted analytical and capacity-building work, which paved the way in the formulation of policies and programs that are conducive to agricultural productivity growth and poverty reduction in many Asian countries.

In particular, he helped formulate IFAD's strategy for Asia and the Pacific, with a focus on the development of less-favored areas—mountains and uplands, marginal coastal areas, and dryland and rainfed areas—which led to investment projects in many Asian countries and grant-funded research projects.

As IFAD task manager, Dr. Thapa worked with IRRI scientists in designing and supervising some projects under the Consortium for Unfavorable Rice Environments (CURE). Thus, stress-tolerant rice varieties have been developed along with improved crop management practices. These technologies are now increasing yields in unfavorable rice environments.

As a development economist, Dr. Thapa also worked together with other CGIAR centers and other regional/international organizations in many projects to develop new technologies and approaches suitable for resource-poor farmers.

Rice crop improvement

Chay Bounphanousay
Director, Agricultural Research Centre (ARC)
National Agriculture and Forestry Research Institute
Ministry of Agriculture and Forestry, Lao PDR

Early in her career, Chay Bounphanousay saw agriculture as a powerful tool in order to meet the needs of the growing population of Laos.

She learned about the importance of germplasm evaluation in rice improvement after attending training on genetic evaluation and use at IRRI. And, since 1995, Dr. Bounphanousay has taken part in organizing, promoting the accelerated collection of, and conserving indigenous rice germplasm in Lao PDR. Since then and until 2003, she led and also participated in germplasm collection missions that catalogued more than 14,000 rice samples. With her rich knowledge and experience, she developed teaching materials for local extension workers and researchers on germplasm collection, evaluation, conservation, and seed multiplication to promote decentralized collection. Lao germplasm is now the second-largest component of the IRRI genebank collection.

During the course of evaluation and characterization, 45 varieties of black rice, including two aromatic nonglutinous black rice and two aromatic glutinous rice varieties, were registered as Lao varieties. Novel plant types and new traits were also identified and, together with the rice improvement team at ARC, more than 10 new rice varieties with higher yields, disease resistance, and improved taste have been released.

She is the brains behind the establishment of the first National Gene Bank in Laos. Now, she is involved with the Biodiversity Use and Conservation in Asia Program that aims to conserve plant genetic resources and at the same time strengthen farmer communities in Lao PDR, Bhutan, and Vietnam.

Truly, her efforts have not only invigorated the conservation of rice biodiversity; she has also provided skills that can be applied to the conservation of other crops, and made governments more aware of the impact of genetic erosion on plant genetic resources.

Mr. Santiaguel is an associate editor of Rice Today.

SKULL AND RICE decorate Dia de los Muertos festival in Mexico City.

ALEJANDRO DE LA CRUZ

Rice revival in the land of maize

by **Nathan Russell**

RICE production regions of Mexico.

ARROZ A LA tumbada, a popular Mexican mix of seafood and rice with other local ingredients.

MEXICAN RICE COUNCIL (2)

A FIELD of Milagro Filipino (IR8) in Nayarit State (star on map).

Anyone worried about the impacts of trade liberalization on developing-country rice sectors should take a close look at Mexico's experience and learn from a recent campaign—led by the Mexican Rice Council and its partners—to revive national production. That may sound like odd advice. After all, Mexico is not widely perceived as being strong on rice—a distinction that in Latin America goes instead to Brazil, Colombia, Peru, and others.

Maize gods, move over!

On the contrary, this is the country where, thousands of years ago, farmers domesticated maize, which was central to Mexico's pre-Columbian cultures and continues to be a mainstay of the national diet. More than half a century ago, Mexico also provided Nobel Peace Prize winner Norman Borlaug with an ideal setting in which to breed modern wheat varieties, which formed the genetic foundations of a global Green Revolution. Both crops are now the focus of a major initiative—called MasAgro—aimed at strengthening Mexico's food security, in which the International Maize and Wheat Improvement Center (CIMMYT) is working closely with the country's Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA).

Yet, within this country's original but eclectic culinary traditions, rice has also found a place of distinction. This began when rice was introduced from Spain during colonial times and came to fruition in the country's postrevolutionary period. As Mexican society quickly urbanized and incomes rose after the 1940s, more and more consumers turned to rice, because it offered convenience, while also contributing to a diverse and nutritious diet.

The simple dish of Mexican-style rice—prepared with a tomato sauce and generally served separately as *sopa seca* (dry soup)—thus became a standard feature of the national cuisine. Particularly in rural areas, it is hard to imagine a wedding or other family gathering without big clay pans of Mexican-style rice. The grain is used in more elaborate dishes as well, mixed with seafood and other local ingredients. It even takes the form of *orchata*, a refreshing drink made from boiled rice water with cinnamon, and a popular dessert consisting of *arroz con leche* (rice with milk).

Institutional green revolution

Mexico's rice production rose to meet increasing demand, reaching more than 800,000 tons on nearly 270,000 hectares by 1985.

The country's varied agro-ecosystems provide diverse, low-lying niches for irrigated and rainfed rice, giving farmers a welcome alternative for rotation with sugarcane and other crops. Today, rice cultivation is scattered across a dozen states, with four of them—Nayarit, Campeche, Veracruz, and Michoacán—accounting for about two-thirds of national production.

The worldwide Green Revolution in rice greatly boosted the production of the crop in Mexico, starting in the 1960s. Impressed with the high yields of IR8—the world's first modern semidwarf rice—growers quickly embraced the new variety, which had resulted from the work of Peter Jennings and others at the International Rice Research Institute (IRRI). Known in Mexico as *Milagro Filipino* or "Philippine Miracle," it is still the country's most widely grown rice variety.

So, just as a Mexican political party institutionalized the country's postrevolutionary socioeconomic program, farmers moved to institutionalize the Green Revolution in rice by making IR8 an enduring feature of the nation's diet and agricultural landscape.

Down but not out

Mexico's rice revolution lost ground, however, when the government began implementing trade liberalization policies in the 1980s. By 2013, domestic production had steadily declined to just 200,000 tons, while imports had expanded to 800,000 tons.

DR. JENNINGS, IRRI's first rice breeder, briefs visitors about IR8 in April 1966, just before it is released to Mexico and the world.

URBITO ONGLEO

Even as the country was flooded with cheap long-grain rice, Mexican growers clung to Milagro Filipino. The reason is that its medium-sized grain and special cooking properties had earned the loyalty of many consumers in central and western Mexico, securing a premium-price niche for this variety in the market.

The country's rice sector faced especially trying times in the wake of the global food price crisis of 2007-08, explained Ricardo Mendoza, CEO of the Mexican Rice Council, which receives support from both the rice processing industry and producers. The government reacted by eliminating rice import duties to avoid shortages. Several Asian countries—Pakistan, Thailand, and Vietnam—seized the opportunity by boosting rice exports to Mexico. This put even greater pressure on Mexican growers and also revealed how excessive dependence on rice imports was undermining national food security.

A comeback in the making

Mexico's rice sector has confronted this situation through a two-pronged strategy focused on (1) creating a fair playing field for the country's rice producers and (2) making the home team more competitive. The strategy's modest aim is to restore a prudent balance between domestic production and rice imports.

To this end, the Mexican Rice Council—together with the National Rice Production Committee and the National Council of Mexican Rice Producers—has made a strong case to the government for restoring a 20% duty on imported rice from countries with which Mexico does not have trade agreements. This will prevent dumping of cheap rice in the Mexican market. The measure is strongly supported by SAGARPA and is widely expected to be finally approved by the Economics Secretariat within the coming months, according to Mr. Mendoza.

He also believes that Mexico can be more competitive in rice production, especially if growers take up more productive long-grained varieties on a large scale. To this end, the country has introduced experimental rice lines from the International Center for Tropical Agriculture (CIAT) and the CIAT-supported Latin American Fund for Irrigated Rice (FLAR). Several new varieties developed from these lines by researchers at the National Institute of Agricultural, Livestock, and Fisheries Research (INIFAP) have been released recently.

The country's rice organizations have also obtained extensive training from FLAR scientists in improved management practices (including the use of water harvesting), which will narrow the gaps between the high genetic potential of the new varieties and their actual performance in farmers' fields. This is critical for giving Mexican rice growers a competitive edge in high-potential production areas.

"FLAR's integrated approach to crop management helped us a lot," said Mr. Mendoza.

If all goes well, he expects that, by 2018, Mexico's rice production should be able to meet 40% of demand. "We're hoping that 2015 will be the year of the turnaround," he said.

Mr. Russell is the head of Communications and Knowledge Management at CIAT.

MARY HENSLEY (*left*) and Victoria Garcia have teamed up to bring Cordillera heirloom rice to the world.

MARY HENSLEY

Women who moved mountains

by **Ma. Lizbeth Baroña-Edra**

The Cordillera heirloom rice from the Philippines has palates half-way around the globe coming back for more

The jostling streams and golden patches that paint the scenery tucked deep in the crevices of the Cordilleras in the Philippines are common places in the bustling communities nearby. But to those who have never set foot in this world, shaped by the arduousness of the terrain and richness of its traditions, the Cordilleras are anything but humdrum.

Mary Hensley, then a 22-year-old Peace Corps volunteer from Montana in the U.S., was one such person captivated by the land. Today, Ms. Hensley is the founder of Eighth Wonder Inc., which markets the traditional rice grown in the Cordilleras to the U.S., in partnership with the Philippines nonprofit RICE, Inc.

Ms. Hensley has not only brought the heirloom rice to the shores of the United States, but she created economic opportunities for what was previously regarded as a dying farming practice in the famed rice terraces that UNESCO declared a World Heritage Site in 1995.

And it all started with renewing old friendships in Kalinga Province, a familiar region where the Peace Corps had originally stationed her (see centerfold on pages 24-25).

Are you lost?

"It was usually the first question people asked me," recalled Victoria Garcia, executive director of RICE, Inc., which successfully linked heirloom rice to the market. Reaching out to the farmers was hard because of the fragmented communities nestled in different corners of the mountain range.

"At a waiting shed, I'd usually strike a conversation with farmers waiting for transportation," said Ms. Garcia. "My goal was to establish contact with one farmer and, eventually, he would take me to his relatives, and into their community. Sometimes, we went to farmers' meetings organized by the local government. But mostly, it was farmer-to-farmer outreach. Mary happens to still have friends in the areas where she served decades ago. So, we started with them."

"Hope pulled me in"

However, being accepted by the farming communities was just the beginning. "When the project started, it was like working with a clean slate," Ms. Garcia recalled. "There was almost nothing to start with. Farm-to-market roads were few and there was no electricity to run the milling machines. I talked to the Department of Public Works and Highways, to the National Irrigation Authority, to electricity providers. The idea of quality had to be taught to the farmers."

