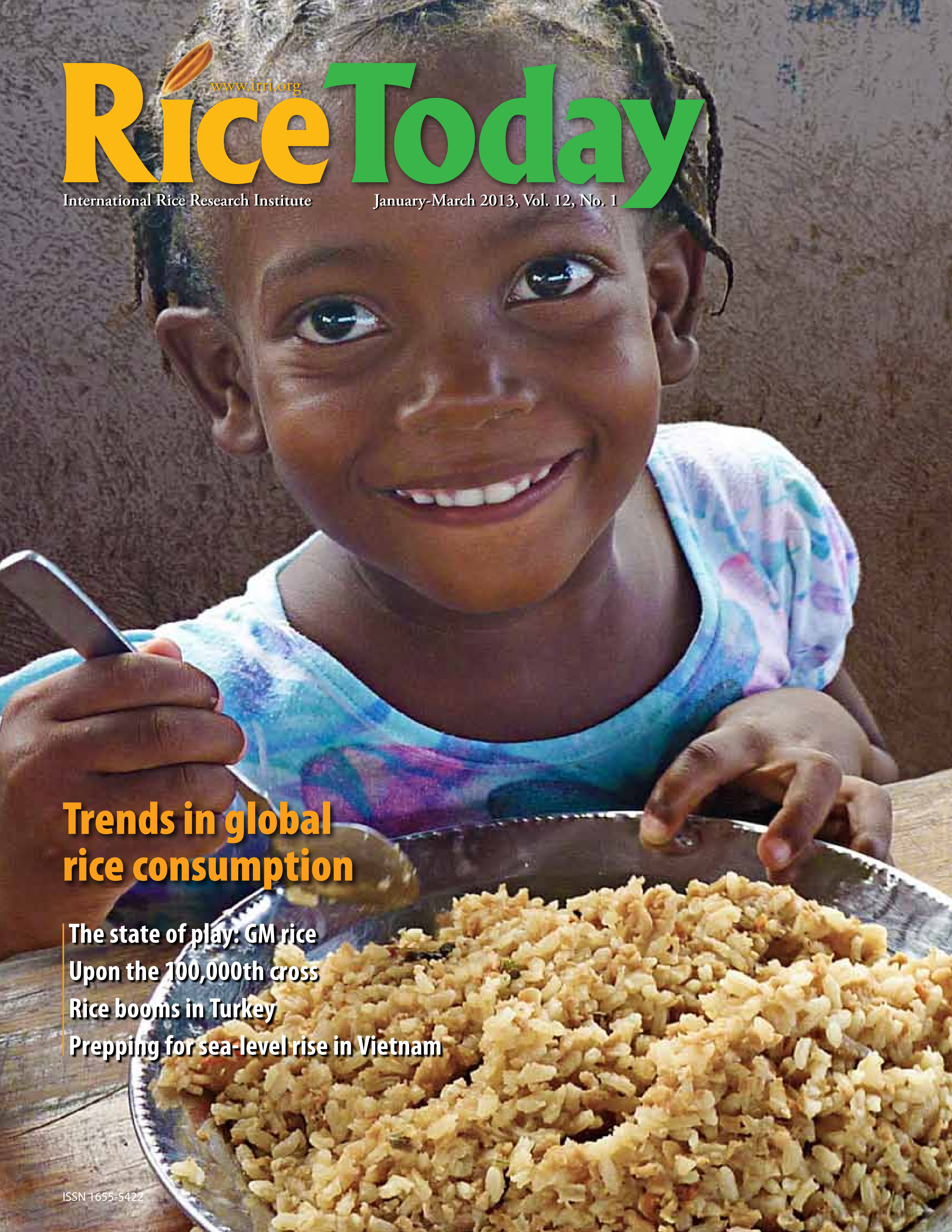

Rice Today

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Trends in global rice consumption

The state of play: GM rice
Upon the 100,000th cross
Rice booms in Turkey
Prepping for sea-level rise in Vietnam

ISSN 1655-5422

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The world needs more agronomists

About the cover. Like this little girl in Haiti, nearly half of the world's population of 7 billion eats rice. And, when the global population reaches 9 billion around mid-century, more mouths will have to be fed. Add to this are challenges in rice production such as increasing competition for land, labor, and water as well as concerns related to climate change. Thus, rice scientists are working together in finding ways to ensure sustainable food security. (Photo by ©Lucas Phillips, Free The Kids, Inc.)