"There was a point in the beginning when Vicky said she could not do it," shared Ms. Hensley. "She found it daunting." But their common passion for community development got them through the moments of doubt.

"The farmers are really hopeful," said Ms. Garcia. "They understood that they have a chance to preserve their traditions and heirloom rice. Now, they have a reason to continue planting." The hope she saw in the farmers overpowered her initial reluctance. "I felt as though I was bringing the rain to them after a long time of living with parched dreams."

Momentum of partnerships

The two women found an ally in UNESCO Ambassador Preciosa Soliven, who was, at that time, advocating for the preservation and restoration of the rice terraces.

"Their advocacy was not gaining much traction," shared Ms. Garcia.

EXOTIC HEIRLOOM rice varieties from the Cordillera rice terraces of the Philippines now being purchased in specialty shops in the United States.

"So, in 2006, when I heard that there was going to be a UNESCO workshop, I decided to attend, uninvited, and shared the idea of marketing heirloom rice." At this point, partnerships started to take shape.

"Abraham Akilit, a former director of the National Irrigation Authority of the Cordillera Administrative Region and now mayor of the town of Bauko, immediately saw how the project complemented their work with farmer irrigators," said Ms. Garcia.

In 2007, OB Montessori School, through Ambassador Soliven, donated more than PHP 100,000 (US$2,000) to RICE, Inc. Ms. Garcia used the fund to have a milling machine custom-made for traditional Cordillera rice varieties. "Experts at the Bureau of Postharvest Research and Extension and the Philippine Rice Research Institute provided technical assistance," she said.

Culture is key

There is something romantic about the role heirloom rice plays in binding the indigenous communities of the Cordilleras. Reverentially selected and planted, their seeds are preserved and handed to the next generation. But to be part of the modern world, changes were necessary.

"Their rice is aromatic and beautiful. But the grains are of different sizes and broken," Ms. Garcia added. "We provided training activities on quality control so they could produce unbroken, uniformly sized grains. We trained them to be good entrepreneurs. We taught them skills such as keeping tabs on how much they produce and managing their product.

"Being sensitive to the culture of the different farmer groups is key to engaging them," she added. "We want them to be better farm managers but without losing their identities and traditions."

When orders poured in, farmers were asked to make "pledges." The project shied away from getting "commitments" from the farmers, as this gives a sense of being "forced" to produce something. "The concept of preparing and processing more rice than they need for a couple of days is new to them," said Ms. Hensley.

"We made them understand that a `pledge` is something they are free to make," Ms. Garcia explained. "We made them understand that someone wants to buy their rice and that it will help their families."

One of the good things that came out of this project was that the Department of Agriculture has institutionalized technology transfer sensitivities to the Cordillera farmers. "The government now recognizes that it must support the traditional way of farming" she said.

Ms. Garcia and Ms. Hensley are now working with the Heirloom Rice Project, funded by the Department of Agriculture and led by the International Rice Research Institute (IRRI). The Project seeks to widen the initial marketing success of Rice, Inc. and Eighth Wonder and bring the production of heirloom rice to the attention of the national government for developing policies for the industry. The Heirloom Rice Project will also systematically characterize traditional varieties of the Cordilleras and conserve them.

"A very important part of the project is helping farmers produce quality heirloom rice seeds, which help produce more for the market," said Dr. Casiana Vera Cruz, a scientist at IRRI and overall leader of the Project. "We want to empower highland smallholders to manage their own enterprise, conserve their rice biodiversity, and preserve their cultural heritage."

"We are excited to build upon the successes of Vicky and Mary," said Dr. Digna Manzanilla, project co-lead and coordinator of the Consortium for Unfavorable Rice Environments at IRRI. "The Heirloom Rice Project, which pulls together government agencies, local government units, state colleges and universities, farmers' groups, and private entities, stands to learn from their experiences in how to make the value chain work."

The future of ancient rice

When Ms. Hensley and Ms. Garcia started their project, they were told that they would fold up after 3 years. Now, they are in their ninth year of providing a sustainable livelihood to farmers in one of the most marginal rice ecosystems in the country. In 2013, 29 tons of Cordillera heirloom rice were shipped to the United States, valued at $38,079. This year, 19 tons valued at about $26,000 have been produced.

"We're working with 272 farming families," said Ms. Hensley. "There are about 100,000 of them in the region. There is a long way to go."

"I believe that the farmers in the project have found a new sense of pride in their culture and their work," said Ms. Garcia.

That pride is palpable as one traverses the mountainsides of the Cordilleras—and it will save the treasured heirloom rice of the mountains.

Ms. Baroña-Edra is a science communications specialist at IRRI.

Harvest time in Kalinga Province in the mountainous Cordillera region of the northern Philippines. Kalinga is one of the original regions of the Heirloom Rice Project designed to help local farmers increase production and assure the quality of their unique indigenous rice varieties.

Fire for rice: The origin of Ifugao Tinawon

Retold by **Ana Dulnuan-Habbiling**
Carvings by **Albert Magguling**

A tale on how the Ifugao tribe in the Cordillera region of the northern Philippines got hold of the Tinawon rice from the god of the Skyworld

©EIGHTH WONDER, INC. (3)

There once lived two young brothers, Wigan and Kabigat, who lived with their father, Pudol, in Kayang, a prosperous village in Kiyangan. The gods blessed them with a good life, plenty of chickens, pigs, ducks, dogs, and other precious possessions.

Upon learning from their father that the dogs were for hunting wild animals, the brothers prepared for a hunting trip. When everything was ready, they fastened their scabbards to their waists, tucked in their betel nut bags, carried their backpacks, pulled out their shining sharpened spears and then departed with their dogs.

Upon reaching the hunting grounds, they let loose the dogs that ran barking and chasing the wild animals, among them wild pigs. When the brothers noticed that the dogs were chasing their quarry towards Kabunyan, where Liddum, a god of the Ifugao resides, they decided to follow closely fearing that they might lose them.

Tracking the footprints of their dogs and quarry, the brothers entered Kabunyan. The quarry, a wild pig, went straight to a bamboo grove in the backyard of Liddum.

The brothers took aim with their spears and hit the wild pig. The whimper of the dying pig prompted Liddum and his people to come around and investigate. When Liddum saw the slaughtered animal, he confronted the brothers and accused them of killing his people's pig.

"The animal we killed came from the jungle of Kiyangan and our dogs had chased it into Kabunyan," Wigan explained humbly to Liddum. He pointed out the physical differences between the wild pigs of Kiyangan and those of Kabunyan. "The snout of the wild pigs of Kiyangan is longer and more pointed than the wild pigs of Kabunyan," he said.

Liddum, being the god who blessed them with many animals, knew that to be true and he accepted Wigan's explanation and made peace with the brothers.

Wigan explained further that most people of Kiyangan hunt these wild pigs for their food

Then the two brothers cut their quarry and shared some with Liddum and his people. Much to the brothers' surprise, Liddum and his people quickly gobbled up their share of meat together with uncooked rice. They realized that the Kabunyan people eat their food raw.

Wigan decided to show them how good cooked food tastes. He quickly brought out his flint with a special stone and produced fire from it. He cooked the meat of the wild pig and some rice, which he had asked from Liddum, in bamboo tubes.

When the meat and the rice were cooked, the brothers invited Liddum and his people to eat with them. The Kabunyan people found the aroma of the cooked food very appetizing. They also found out that cooked rice was so filling that a small portion is enough to make them feel full and satisfied. They were really amazed.

"Fire can make food taste so good," said Wigan.

Because of the good taste of the cooked food, Liddum wanted to have their fire. He offered them some of his pigs, chickens, gold, and other possessions in exchange for the fire. But the brothers refused all of it saying that they had plenty of those things in their home in Kayang. What they actually wanted was Liddum's aromatic large grain rice variety that they found to be more filling and satisfying compared with their rice in Kayang.

So Wigan asked Liddum if he would trade his aromatic large-grain rice for their fire. Liddum was delighted by the offer because the fire meant so much to him and his people.

"That was a smart idea," Liddum said to Wigan, "It is true that you have plenty of rice in Kayang but it is the upland rice with no ritual and thus it does not last long. Your big granaries are filled with your harvest but they would only last for two months unlike our Skyworld rice that would last a whole year."

Liddum, god of the Skyworld and the god of plenty, traded his aromatic large-grain rice variety to Wigan of Kiyangan for fire. But before Liddum handed them two bundles of the Skyworld rice, he first taught them the rice rituals and earnestly told them that it is important to perform these rituals starting from the sowing of the rice seeds up to the postharvest.

"By observing the rituals properly and religiously this rice variety with its aroma and good taste will be free from rice pests and diseases," Liddum said. "And there will be a good harvest that will last the whole year round."

Wigan and Kabigat thanked Liddum and promised him that they would perform the rice rituals in caring for the Skyworld rice.

Before the brothers went home, they taught the Kabunyan people how to produce fire and how to cook food using the fire. To show his gratitude for the generosity of Liddum, Wigan built a fireplace and cooking place for Liddum.

Then the brothers went home feeling good and proud. They had not only brought home wild pig meat but also a wonderful rice plant.

The brothers planted the Skyworld rice in their field in Kayang, propagated it, and shared the seeds with other Ifugao people. As the people tasted it and experienced its satisfying effect, many built rice fields across the mountain slopes and wherever else possible just to plant the Skyworld rice plant. Until now, this is the only rice variety that the Ifugao planted in their rice fields.

Because the Ifugao people believe that it came from Liddum of Kabunyan, they sometimes call it the Skyworld rice. Today, it is commonly known as Tinawon rice, which means "planted only once a year."

Ms. Dulnuan-Habbiling is the matriarch of an Ifugao farming family. There are different local fables of how Tinawon rice came to be. Excerpts from this version are the closest to her beliefs. See the full story at www.heirloomrice.com/pages/Story_of Tinawon.pdf

GENE HETTEL

VISITING HEIRLOOM demonstration plots at the International Rice Research Institute during Farmers' Day on 1 October, Ms. Dulnuan-Habbiling spotted one of the glutinous Tinawon varieties that she grows in her fields--a descendant of Liddum's Skyworld rice no doubt.

What's cooking?

by **Amy Besa**

JEO NARCISO (3)

Fried Ominio rice à la Purple Yam

The Purple Yam is a restaurant in Brooklyn, New York, founded in 2009 by me and chef Romy Dorotan, with a branch in Manila in the Philippines. The restaurant specializes in the culinary heritage of the Philippines infused with modern innovative flair and influences from other Asian countries, particularly Korea. In a 2009 review, the *New York Times* described dining at the Purple Yam, for dishes such as its *adobo* and *halo-halo*, as "something worth experiencing."

Ominio fragrant rice is a medium-grain variety cultivated in the rice terraces of Mountain Province and Ifugao Province in the Central Cordillera Mountains in northern Philippines. This heirloom rice has a deep violet or black color and is the preferred variety of the indigenous people in the area for making rice desserts and rice wine. Ominio has been included in the Ark of Taste, an international list of endangered heritage food from different countries.

In the 1990s, I was introduced to heirloom rice and was asked to help develop a market in the U.S. For me, it was a no-brainer because organic heirloom rice passes my standards of quality ingredients. Heirloom rice is healthy—packed with nutrients and flavorful. In fact, it is so flavorful that, at my restaurants, heirloom rice is not an accompaniment but is considered as a dish.

My mantra is that, if we want to preserve heirloom rice, we should eat and cook with it on a daily basis. Preserving it is not just keeping it and treating it just as an interesting factoid. Eating it and bringing it back to the table will take heirloom rice out of anonymity and hence increase its commercial viability.

In turn, patronizing heirloom rice will increase farmers' incentive to grow it and help them earn a lucrative livelihood.

I am is also espousing establishing a link between farmers and consumers. Farmers should know who will be eating their product. And, it is the responsibility of a diner, a restaurateur, and a home cook to know the amount of work it takes to produce a grain of rice. If they understand how rice is produced, they won't throw away a single grain of rice. They will respect not just the product but the farmers who grew it.

Ingredients

- 300 grams Ominio rice (preferably day-old or slightly cooked)
- 50 grams carrots, diced
- 50 grams white onions, sliced
- 50 grams green peas
- 50 grams corn kernels, steamed
- 4 cloves garlic
- 2 tablespoons turmeric oil
- 1 egg
- Salt and pepper to taste

Directions

1. Rinse uncooked rice in a pot with water and drain. Do this several times until the water becomes clear.
2. Cook the rice in a pot with equal parts water. As soon as the water starts to boil vigorously, put a lid on the pot and turn the heat down to low. Simmer for 20–30 minutes until all the water has been absorbed and the rice is tender. The rice can also be cooked in a rice cooker using equal parts water. (Note: This can go up to 40 minutes depending on the moisture content of the rice grains. If the grains are newly harvested, they will not require as much water and as long a time to cook, but if the grains have been stored for a while, they will need a little bit more water and longer cooking time.)
3. Spread the cooked rice on a tray to cool down and dry off some of the excess moisture. Set aside.
4. Dice the carrots and white onions. Crush the garlic. Rinse the green peas.
5. Steam the corn in the husk and then remove or scrape the kernels from the cob.
6. In a wok, heat the turmeric oil with crushed garlic over medium-high heat.
7. When hot, add the carrots, onions, and corn kernels. Sauté until translucent and soft.
8. Add the cooked Ominio rice and mix well with the vegetables. Add the green peas.
9. Crack the egg directly over the rice and mix thoroughly.
10. Add salt and pepper to taste and serve immediately.

In a YouTube video, watch the Manila Purple Yam's sous chef, Rap Cristobal (lower inset photo), demonstrate how to make a tasty fried rice dish using the heirloom Ominio (violet) variety: http://youtu.be/9rU0r_0Ezmo.

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Adding value to Africa's rice

by **Savitri Mohapatra**

Africa researchers are looking at every step rice goes through to lessen wastage and improve its value to help raise income, improve rice quality, and expand the market for locally produced rice products.


1


2


3

R RAMAN, AFRICARICE (4)


4

1. **GHANAIAN CONSUMERS perceive imported rice to be of higher quality than locally produced rice. A scene from a local rice market in Accra, Ghana.**
2. **LOCAL FABRICATORS in target countries are being trained to build and maintain mini combine-harvesters that will help rice farmers do timely harvesting and threshing.**
3. **MCGILL UNIVERSITY is providing technical backstopping to national partners to develop parboiling equipment to produce high-quality parboiled rice.**
4. **THERE IS demand for the new rice-based weaning food developed by the Food Research Institute, Ghana.**

About one-third of the food produced in the world never reaches our plates. Not only is this a colossal loss but all the resources used to produce, harvest, process, and market it are also squandered.

Postharvest grain losses account for US$4 billion in Africa alone, according to the CGIAR Research Program on Climate Change, Agriculture and Food Security. This is enough to meet the minimum annual food requirements of 48 million people.

In Africa, both the quantity and quality of rice suffer huge losses, especially during postharvest operations.

"The qualitative losses come mainly as a result of poor handling after harvesting and poor processing techniques," wrote John Manful, a grain quality scientist at the Africa Rice Center (AfricaRice) in *Quality matters for rich and poor alike.* (Read Dr. Manful's full article at http://sn.im/quality-matters)

Quantity versus quality

Until recently, R&D thrusts in Africa have focused mainly on how to increase rice production but relatively less on how to improve the quality of rice.

"Since the food crisis in 2007-08, governments in African countries have made great efforts to increase rice production, but still quality is less emphasized," said Dr. Rose Fiamohe, policy economist at AfricaRice.

In many African countries, locally milled rice is of variable quality and it has a high percentage of broken grains. Sometimes, unhusked grains as well as bran and husk fractions are found in the milled rice. The inferior quality of local rice makes it less competitive against imported rice on the market. Thus, African rice farmers find it so difficult to sell their rice because locally produced rice is widely perceived as being of poor quality.

"If you raise the production of local rice but you are not doing anything to change the perception of the people, you will not progress much in promoting local rice consumption," said Ms. Lena Forson, doing an MPhil student at the University of Ghana.

However, Africa's rice sector is now more aware that producing just more rice is not enough and that quality is essential. To be competitive, Africa's rice sector needs to make rice quality and marketing important.

The postharvest challenge

Rising to the challenge, Canada's Department of Foreign Affairs, Trade and Development (DFATD) and AfricaRice, in partnership with McGill University, are spearheading an ambitious project on food security in Africa with a focus on rice postharvest handling and marketing.

The project involves Cameroon, Gambia, Ghana, Mali, Nigeria, Senegal, Sierra Leone, and Uganda. It seeks to introduce improved harvesting and postharvest practices and equipment throughout the value chain to achieve high-quality grain.

More smallholder farmers and processors in Africa's rice sector are women who often have fewer rights than male farmers to access the vital resources they need to farm, process, and sell. The project will therefore make sure that women farmers will obtain their fair share of attention in rice R&D.

The project also aims to develop new rice-based products, explore innovative uses of husks and straw, improve the policy environment, and build the capacity of rice stakeholders. By 2020, postharvest losses are expected to decline by 10% and this will help increase farmers' nominal annual income in the eight project countries by about $32 million.

The project has conducted baseline studies on postharvest practices in the eight countries. "This is the first of its kind for rice in Africa," said Dr. Manful. "We now have reliable data on postharvest losses in rice from these countries."

Surveys are being conducted to develop a map of rice consumer preferences for some of the countries. Project countries have been provided with lab equipment to do basic quality analysis of rice.

The project is testing and introducing mini combines, threshers, dryers, and cleaners that are affordable for farmers and processors. Most of these machines are being made and maintained locally. Senegal, Mali, and Ghana have started building mini combines after receiving training. Milling machines that will improve the separation of husk and bran are also being identified.

"Each project will have national fabricators; we train one lead fabricator who will continue training others," said project coordinator Dr. Jean Moreira.

In 2013, 57 fabricators from 10 countries were trained to construct the ADRAO-SAED-ISRA (ASI) thresher-cleaner. A light thresher has also been developed especially for women farmers in Uganda.

The project has promoted the development of equipment for parboiling. McGill University is providing technical backstopping to national partners to develop a parboiling pilot plant.

New rice-based products in Africa

Also, the project will enable screening of African rice (*Oryza glaberrima)* germplasm for constituents that make cereal grain slow-digesting to help consumers with Type II diabetes. It is also testing the use of low-value broken rice as the basis of a breakfast porridge fortified with protein-rich groundnut or soybean for undernourished babies and children.

The project is using flour from broken rice to prepare food products such as noodles, biscuits, and porridges. "Tasty and innovative uses of rice can catalyze rural enterprises and raise income, especially for women farmers and processors in our region," said Ms. Lynda Hagan, scientist at the Food Research Institute (FRI) in Ghana.

Reusing waste products

Rice straw: Farmers in Africa mostly dispose of rice straw from fields by burning it, which helps control rice disease and pest problems. However, burning of rice straw emits carbon dioxide (CO_2), which is the major cause of global warming.

As part of the project, AfricaRice, in partnership with FRI, is supporting a study in Ghana to assess rice straw and husk as potential substrate in cultivating oyster mushroom. The study also ascertained the potential of the spent compost (the organic matter left over after mushrooms grown on rice straw have been harvested) as a biofertilizer.

Rice husks: Traditionally, rice husks (or hulls) are wasted in Africa. Stockpiles of rice husks are either dumped near the mills, where they rot, producing methane (a potent greenhouse gas), or burned in the fields, thus polluting the atmosphere.

The project has developed a machine to compress rice husks to make briquettes, which burn efficiently in any well-ventilated stove. "This, we think, is an important step in reducing deforestation," said Dr. Sali Atanga Ndindeng, grain quality and postharvest scientist at AfricaRice.

Rice policy

The project will feed into AfricaRice's ongoing efforts to harmonize rice policy across the region through the regional economic communities.

"In the long run, rice will be cheaper when the continent is producing most of its rice from here," remarked Dr. Aliou Diagne, former program leader of Policy, Innovation Systems and Impact Assessment at AfricaRice.

Scientists are working with producers to improve quality and processing, while also working with consumers to encourage them to buy local rice. Experimental auctions have revealed that consumers choose local rice and are also willing to pay more for it.

Building capacity in rice postharvest technology

Building the capacity of rice stakeholders throughout the value chain, from farmers, through millers and parboilers, to marketers is a vital part of the project.

"We have had lots of cross-fertilization of ideas and scientific outputs thanks to the project," observed Dr. Paa Nii Johnson from the Council for Scientific and Industrial Research in Ghana. "Some of the success stories can be replicated and scaled up through the Rice Hubs network initiated by AfricaRice."

By helping actors along the value chain add value to rice, the project is helping raise income, improve rice quality, and expand the market for locally produced rice products.

Ms. Mohapatra is the head of Marketing and Communications at AfricaRice.

THE NEW GREEN REVOLUTION:

A bigger rice bowl

ISAGANI SERRANO (2)

Another green revolution is stirring in the world's paddy fields

A seed of rice that could transform the developing world saved Asha Ram Pal's farm in the Indian state of Uttar Pradesh in the summer of 2008. Mr. Pal had planted rice on his small plot, not much bigger than a football field. Floods are an ever-present threat in the state, making it one of the poorest places in the world. And that year the monsoon was particularly heavy, remembers Robert Zeigler, director general of the International Rice Research Institute (IRRI). Mr. Pal's fields flooded for two weeks after he planted the rice seedlings; a few weeks later, they were inundated again. He thought his crop was lost. His neighbors advised him to do what they have always done when the floods come: prepare for hunger.