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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Ringing in the new year!

In this year's first issue, *Rice Today* continues to bring together informative and inspiring stories that show the world of rice.

We look into how rice scientists and their colleagues at partner organizations work together to respond to the many challenges in the face of climate change and increasing competition for land, labor, and water. In Vietnam, scientists are working together to help farmers adapt their rice farming practices to climate change, as farmers in the Mekong Delta brace for flooding and salinity because of sea-level rise (see "Appeasing 'nine dragons' enraged by climate change").

In his "Rice facts" column, "Trends in global rice consumption," Dr. Sam Mohanty indicates that 2 billion more mouths will have to be fed by mid-century.

Also, rice production of two countries in West-Central Asia is featured in this issue to show success. In Turkey, sustained investment in research and extension for more than 30 years has given it the third-highest average yield in the world (see "Rice booms in Turkey"). Our "Country highlight" centers on Iran, which now has the biggest area in rice production in West-Central Asia because of intensified research and training in the region.

But, it is not enough that farmers increase their harvests. In "Eclipsing the sun: flatbed dryers," millions of Southeast Asian farmers are protected from postharvest losses and need not struggle with poor-quality sun-dried grain.

One of our cover stories, "The state of play: genetically modified rice," examines the status of genetic modification both as a method for developing a potential product and as a tool for identifying economically important genes that can be used in conventional breeding.

As for inspiring stories, let's name a few. "Breeding a grain of life in Latin America and the Caribbean" is about Dr. César Martínez and how he made his mark among rice researchers and rice farmers in Colombia and the LAC region.

"Upon the 100,000th cross" documents a major milestone as IRRI rolls out IR100,000. It reflects on the contribution of rice breeding in history while hailing its potential to overcome new and bigger challenges.

We also look at the importance of preparing young professionals today to be problem solvers tomorrow. In "The future faces of rice science," IRRI holds its first international conference designed to educate, inspire, and motivate young scientists to become the best they can be. In the "Grain of truth" column, Dr. Noel Magor discusses the need to train a new generation of researchers and extension agents that can work with farmers and researchers in a "multiactor" system.

In "A city with a heart for rice," high-school teachers in highly urbanized Singapore are exposed to rice production so they can help their students appreciate and understand how their staple food is grown. Meanwhile, in the Philippines, school children learn the value of rice through "The adventures of Gabby Ghas," a picture story book about a tiny grain of rice who wants to know his place in the world.

With the holidays behind us, I look forward to the start of a fresh, clean year, full of promising developments and unlimited potential. We welcome a new member of the editorial board of *Rice Today*, Dr. Bas Bouman—the new director of the Global Rice Science Partnership (GRiSP), the CGIAR research program on rice.

And finally, two of our cover stories (on GM rice and the 100,000th cross) have related podcasts on the newly inaugurated IRRI Radio, which you can find at https://soundcloud.com/irri-radio. Here, you can also follow, throughout the first quarter of 2013, the exploits of the Rice Survivor team members that Dr. Magor mentions in his "Grain of truth."

We hope you enjoy reading *Rice Today* even more as it aims to have a more global coverage of the various areas in rice research and industry.

Happy New Year!

Lanie Reyes
Rice Today editor

Identifying rice weeds in Africa

THE WEED identification tool is also accessible as an app on a tablet.

A new interactive tool can now identify nearly 200 different weed species of lowland rice in East and West Africa.

Africa Rice Center (AfricaRice) recently unveiled this tool built on a comprehensive knowledge base. It is accessible online and offline (CD or as an app on smartphones and tablet computers).

"Weeds are perhaps the most important constraint in rice production."

Dr. Jonne Rodenburg, AfricaRice weed scientist

"Weeds are perhaps the most important constraint in rice production, so this is a valuable resource for all those involved in research, training, and management of rice weeds in sub-Saharan Africa, where total rice production losses because of weeds are estimated at US$1.5 billion," said Dr. Jonne Rodenburg, AfricaRice weed scientist.

The weed identification tool is the product of a 3-year project on "African Weeds of Rice" (AFROweeds), which is coordinated by the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) and AfricaRice, with support from the EU Africa, Caribbean, Pacific (ACP) Science and Technology Program.

The project, now almost complete, is carried out in partnership with national agricultural research and extension systems in sub-Saharan Africa.

The project has also developed "Weedsbook"—a professional social network for sharing information between professionals and students interested in applied botany, weed science, and weed management in rice in Africa.

"These resources have been developed to help disseminate knowledge and exchange information not only among the project members but also among all the community of actors in the rice value chain," said Dr. Thomas Le Bourgeois, weed scientist from CIRAD and leader of the AFROweeds project.

"The target users are weed scientists and agronomists, students and professors of universities, farmers' associations, and extension services," he added.

A financial boost for C_4 rice

The pursuit to rein in hunger with the development of a "cutting-edge" rice of the future has received a financial boost, and is now rolling into its second phase.

The project seeks to create "C_4 rice"—rice with a built-in fuel injector to better convert sunlight into grain, potentially resulting in up to 50% higher production while using less water and nutrients.

The Bill & Melinda Gates Foundation, the UK government, and IRRI have put $14 million behind C_4 rice over the next 3 years.

"This is exactly the sort of innovative scientific research that the Prime Minister was calling for at the Hunger Summit at Downing Street earlier this year," said Lynne Featherstone, UK Parliamentary Under-Secretary of State for International Development.

The researchers have already identified crucial genes needed to assemble C_4 photosynthesis in rice, defined the basic elements required for functional C_4 photosynthesis, and successfully introduced 10 out of the 13 genes needed for C_4 rice.

In this second phase of the project, the team aims to produce C_4 rice prototypes for testing (see more on C_4 on page 14).

More greenhouse gas per grain of rice

More carbon dioxide in the atmosphere and rising temperatures cause rice agriculture to release more of the potent greenhouse gas methane (CH_4) for each kilogram of rice produced, new research published recently in the online edition of *Nature Climate Change* reveals.

"Our results show that rice agriculture becomes less climate-friendly as our atmosphere continues to change," said Dr. Kees Jan van Groenigen, research fellow in the Botany Department of the School of Natural Sciences, Trinity College Dublin, and lead author of the study.

"This is important, because rice paddies are one of the largest human sources of methane, and rice is the world's second-most-produced staple crop," he said.

> **"These findings ... really stress the need for mitigation and adaptation measures to secure global food supply while at the same time keeping greenhouse gas emissions in check."**
>
> Dr. Kees Jan van Groenigen, Trinity College Dublin

Dr. van Groenigen, along with colleagues from Northern Arizona University and the University of California-Davis, gathered all published research to date from 63 different experiments on rice paddies, mostly from Asia and North America.

"Two strong patterns emerged when we analyzed all the data: first, more CO_2 boosted emissions of methane from rice paddies; second, higher temperatures caused a decline in rice yields," explained Professor Bruce Hungate of Northern Arizona University and co-author of the study.

However, the authors point out that several options are available to reduce CH_4 emissions from rice agriculture.

For instance, management practices such as mid-season drainage and using alternative fertilizers reduce CH_4 emissions from rice paddies.

Moreover, by switching to more heat-tolerant rice cultivars and by adjusting sowing dates, declines in yield because of increases in temperature can largely be prevented, thereby reducing the effect of warming on CH_4 emissions per yield.