But this time Mr. Pal had planted an experimental seed developed by scientists from IRRI in the Philippines. The seed has a genetic sequence bred into it, which puts it into a sort of suspended animation when submerged. Instead of drowning, Mr. Pal's rice sprang back when the water receded. In a normal year, he gets a ton or so from his one-hectare (2.5-acre) plot; in a bad year nothing. In that terrible flooded season, he harvested 4.5 tons—as good a yield as on any rainfed paddy in the world.

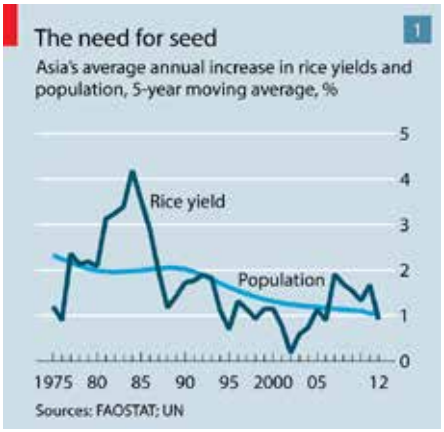
Flood-tolerant rice is now spreading as fast as the waters themselves. Five years after the first field trials, 5 million farmers across the world are planting more than a dozen varieties of rice with flood-resistant genes, collectively called Sub 1. They are proliferating even faster than new rice varieties during the heady early days of the first green revolution in the 1960s. "And Sub 1 is the first of a new generation of seeds," says Dr. Zeigler. If all goes well, over the next few years plants that tolerate drought, salinity, and extreme heat will revolutionize the cultivation of mankind's most important source of

IRRI

MR. ASHA Ram Pal's rice field, Palia Goa village, Faizabad district, Uttar Pradesh, India.

FLOOD-TOLERANT Swarna-Sub1, a variety that can survive full submergence for more than 2 weeks. is changing the lives of farm families who must grow their rice crop in flood-prone areas of eastern India.

ADAM BARCLAY



calories. But that will depend on the technology working as promised and, in particular, on public policies that support a second green revolution. Neither is guaranteed.

The first green revolution helped save the developing world from disaster. Two plant breeders, Dr. Norman Borlaug with wheat and Dr. M.S. Swaminathan with rice, persuaded governments in Asia and elsewhere to encourage the planting of higher-yielding varieties, especially of rice; 3.5 billion people, half of mankind, get a fifth of their calories or more from the stuff. When the men started work in the early 1960s, China was suffering the famine of the Great Leap Forward. And India was widely thought to be on the brink of starvation.

Today in Asia, famines are things of the past. One reason is the spread of democracy. Another is the green revolution, which has ensured that there is plenty of rice—India even exports it. And demand seems to be shrinking: the richest Asian countries, Japan, Taiwan, and South Korea, are eating less rice. This has led governments, which once supported the green revolution, to think that a new one would be unnecessary. Rice, they reason, is a problem that has been solved. Better to improve the diets that are causing obesity or change the intensive-farming practices that are damaging the environment.

But it is not clear that the mission has been accomplished. In Asia as a whole, consumption per person is flat, not falling. The population is still growing, so demand for rice is rising on the continent where 90% of the crop is raised. In Africa, where a third of the population depends on rice, demand is rising by almost 20% a year. At that rate, rice will surpass maize as Africa's main source of calories within 20 years.

Seeds of stagnation

As a rule of thumb, if the world's population grows by 1 billion, an extra 100 million tons of rice is required to feed them. Given current world-population forecasts, total rice consumption, now under 450 million tons, is likely to grow to 500 million tons a year by 2020 and to 555 million by 2035—an increase of 1.2–1.5% a year. That would be manageable if rice yields were also growing at that rate. But they are not. They are rising at barely half that pace.

The first green revolution almost doubled yields from 1.9 tons per hectare in 1950-64 to 3.5 tons in 1985-98. Even that was only enough to keep pace with population growth: yields and population rose at the same rate (1.75% a year) in the half century after the green revolution started.

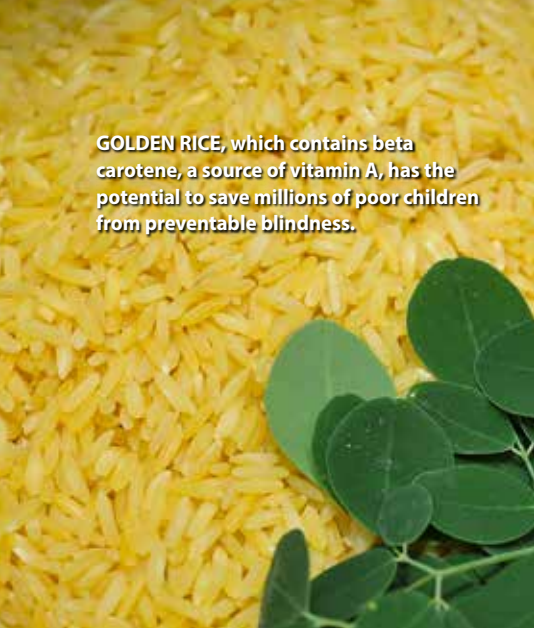
Now the gains seem to have leveled off. Plant breeders fear that, with current technology, 10 tons per hectare for rice in intensive-farming systems may be the limit, though it is not clear why. What is clear is that, out in the fields, output per hectare is stalling, and in some places falling.

For over 50 years, IRRI has been planting a field using its best seeds. The field itself has remained much the same: the bugs and microbes that live in the roots of the rice plant mean that soil fertility is maintained even if three crops are grown each year. But output from the plot has fallen from 9 to 10 tons a hectare in the early 1990s to 7 to 8 tons now, as pests and diseases have taken their toll. Rice yields were rising at 2.5% a year between 1962 and 1982. But between 1992 and 2012, growth fell to just 0.8% a year (see chart 1).

The facts of rice

Without new seeds, yields will decline further. Global warming will tend to push harvests down: higher night-time temperatures are associated with lower yields. The richest rice-growing areas in the world are the deltas of Asia's great rivers, such as the Mekong, Brahmaputra, and Irawaddy; they are vulnerable to rising sea levels and increased salinity, which kills rice. The plant uses two to three times as much water as other cereals (largely for leveling the paddies; the plant itself consumes no more than wheat or maize), but water is scarce everywhere. And each year, the spread of Asian—especially Chinese—cities converts millions of acres of good rice-growing land into buildings and roads.

The consequences could be momentous. Rice plays a role in Asian societies that is hard for outsiders to appreciate. (A small example: Toyota means "bountiful rice field" and Honda means "main rice field.") In the river basins that are the world's rice bowls, nothing else will grow with the same productivity. It is rice or nothing, and if there are problems with rice, there are problems with



GOLDEN RICE, which contains beta carotene, a source of vitamin A, has the potential to save millions of poor children from preventable blindness.

everything. A rice shortage would have geopolitical implications. No Indian or Chinese government could contemplate the possibility with equanimity. They would do whatever it takes to ensure they have enough rice. If this pushes up world food prices, so be it. If they must twist the arms of exporting countries, they will. If Asia's giants feel insecure, their neighbors will tremble.

So a lot is riding on boosting rice yields. But how likely is it that a second green revolution will take off?

The first was a relatively simple affair, technologically at least. Conventional rice varieties were long and leggy. If you gave them fertilizer, they grew too tall and fell over. That changed in 1966, when IRRI released a semidwarf variety called IR8. Because its stem was short, it was able to absorb fertilizer without collapsing. So now farmers had a crop they could feed. And with stem growth restricted, more of the increase in plant size went into the head of seeds (called a panicle). IR8 spread from the Punjab to the Philippines, transforming farming wherever water could be controlled and fertilizer delivered.

The second revolution will be different. Farmers will not adopt a single miracle variety. Instead, researchers will tailor seeds for particular environments (dry, flooded, salty, and so on). And they are also trying to boost the nutritional quality of rice, not just the number of calories. As a result, the second revolution will be felt most profoundly in the poorest areas and among the poorest farmers. In contrast, the first had the biggest impact in the richest fields, with the most water and fertilizer.

The flood-tolerant trait that rescued Mr. Pal's crop was first identified in the 1980s, in a few old-fashioned varieties native to Odisha, another flood-prone state in eastern India. After more than a decade of false starts, plant scientists identified the genes that make the Odisha varieties flood-tolerant. They went back to IR8's descendants, spliced these genes into them and bred from the result. Having spent years getting nowhere with traditional plant-breeding methods, scientists went from marking the genetic sequence to producing flood-resistant seeds in 4 short years.

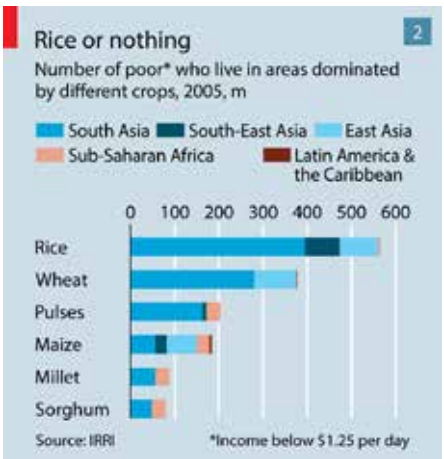
Dr. Abdelbagi Ismail, a principal scientist at IRRI, hopes to do the same for other traits that have so far eluded breeders, such as drought tolerance and heat tolerance. High temperatures during rice flowering can lead to sterility. If it is too hot, the anthers of the plant, which contain the pollen, do not open properly; the pollen is not released, the stigmas are not pollinated and the crop is lost. The problem occurs during the hour or so when the plant flowers. It could be overcome if it were possible to encourage rice to flower in the cool of the early morning—as opposed to scorching midday, its usual hour. Dr. Tom Ishimaru, who works at IRRI and the Japan International Research Centre for Agricultural Sciences, has found a gene which codes for early-morning flowering, raising hopes of solving the problem.

Such breeding programs will not have the same dramatic impact that IR8 did. But developing miracle seeds is not the only way to boost yields. During the 1990s, China did it by improving hybrids: crossing different lines to combine the advantages of both. This is the usual way of improving maize, but it is less common with rice. Unlike maize, rice breeds true in successive generations, so farmers can retain seeds from one harvest and plant them for the next. Farmers will switch if a new variety gives them a big one-off boost, but not just to get the small increments offered through hybrid improvements. Hence, it takes a long time to boost yields using hybrids—unless the government forces farmers to use new seeds. China's rulers could do that; less authoritarian regimes cannot.