"These findings, together with our own results, really stress the need for mitigation and adaptation measures to secure global food supply while at the same time keeping greenhouse gas emissions in check," Dr. van Groenigen concluded.

Source: www.tcd.ie

Myanmar: Asia's next rice granary?

As Myanmar comes out of isolation with recent political reforms, the international community is closing ranks to help the country recover—with a focus on helping rice farmers reach the country's production potential.

A new collaboration among Myanmar, IRRI, and the Livelihoods and Food Security Trust Fund (LIFT) seeks to realize the country's rice production potential.

"Interventions to reduce the vulnerability of Myanmar's farmers to extreme weather being caused by climate change mean promoting the use of rice varieties that can tolerate floods, salinity, and drought, as well as management approaches that support optimum performance of these improved rice varieties," says IRRI scientist Dr. David Johnson.

IRRI has been working in Myanmar since the 1970s and is now helping to pull together national and international partners to provide support to rice farmers. IRRI and its partners in Myanmar—including Myanmar's Department of Agriculture and Department of Agricultural Research—have been engaged in stakeholder consultations as they target the rural poor in rice-producing areas in the lower and upper delta, and in the central dry region. ■

TRAINING COURSES AT IRRI

Course title	Date	Target participants
Rice Breeding Course	11-22 March	Breeders, agronomists, and research managers
SNP Data Analysis	22-27 April	IRRI researchers/scholars; and open to NARES partners
Basic Rice Production Course	9-11 April	IRRI NRS, scholars, postdocs, and IRS
Rice: Research to Production	20 May-7 June	Young scientists 21–35 years old

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.

Awards for AfricaRice's value chain research

The 2012 Louis Malassis Young Promising Scientist Prize was presented to Dr. Matty Demont, agricultural economist at the Africa Rice Center (AfricaRice), for his research in the field of rice value chain development in Africa.

Dr. Demont's research has shown that, to become competitive, Africa's rice sector needs to emphasize rice quality and marketing.

Based on this analysis, he designed a policy framework for the sustainable development of rice value chains in Africa to enhance the competitiveness of domestically produced rice vis-à-vis imported rice.

Dr. Demont also led the AfricaRice team and their Belgian partners who won the T.W. Schultz Prize for Best Contributed Paper at the 28th International Conference of Agricultural Economists (ICAE) held recently in Foz do Iguaçu, Brazil.

They received the prize for their paper on "Experimental auctions, collective induction and choice shift: Willingness-to-pay for rice quality in Senegal."

This will come out in the *European Review of Agricultural Economics* in 2013.

The paper presents the new method developed by AfricaRice for conducting experimental auctions in the African context. An experimental auction creates a market in a laboratory setting, which allows testing to determine whether consumer behavior can be altered under certain conditions.

This provides more and different information than what can be obtained through classical surveys.

AfricaRice has used experimental auctions as an important research tool to find out consumers' perceptions of different types of rice and the price they would be willing to pay for them. So far, it has conducted 12 experiments involving more than 1,600 women throughout Africa.

The experimental research program has confirmed that local rice can be competitive with imports in urban markets if quality is tailored to consumer standards and, even more so, if it is attractively packaged and labeled.

(*Left to right*) Guido Gryseels, Prize jury chair; Anne-Lucie Wack, Agropolis Fondation director; Henri Carsalade, Agropolis Foundation board chair; and Matty Demont, AfricaRice awardee.

OLIVER OLIVEROS, AGROPOLIS FOUNDATION

Arsenic in rice?

In September 2012, the United States Food and Drug Administration (FDA) released a preliminary study on arsenic in rice.

"Based on the available data and scientific literature, the FDA is not recommending changes by consumers regarding their consumption of rice and rice products," states the FDA.

IRRI's assessment of current research supports this, and indicates that there is no evidence to show that people should stop eating rice grown in Asia because of concerns about arsenic.

Aquino declares 2013 year of rice

President of the Philippines Benigno Aquino has declared 2013 as the "National Year of Rice" to help intensify the country's efforts to attain rice self-sufficiency during the same period.