Cereal killers

China's experience shows that a series of small improvements can add up to something large. This will be true of the second revolution on the poorest lands. The first green revolution had most impact on irrigated land and, thanks to it, the 80 million hectares, which are irrigated (an area equivalent to Vietnam, Laos, and Cambodia put together) now have yields of 5 to 6 tons a hectare; they produce three-quarters of the world's rice. But there is nearly as much rice land which depends on rainwater. Yields there are far lower—between one and two and a half tons a hectare—and rainfed lands produce only a quarter of the world's rice. Yields are low because almost half this land is prone to drought and a third to floods. Most African paddies fall into this category, which is why the first green revolution passed Africa by.

Drought- and flood-tolerant seeds could double yields from these areas. That would boost harvests from 110 million to 220 million tons, and push global output to 550 million tons—enough to meet expected demand in 2035. In short, all the extra rice could come from rain-fed areas alone.



Because yields on rainfed lands are low, even a doubling would not increase total production by as much as the first green revolution did. But the impact on poverty would be greater. More than 500 million of the absolute poor (those with US$1.25 a day or less) depend on rice, far more than on any other food (see chart 2). A disproportionate number of them live in northeast India, Bangladesh, and the Irrawaddy Delta of Myanmar. In these areas the lowest castes and tribes have been forced onto the worst lands.

Those are the very places where the second green revolution would make the biggest impact. Flood-tolerant rice "differentially benefits [India's] scheduled castes and tribes", a recent study of one of the early field trials concludes. If these improvements were combined with another program to boost the nutritional quality of rice—the so-called Golden Rice project which genetically modifies rice to include vitamin A—then the benefits to some of the poorest people in the world would be vast.

The first green revolution did not improve people's livelihoods just by providing technological fixes. It did so because the new seeds attracted new capital into farming, encouraged mechanization, credit markets, new management techniques and so on. The second revolution will also do this. Already, rice farming is changing faster than for generations. Age-old habits of raising seedlings, transplanting them into the fields and threshing, drying and storing the plant are being rejected. Now, seeds are planted directly into the field by machine and everything from threshing to milling is done by specialist firms. For such changes to become more widespread, though, incentives and policies need to push in the right direction. Alas, they don't all do so.

On the face of it, the second revolution is subsidized. Not only do governments finance the basic research. In many Asian countries, from rice importers such as Indonesia to exporters such as Thailand, they

JOSE RAYMOND PANALIGAN

RICE IS the staple food of nearly half the world's 7.2 billion inhabitants.

also pay farmers above the world price. Thailand's scheme is so generous that it ran out of money this year. Such price distortions artificially boost demand for green-revolution seeds in the short run.

But high domestic prices are also bad for the economy. They impose heavy costs on consumers. And they undermine incentives to export, making world prices more volatile and international markets thinner. This hurts farmers who stand to gain from the shift of comparative advantage in rice-growing towards India and Bangladesh thanks to the second green revolution. If world trade becomes even more marginal, any advantage those countries gain will be muted.

High domestic prices also tend to drive up local wages, reducing the competitiveness of manufacturing and making rural labor dearer. And by making rice farming a safe bet, the policies blunt entrepreneurship in agriculture too, reducing farmers' incentives to invest in new machinery and new ways of farming. On balance, therefore, artificially high rice prices make the new generation of seeds attractive, but by less than one might expect.

LANIE REYES

SMALL FARM size in much of Asia has hindered the adoption of mechanization and other technologies.

Land-use policy is equally messed up. In America and Europe, technological change has tended to make farms bigger. The bigger the operation, the greater the gains from technology. That has not happened in Asia. In the most productive irrigated areas, farms are often smaller than two hectares and, despite mass migration from the countryside, have been getting even smaller during the past three decades. Governments have intervened to prevent farm consolidation partly because they want to slow down urbanization, fearing that it could drive up unemployment in cities. Such policies have only not done considerable harm because of an extraordinary proliferation of efficient rental markets.

The original green revolution transformed Asia from a continent stalked by hunger into one that could think and plan beyond the next harvest. It helped lay the foundation for the continent's economic miracle and made possible Asia's demographic transition from high fertility and high mortality to smaller, richer families. The second green revolution will not do that. But it should complete the first one, mainly by bringing benefits to the poorest, who missed out first time around. It will help mechanize and move more people off farms and into more productive labor. And it should prevent Asia slipping back under the shadow of hunger and all the political and social disruptions that such misery causes. Few other things can promise as much.

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Rice on the move

by **Lorena Villano, Charles Johnson, Andy Nelson,** and **David Dawe**

Understanding and visualizing trends in rice-producing countries is a major task of the Geographic Information Systems (GIS) laboratory at the International Rice Research Institute (IRRI). Inspired by a demographic concept of "center of population" as used by the United States Census Bureau, among others, we trace the shifts in the center of a country's rice area over time and try to understand the reasons for the shifts (climatic, political, or market-driven), as well as possible future shifts and their implications. We illustrate with provincial data for single- and double-cropped rice in China (1981-2010) and state data for kharif- and rabi-season rice from India (1962-2010).

In China, the center of annual rice area has shifted northward by some 300 kilometers from Hunan to Hubei Province over 30 years. Overall, the area has decreased slightly. But this hides two distinct and opposite trends.

The center of one-crop-per-year rice area has shifted northeast by more than 450 kilometers into northeastern Henan Province and, over time, the area has increased substantially. One reason for this is increasing demand for japonica rice (as Chinese consumers become wealthier). Moreover, new japonica rice areas have opened up in the far northeastern provinces, and temperatures have become warmer.

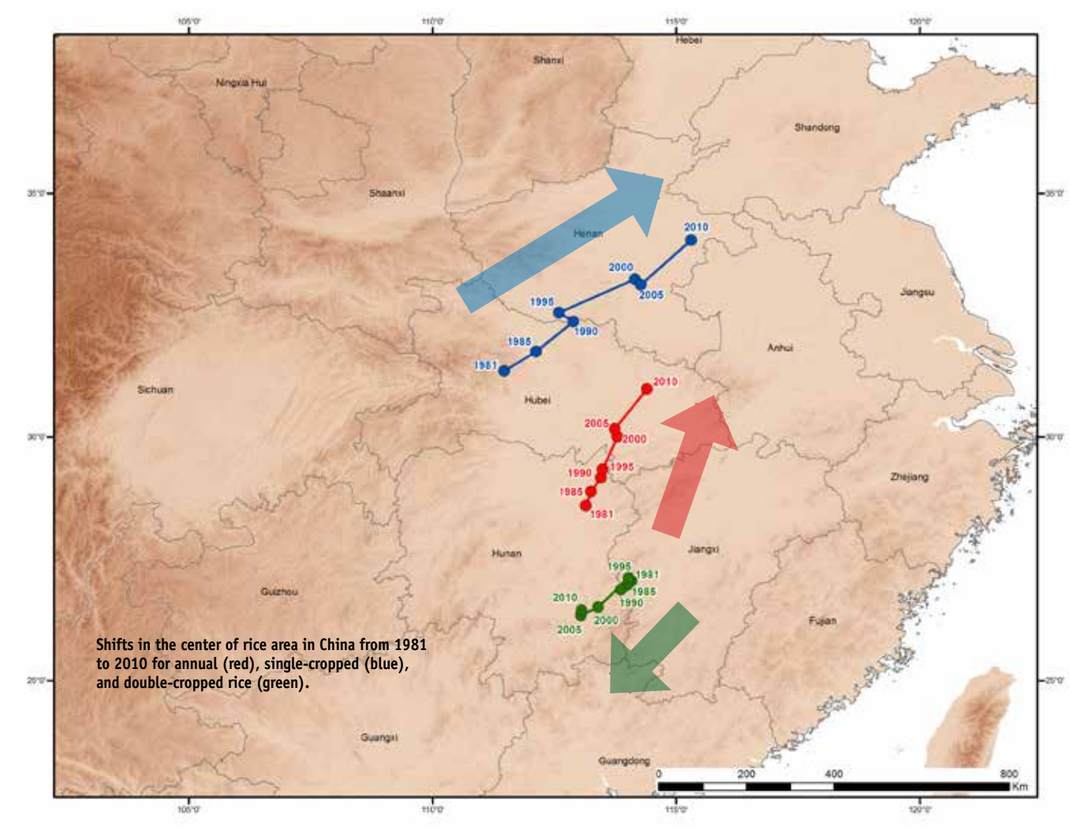
The area planted with two crops per year has moved in the opposite direction by about 120 kilometers into Hunan Province and has shrunk dramatically because of labor shortages. Rice farming has been abandoned or has shifted from two crops to one crop per year in provinces such as Zhejiang, Anhui, and Jiangsu. Double cropping is declining everywhere in China, but it is increasingly concentrated in Hunan, Jiangxi, Guangxi, and Guangdong, which now accounts for 83% of double-cropped area (compared with 61% in 1979).

In India, the area for both wet and dry seasons is increasing. The wet-season crop (kharif) has moved to the northwest by some 180 kilometers over 50 years and has increased slightly. Although area in the far south (Tamil Nadu and Kerala) is declining, large areas in the northern states of Punjab, Haryana, and Uttar Pradesh are expanding. Some of this is due to increased irrigation investment in the north, and may also be due to warmer temperatures pushing the rice area slowly northward. The smaller rabi-season crop has grown massively because of irrigation expansion (especially groundwater irrigation in West Bengal) and has raced in a northeasterly direction by around 530 kilometers from Andhra Pradesh into Odisha.

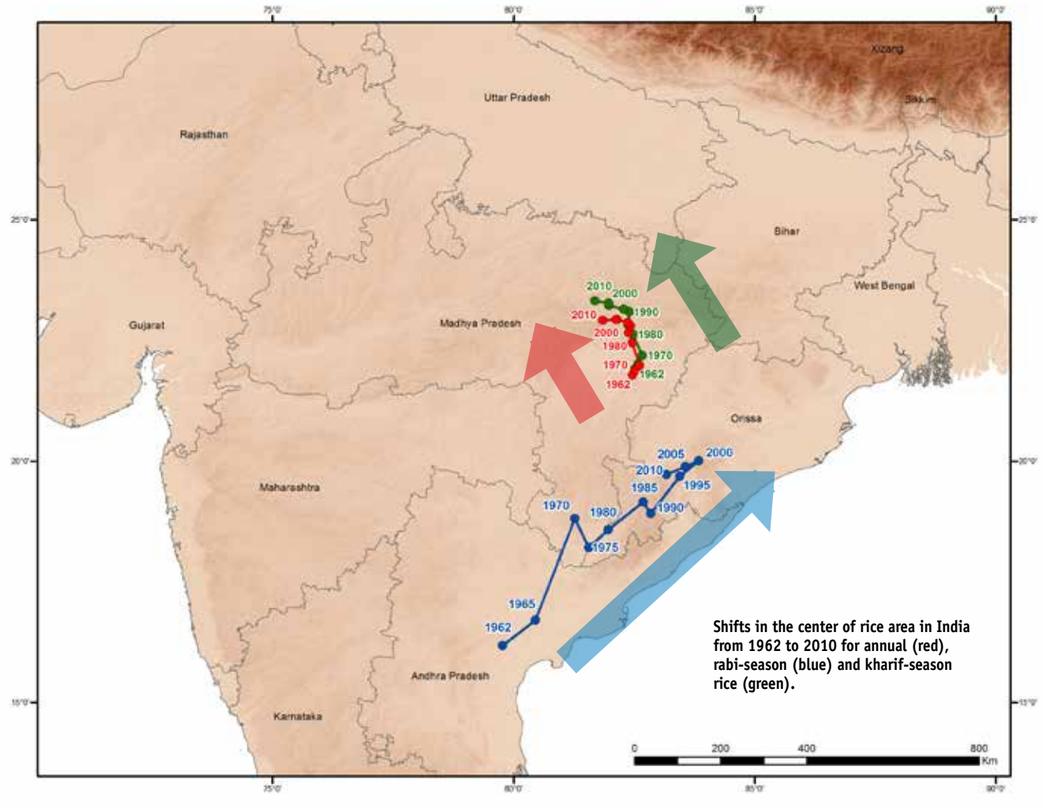
The trends in China are likely to continue as the underlying drivers of economic growth and perhaps climate change continue. In India, the trends may change because of water shortages in the north and increased investment in eastern India.

These maps show that rice farmers are very dynamic and they readily adapt to changing technological, economic, and climatic factors.

Ms. Villano is a researcher at IRRI's GIS laboratory and Dr. Nelson is geographer and the head of the GIS laboratory. Mr. Johnson is geographer at the University of Bristol. Dr. Dawe is senior economist at the Food and Agriculture Organization in Bangkok, Thailand.



Shifts in the center of rice area in China from 1981 to 2010 for annual (red), single-cropped (blue), and double-cropped rice (green).



Shifts in the center of rice area in India from 1962 to 2010 for annual (red), rabi-season (blue) and kharif-season rice (green).

Reassessing Japan's development assistance

by **Keijiro Otsuka**

A development economist calls for a strategic approach for Japan's official development assistance, with emphasis on developing human capital

What country is a major salmon producer and exporter to Japan? The answer is Chile. And what country, also in the Southern Hemisphere, grows large amounts of soybeans? Brazil.

But, 40 or 50 years ago, Chile did not produce a single salmon and Brazil was not a major producer of soybeans. So, who started raising salmon in Chile and who started growing soybeans in Brazil's *cerrado*, a vast savanna thought to be barren? The Japanese people and the Japan International Cooperation Agency (JICA) are the answer. These accomplishments, however, are less known in Japan and elsewhere. The World Bank often refers to Chile's salmon and Brazil's soybean production as success stories, but it shows no sign of recognizing Japan's contributions.[1]

Another question: Why is it that Thailand has become a major manufacturer of automobiles, to the point that it has been dubbed the "Detroit of the East"? What made this possible was guidance from the Japanese, including their companies in the auto industry. Another major hub of car manufacturing is the Pearl River Delta area of southern China. Also, this has input from Japan, namely, training of the personnel required by carmakers.

Japan and Asia's Green Revolution

Japan can take pride that its official development assistance (ODA) played a key role in all of the above success stories. A case that I am quite familiar with is Asia's Green Revolution.

As of the 1960s, food production in tropical Asia was increasing much slower than population. The room to expand cultivation areas was less and farm productivity was not improving significantly. It was feared that major food shortages would occur. But, this was averted by the development of new, higher-yielding rice varieties by the International Rice Research Institute (IRRI) in the Philippines. These varieties were supported by investment in irrigation.

Japanese researchers, such as physiologist Akira Tanaka, played a key role at IRRI as it set the stage for the start of the Green Revolution. From the 1970s to 2000, the yield per unit area of rice in tropical Asia approximately doubled, and total rice production roughly tripled. Thus, the warning of the danger of famine in Asia stopped. The Japanese government provided generous financial support for IRRI's research and training of its personnel. Japan also joined the Asian Development Bank in supporting investment in irrigation. This is another example of Japan's ODA producing a game-changing advance. Only a few people are aware of this.

Japanese development assistance has produced other major advances in Asia and elsewhere. But, the track record of Japan's ODA is less known—even to people like me, a specialist in development economics. Although the details await further study, my assessment is that Japan's aid program has contributed to industrial development in many countries through this combined focus on people and infrastructure.

The need for effective strategies

Japan's ODA officers tend to think that the aid programs aim only to promote industrial development in developing countries through financial assistance. This view is not terribly wrong, but somewhat problematic.

IRRI (2)

AKIRA TANAKA (*left*), head of IRRI's Plant Physiology Department (1962-66), confers with the Institute's first breeder Peter Jennings during the early 1960s. Dr. Tanaka contributed to the development of IR8, the "miracle" variety that jump started the Green Revolution in rice.

[1] The JICA Research Institute has published a pair of interesting works concerning these two cases: Hosono Akio, *Nanbei Chiri o sake no yushutsukoku ni kaeta Nihonjintachi* (The Japanese Who Turned Chile into a Salmon Exporter) (2010), and Hongō Yutaka and Hosono Akio, *Burajiru no fumō no daichi 'serādo' kaihatsu no kiseki* (The Miracle of Development of Brazil's Vast, Barren *Cerrado* Savanna) (2012).


IRRI

EXTENSION WORKERS from countries that are part of the JICA-supported Coalition for African Rice Development have attended 16-week training courses on rice farming at IRRI and other locations in the Philippines. They then returned to their home countries to pass on their new knowledge to farmers.

At present, nowhere in the international community of aid donors can one find a consensus on the strategies that can promote development and reduce poverty in developing countries. Aid without a strategy is unlikely to produce successful outcomes. It is like kicking a ball blindly toward a goal. What is needed is to set effective strategies. This should be an important goal of ODA. Although Japan's assistance has been effective, evidence-based results have not been collected yet. Therefore, Japan's ODA has not been a source of examples for other donor countries to learn from.

People have been calling for the reduction of poverty for years, but the discussion of development strategies has failed to achieve much progress on this. The only points of consensus are that, (1) in order to reduce poverty, jobs for poor people must be created; and (2) to create such jobs, agriculture and manufacturing must be developed through new technologies.

The theme of the World Bank's 2013 World Development Report was "jobs," but the soon-to-be-published 2016 edition will focus on "the Internet and development." The World Bank is presumably sketching a scenario in which IT innovation leads to industrial development, thus creating jobs and thereby reducing poverty. To make this happen, however, to have strategies to spark innovation is necessary.[2]

People first

The first priority should be human resource development. In manufacturing, this means training of executives. No amount of fine equipment and good infrastructure will help a company grow unless its chief executive knows about management and technology. Recent research has shown that executives in developing countries tend to lack management know-how and this is preventing their companies from developing. Advanced countries have stocks of superior technologies and knowledge about management. Executives in developing countries should tap into these intellectual resources.

My colleague Sonobe Tetsushi and I are currently working with JICA and the World Bank on a project in Africa—testing the effectiveness of *kaizen*, a Japanese management technique of pursuing continuous incremental improvement. So far, the results look good. Infrastructure improvements and loans produce more positive results after corporate management has become more efficient. This is particularly effective in supporting up-and-coming companies by constructing plants in industrial zones. This is our idea of a good development strategy for manufacturing.

This can also be applied to agriculture. The key, as well, is human resources, which means researchers and extension agents to spread new technologies. Farming technologies depend on climate and local conditions, so they cannot simply be imported from other countries. Applied research is needed to adjust advanced technologies from elsewhere to work under local conditions. Surprisingly, in rice growing, Asian technologies can be used in Africa without modification. So, a Green Revolution for rice in Africa is possible even without applied research.

In 2008, I was able to persuade JICA to organize an initiative called the Coalition for African Rice Development, which aimed to double rice production in Africa in 10 years. Unfortunately, funding was lacking to train extension agents, and it is not clear whether the initiative can double production by 2018. But, if the training of agents progresses, the new technologies will start to spread. So, investing in irrigation, as well as in transportation and communications, will make infrastructure for enhanced marketing more profitable. As with manufacturing, investment that is timed in this way is sure to result in higher productivity for agriculture. These are my ideas for a development strategy in the agricultural sector.

These strategies do not conflict basically with the thinking Japan has adopted up to now in its ODA. The next step is to improve the development strategies through joint efforts by JICA, private companies, and researchers, to test the effectiveness of these strategies, and to advertise them globally as useful development models. If this can be done, it will surely greatly enhance other countries' assessments of Japan's ODA.

Dr. Otsuka, former chair of IRRI's board of trustees (2004-07), is a professor at the National Graduate Institute for Policy Studies in Tokyo, Japan.

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[2] Otsuka K. 2014. *Naze mazushii kuni wa naku naranai no ka* (Why Do Poor Countries Persist?) (Tokyo: Nikkei).

CIAT's award-winning data crunchers:
(*From left – above*) María Camila Rebolledo, Daniel Jiménez, Víctor Hugo Patiño, Juan Felipe Rodríguez.
(*From left – below*) Hugo Andrés Dorado, Sylvain Delerce.

CIAT

Harnessing big data for climate change

by **Nathan Russell**

Scientists at the International Center for Tropical Agriculture (CIAT) are crunching big data to avoid great economic losses for rice growers

CGIAR scientists wielding big data tools to blunt the impacts of climate change on Latin America's rice production have been named one of two winners of the Big Data Climate Challenge at the recent United Nations Climate Summit held in New York City, U.S.A. The other winner was the World Resource Institute's Global Forest Watch.

The challenge was launched in May by the Global Pulse—a UN initiative created to harness big data, as a public good, for sustainable development—together with the Secretary-General's Climate Change Team. The initiative aims to "address climate change by sourcing the best ideas in the world to strengthen the case for climate action."

Making agroecosystems more resilient in the face of climate change was also a key theme of the CGIAR Development Dialogues, which took place alongside UN deliberations on climate change and on the Sustainable Development Goals.

From analysis to action

Climate action is what Colombian rice farmers desperately need, as seemingly crazy weather—subtle shifts in rainfall plus more extreme climate events—forces them to toss aside familiar assumptions on when and what to plant. In the last 5 years, emerging climate change impacts have already driven down yields of irrigated rice from an average of 6 tons per hectare to 5 tons, according to FEDEARROZ, the national rice growers association.

At stake is the ability of Colombia's rice sector to remain competitive—catering to its own consumers while also trying to

generate export earnings—under the country's new trade liberalization policies. Climate change also poses a broader threat to Latin America's ability to reap its enormous potential as an export-centered granary for the rapidly growing global population.

To attack the immediate problem faced by Colombian rice growers, scientists at CIAT analyzed mounds of data in close collaboration with FEDEARROZ. The association conducts an annual rice survey, maintains a harvest monitoring dataset, and recently carried out experiments on rice sowing date. Researchers also tapped into streams of weather data collected by FEDEARROZ and the Colombian Institute of Hydrology, Meteorology, and Environmental Studies.

Then came the fun part for geeky data crunchers: using various data-mining techniques (with names such as "artificial neural network" and "dynamic time warp"), they analyzed all these data and came up with some pretty straightforward conclusions.

"Through a case study, we observed that the big climate factor limiting yields in some areas is accumulated solar energy during the grain ripening phase," said CIAT researcher Daniel Jiménez. "To ensure that crops get optimum radiation, farmers can shift the sowing date, and to further reduce yield losses, they can adopt rice varieties that are less sensitive to the amount of radiation received."

This finding coincides with the results of many years of field research. But the difference is that the big data reached this conclusion in just one year and offers the possibility of linking it with climate data analysis to provide farmers with timely and site-specific recommendations.

Putting big data to work

The approach seems to be working. "Your analysis was very helpful for discussing possible climate change impacts with the farmers; we were able to avoid big economic losses for about 170 rice growers on 1,800 hectares," said Patricia Guzmán, who leads FEDEARROZ's technical department, in an email reporting on field testing of the recommendations in Colombia's Córdoba Department.

In another case study, the analysis of historical weather data revealed that a diverse set of distinct climate patterns occurring over the years in Meta Department, a major upland rice area, is clearly associated with growing conditions that are favorable or not for production. This means that, based on seasonal climate forecasts made with advanced simulation tools, researchers can give farmers reliable recommendations about the appropriate planting date and rice variety months in advance, helping them to avoid losses of 1–2 tons per hectare, Dr. Jiménez explained.

He and Sylvain Delerce, an award co-winner, are part of CIAT's crop and climate modeling team.Their work on rice forms part of a major initiative on climate change, carried out by CIAT in partnership with Colombia's Ministry of Agriculture and Rural Development, which generously supports the work.

The sky's the limit

The scope of the big data approach seems limitless: "As we get more and more data, we'll soon be able to develop site-specific recommendations for every rice-producing area in Colombia," said Dr. Jiménez. This information should also prove valuable for rice breeders, better enabling them to develop new lines that are adapted to a changing climate.

Further research will incorporate data on soils and other factors into the new tools to increase their explanatory power. CIAT researchers will also work with the Fund for Irrigated Rice in Latin America (FLAR) to scale up the approach with rice growers associations in other countries, starting with Nicaragua and Peru.

The organizers of the Big Data Climate Challenge referred to the CGIAR work as a "uniquely innovative project that uses big data to drive climate action."

"Climate change obligates us to manage our food systems in a more dynamic way, and big data offers the most effective way to achieve this," said award co-winner Andy Jarvis, who is director of CIAT's Policy Analysis (DAPA) Research Area. "Like the hoe and spade, these new tools are becoming crucial implements for global food production."

Mr. Russell is the head of Communications and Knowledge Management at CIAT.

Women rising

by **Samarendu Mohanty** and **Humnath Bhandari**

Asian rice farming at a crossroads

In Asia, women are an indispensable part of rice farming. Their roles are somewhat dictated by farming practices and sociocultural norms across countries. In general, women are primarily involved in establishing the crop, harvesting, and doing postharvesting activities while men take the lead in preparing the land, managing the crop, operating farm machines, and marketing (Table).

In Bangladesh, however, women's involvement in rice farming is minimal. It is limited to postharvest activities mainly because of their religious and cultural practices. Women traditionally are in charge of household affairs and are discouraged from working outside their homes.

On average, Asian women contribute nearly half of the total labor input into rice production ranging from 17% in the Philippines to 74% in the Indian state of Uttar Pradesh (Fig. 1).

More importantly, the traditional role of women in rice farming is rapidly changing. They are going from farm laborers to farm managers and owners because of the outmigration of male farmers to urban areas in search of better economic opportunities. This is reflected in the rise of women farm landholders across Asia, with striking increases in Nepal and Thailand in the past two decades.

Percentage share of female and male labor inputs by rice production activities in selected Asian countries (2008-10).

Country	Gender	Land preparation	Crop establishment	Crop care management	Harvesting & threshing	Postharvest activities
Bangladesh	M	98	89	77	95	49
	F	2	11	23	5	51
India (Assam)	M	100	0	100	40	10
	F	0	100	0	60	90
Nepal	M	80	26	43	48	57
	F	20	74	57	52	43
Sri Lanka	M	92	86	92	61	67
	F	8	14	8	39	33
Cambodia	M	86	39	76	47	60
	F	14	61	24	53	40
Laos	M	62	45	58	53	33
	F	38	55	42	47	67
Average	M	82	45	65	55	43
	F	18	55	35	45	57

Source: IRRI farm household survey database.

In Nepal, the share of agricultural holdings by women made an 11-point jump from 8 to 19% between 2001 and 2011. Similarly, Thailand witnessed a big jump in women's agricultural holdings from 15 to 27% between 1993 and 2003. Steady, but small increases in agricultural holdings by women have been recorded in both Bangladesh and India in the past two decades with an increase from 3.5 to 4.6% between 1996 and 2006 in Bangladesh, and an increase from 10 to 13% between 1995 and 2010 in India.

At the same time, in many Southeast Asian countries such as Thailand, Vietnam, and the Philippines, the labor input of women into rice farming has been on the decline because of the outmigration of rural women and mechanization of rice farming. In the past two decades, their share in rice farm labor in these countries has decreased by at least 10 percentage points. This declining trend has not been witnessed in South Asia; but, it will not be long before this trend will be evident in the region.

Despite many positive trends in rice farming, the share of agricultural holdings by women is still very low at less than 20% for most Asian rice economies, except for Thailand (Fig. 2). In many other Southeast Asian countries, such as Vietnam, Indonesia, Malaysia, Laos, and the Philippines, the share of women farm landholders is surprisingly low. At the bottom of the pack is Bangladesh where women account for only 5% of agricultural holdings.

The role of women in rice farming in Asia will continue to change as the out migration of males accelerates in the future. This warrants crafting policies and programs that will strengthen women's access to resources and services. The providers of rice technologies, including equipment and machinery, need to be sensitized to women's needs.

Dr. Mohanty is the head of the Social Sciences Division (SSD) and program leader (targeting and policy) at the International Rice Research Institute (IRRI). Dr. Bhandari, who is based in the IRRI Bangladesh Office, is an agricultural economist in SSD.

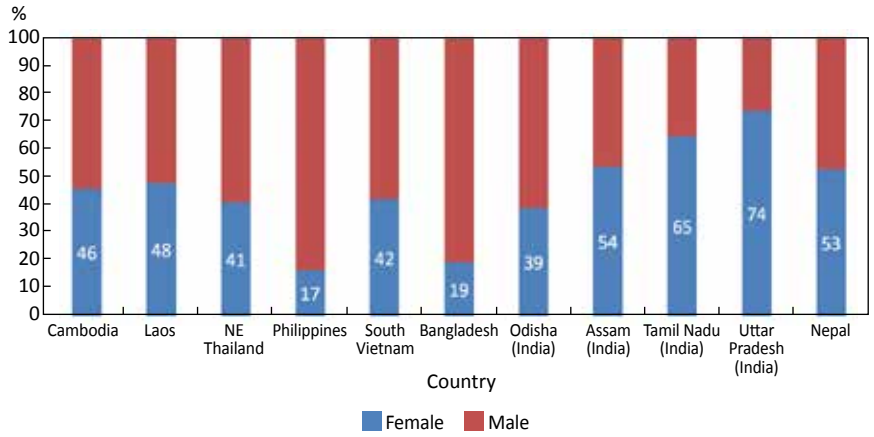

Fig. 1. Female-male labor input in rice production (2004-10).
Source: IRRI farm household survey database.

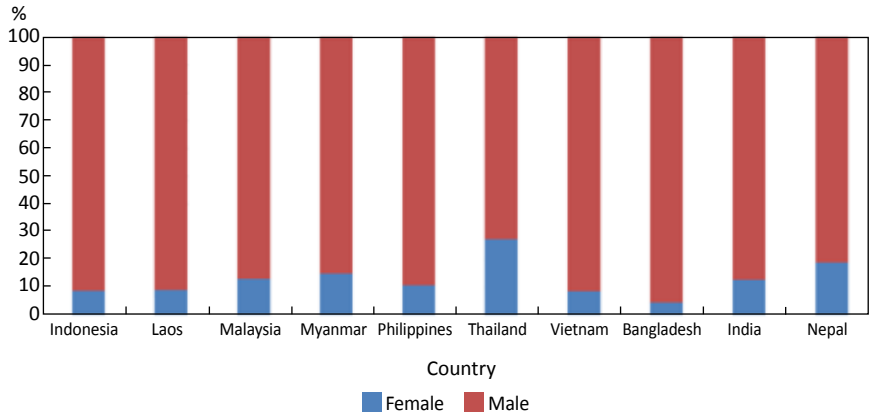

Fig. 2. Share of agricultural landholdings by gender.
Source: Gender and land rights database, FAO.

A SOLID FOUNDATION FOR THE NEXT GENERATION OF RICE RESEARCHERS

by **Gene Hettel**

Asia Rice Foundation USA is making students aware of the unique opportunities in rice research

"*My ARFUSA experience was extremely enriching for me as I continue with my PhD research on the gender dimensions of land reform in Cambodia. It not only provided me with resources to undertake an extended period of research, but also connected me with a whole new network of wonderful Cambodian and international scholars.*"

Testimonials such as this one coming from Alice Beban, a PhD candidate in the Department of Development Sociology at Cornell University in Ithaca, New York, bring a smile to the face of Russell Freed, board chair of the Asia Rice Foundation USA (ARFUSA).

"I think 'mission accomplished' whenever I get one of these messages in my email inbox," said Dr. Freed, whose day job is professor of international agronomy at Michigan State University (MSU) in East Lansing.

ARFUSA is made up of a group of mainly former staff members of the International Rice Research Institute (IRRI) who have worked and lived in countries where rice is vital for food and earning a livelihood. The most active country chapter under the umbrella of the parent Asia Rice Foundation (based in Los Baños, Philippines), ARFUSA was founded in July 1999 at Cornell University by a small cadre of U.S.-based IRRI alumni.

The Foundation aims to contribute toward a world that can feed itself, treasure the rich heritage of different rice cultures, and value rice-growing land as a precious resource to be shared with future generations. Over the last 15 years, its membership has grown to include some who are retired in the U.S. and others who are still working at universities and organizations there.

The heart-blood of rice research and production

Dr. Freed worked as a rice breeder at IRRI in the 1970s, living in Sri Lanka, Indonesia, and the Philippines, before coming to MSU in 1980. "My 8 years with IRRI were some of the most exciting ones of my career—and life!" he stated. "Even after being away for 34 years, I consider myself a part of the IRRI family. Living in Michigan, my kids spell it E-R-I-E (referring to one of the nearby Great Lakes), but I spell it I-R-R-I," he winked. "IRRI is the heart-blood of rice research and rice production around the world."

Many other U.S.-based IRRI alumni, who have the same sentiment, make up quite an impressive list of ARFUSA trustee or council members. These include, among others, World Food Prize Laureate Gurdev Khush, currently adjunct professor at the University of California, Davis; Jim Hill, associate dean for international programs and extension agronomist for rice at U.C. Davis; Susan McCouch, professor of plant breeding and genetics at Cornell University; Ronnie Coffman, international professor of plant breeding and genetics and director of international programs at Cornell; and David Mackill, leader of the IRRI research team that

ALICE BEBAN

CORNELL PHD candidate Alice Beban (*left*) used her ARFUSA travel grant to enhance her field research in Cambodia. Here, she interviews a Cambodian farm family about their land security.

ARFUSA TRUSTEES (*from left*) Russell Freed, David Mackill, and Robert Zeigler discuss the Foundation's critical role of encouraging and supporting young rice researchers.

GENE HETTEL

discovered the now-famous *SUB1* flood-tolerance gene in rice and currently rice specialist with the U.S.-based MARS, Inc.

"Like the *SUB1* flood-tolerance research, there is much other tremendously exciting work involving rice," said Dr. Mackill, vice chair of the ARFUSA board of trustees. "I think that, once students attending U.S. colleges and universities realize this and how critically important rice is to world food security and food production, they will become more and more excited about it and want to be involved."

And that has been ARFUSA's main goal since its inception—encouraging the next generation of rice scientists by making students aware of the unique opportunities in rice research and helping young U.S.-based scholars of any nationality to obtain some first-hand knowledge through its Travel and Study Grants Program.

One scholar's experience

A case in point is the experience of Ms. Beban, one of ARFUSA's 2013 grant winners who recently reported her progress to Dr. Freed. "The ARFUSA travel grant has enabled me to go to Cambodia and conduct substantial fieldwork," she said. "It allowed me to expand my research in exciting ways that I hope will be beneficial for Cambodian farmers and the organizations that support them."

Ms. Beban, who hails from Levin, New Zealand, is trying to better understand how land reform affects livelihood strategies and household power relations of Cambodian rice farmers. "My PhD research is examining this land reform and the roles it plays in contemporary Cambodian politics, society, and ecology," she says. "I had a chance to explore this issue with my ARFUSA award. I spent my time mostly in the 'rice bowl' region of Kampong Ch'hang, an area emblematic of national land use tensions between corporate agriculture and small-scale rice production.

"I conducted more than 80 semi-structured interviews and used ethnographic methods to gain the perspectives of government officials at both central and local government levels," she pointed out. "I also got varied perspectives from people in communities where land titles were given out, as well as the views of the organizations working on land rights."

Her initial findings suggest that land titling is equated with land security in the policies of the Cambodian government and donor agencies, but a title is just one vital part of land security. "I believe my data show that focusing only on the technical aspects of land registration, rather than the social aspects of land security, is not sufficient to enable rice-farming families to enjoy sustainable livelihoods from their farms," Ms. Beban said.

She suggested that some important social factors should be considered. These include recognizing elite capture [where resources transferred for the benefit of the many are usurped by the "superior" few] and gender bias in land reform, and the strengthening of networks within communities.

According to Robert Zeigler, IRRI director general, ARFUSA can greatly expand its youth development efforts for international rice research. He believes the Foundation can do more than assist just a few students each year such as Ms. Beban and other recent grant winners.

Getting on the rice research bandwagon

"It is critical that we 'grow' the overall international rice research community and ARFUSA can and should promote the involvement of U.S. universities in such research," said Dr. Zeigler. In fact, he is so fervent about what ARFUSA's role can be in this arena that, even as busy as he is as IRRI's director general, he agreed to serve as an ARFUSA trustee and attended the 15th annual meeting of the ARFUSA trustees and council members last July at U.C. Davis.

Dr. Zeigler told the ARFUSA trustees that, when we think about dealing with all the challenges facing agriculture in the future such as assuring food security for 9 billion people on this planet in 2050 with the specter of climate change dogging us all the way, rice has to be part of any solution equation.

He concluded, "ARFUSA is all about fomenting a large number of U.S. university faculty and students to get on the rice research bandwagon to work directly with IRRI, AfricaRice, and other international and national organizations."

Mr. Hettel is the editor-in-chief of Rice Today *and executive director of ARFUSA. For more information about ARFUSA Travel and Study Grants, see the announcement on page 46 and go to www.asiariceusa.org.*

Asia Rice Foundation USA announces 2014 Travel and Study Grant winners

ARFUSA aims to encourage and support the next generation of rice scientists through its Travel and Study Grants awarded to young scholars.

ARFUSA grants (up to $3,500 per award) assist scholars and artists to learn more about rice in the developing world by subsidizing a trip to a country where rice is important to study aspects of rice production, marketing, consumption, and policy or to create art or interpret culture related to rice.

2014 grant winners

The two grant winners in 2014—Ana Maria Bossa Castro from Bogota, Colombia, and Haley Sater from Minnesota USA—will be traveling to IRRI the Philippines in the coming months.

Ms. Bossa Castro, a second-year PhD student at Colorado State University (CSU), is conducting research that involves *Defeating Bacterial Diseases of Rice: Novel Resistance Sources for Rice Crops in Africa and Latin America*.

At IRRI, she will participate in the Institute's 3-week international course in 2015, *Rice: Research to Production*. The course will provide her with a unique opportunity to learn from experts about the latest rice research. She will also meet with IRRI scientists collaborating with her to update them about her bacterial disease research.

Ms. Sater, working on her master's degree at the University of Arkansas, is conducting research to obtain better abiotic stress tolerance in rice. Her time at IRRI will involve a 3-month research project with breeders there to help close the information gap regarding dual drought and salinity tolerance in rice.

2015 grant application

1 June 2015 is the deadline for receiving the next round of grant applications. Student applicants who may be of any nationality must be registered at an accredited U.S. university or college and have a letter of support from a university faculty member. Creative artists must illustrate their qualifications.

Evaluation of the applications is based on quality, likely contribution to knowledge or ability to cause people to think, potential contribution to resolving issues related to rice in Asia, and leadership potential of the applicant. For more information on sending applications, go to www.asiariceusa.org/awards.html.

Find out more about ARFUSA and its important mission in the article on pages 44-45 and at www.asiariceusa.org.

RICE IN THE SHADOW OF SKYSCRAPERS: Policy choices in East and Southeast Asia



BY DAVID DAWE, STEVEN JAFFEE, AND NUNO SANTOS

During the past few decades, Asia has experienced a period of rapid economic growth that benefited many farmers and consumers. In fact, the decline in poverty has been historically unprecedented in human history. The resulting changes in demographics, eating patterns, and overall economic and agrarian structures will increasingly shape the Asian rice sector.

In light of these changes, the World Bank, the Food and Agriculture Organization (FAO), and the International Rice Research Institute (IRRI) joined together to work with other researchers and institutions in East and Southeast Asia to review a range of existing research that analyzes policies that affect the region's rice sector. The researchers then synthesized the results into short policy notes that are easier to digest by government policymakers, donor organizations, NGOs, and other interested stakeholders.

A range of key issues needs to be examined. For example, rice consumption is growing less rapidly than the consumption of other foods such as fruits, vegetables, meat, and fish. Asian production systems will need to evolve to meet this demand. Policies that encourage farmers to remain dedicated to rice farming—including land-use restrictions, input subsidies, irrigation system design, and international trade policies—are becoming obsolete and may make Asia depend heavily on imports for a range of higher-value foods. The policies also impede better nutrition, as healthy diets rely on people eating a wide variety of foods.

Rice price stability is still important for many Asian countries. Yet, with the declining share of rice in household spending, even among the poor, the benefits of price stabilization are less than they were in the past. Thus, it will help much if we can design more cost-effective mechanisms to make rice prices stable and protect the poor from rice price shocks. Targeted social safety nets may be an option to help the hard-core poor, including those who don't grow rice, cope with volatile food prices.

Environmental concerns are becoming more important, both in the eyes of consumers and in the context of greater competition for available land and water. Yet, some traditional policy instruments (e.g., fertilizer subsidies, water subsidies, and a lack of pesticide taxes) make it difficult to reduce the environmental footprint of rice and meet consumer expectations in this regard.

Pressure is increasing to support farm income with higher prices. A case in point is the paddy pledging policy in Thailand. This policy was very costly, however, and was ultimately unsuccessful in raising prices for farmers. Investments in public goods (e.g., agricultural research, rural access roads) tend to have more sustainable and broadly distributed results than paddy or input subsidies. For many rice farmers now, a better path to higher income may come from diversifying crops and earning money from nonfarm activities.

In today's global economy, increased knowledge is becoming critical for competitiveness and poverty reduction. Extension systems, both public and private, need to evolve in order to equip farmers with the knowledge they need. Governments need to intervene in more innovative ways that mobilize the private sector, especially, but not only, in the area of postproduction. Information and communication technology can be used more to meet farmer demand for knowledge and information.

Although rice research in the past has primarily benefited farmers with irrigated or well-watered land, new technological developments are already transforming the lives of farmers who live in areas with poor-quality land that are prone to floods and drought. Future breakthroughs to deal with climate change and help eradicate poverty will materialize only if agricultural research and development receives continued support from donors.

Trade in rice is important in Asia, both as a commercial activity and in balancing domestic supply and demand. For net importers, efforts to achieve self-sufficiency through trade restrictions can have high costs, in terms of harming consumers and overall agricultural sector growth. Supplementing the region's traditional rice exporters are several emergent players with significant ambitions. Meeting these ambitions will require very significant investments, by both the public and the private sector, and a consistent set of supportive policies.

Dr. Dawe is a senior economist at FAO. Dr. Jaffee is a lead rural development specialist at the World Bank. Dr. Santos is an economist at FAO. *They have put together a compendium of 18 policy notes titled* Rice in the Shadow of Skyscrapers: Policy Choices in a Dynamic East and Southeast Asian Setting. *See the Books section on page 8 for more information.*

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