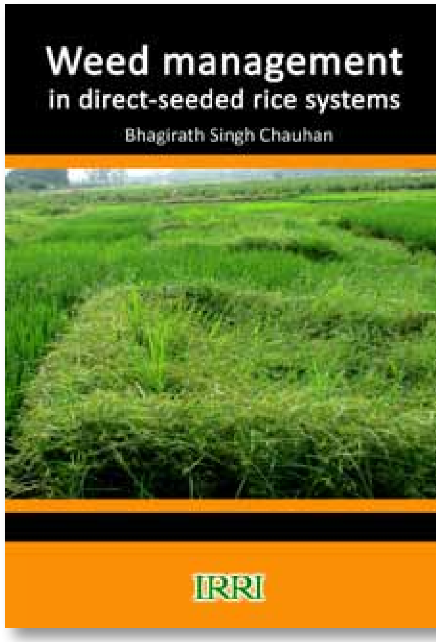
The proclamation aims to help sustain initiatives to boost farmers' morale and motivate them to adopt modern and sustainable technologies, which will improve their farm productivity and income, and encourage the public to be responsible rice consumers.

Meanwhile, IRRI and the Philippine government signed an agreement to advance collaboration in support of the Philippines' Food Staples Self-Sufficiency Program.

Source: www.pia.gov.ph

Weed management in direct-seeded rice systems

By Bhagirath Singh Chauhan



Rice, an important crop in Asia, is mainly grown by manual transplanting of seedlings under wet conditions. Recently, farmers in this region have been shifting to direct-seeded rice systems because of high labor costs and less availability of water. Moreover, laborers have been continually migrating from rural areas to cities.

Mainly, two kinds of direct-seeded systems are practiced in Asia: dry- and wet-seeded rice. Although direct-seeded rice systems have several advantages, weeds are major constraints in these systems. Since rice and weed seedlings emerge simultaneously, rice has no seedling size advantage. Moreover, in direct-seeded systems, no standing water exists to suppress the emergence and growth of weeds.

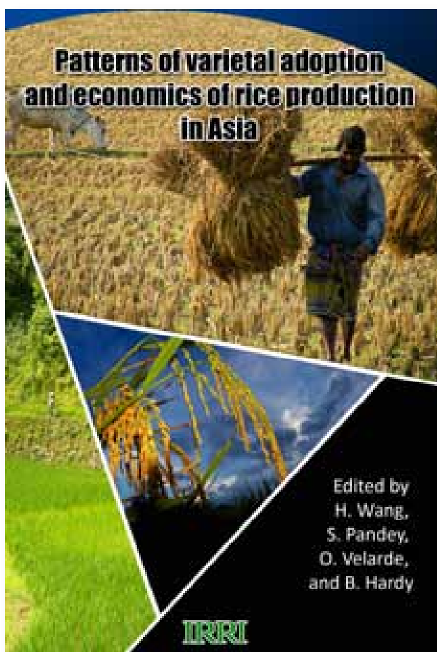
Weeds in direct-seeded systems can cause a substantial rice yield loss. Farmers control weeds by using herbicides or by manual weeding. But, manual weeding is becoming less common because, during critical times, no labor is available; added to this is the high cost of labor.

Herbicides are replacing manual weeding because they are easy to use; however, the sole use of herbicides poses some concerns such as evolution of resistance in weeds, shifts in weed populations, and some negative effects on the environment.

This 20-page publication responds to the need to integrate different weed management strategies for effective and sustainable weed control in direct-seeded rice systems. This book describes different strategies, which include preventive and cultural approaches, in order to manage weeds in these systems. This will be important material for researchers and extension specialists to develop integrated weed management programs for direct-seeded rice systems. ■

Patterns of varietal adoption and economics of rice production in Asia

Edited by H. Wang, S. Pandey, O. Velarde, and B. Hardy



Rice research remains an important global undertaking to ensure an adequate food supply for sustainable food security of the poor. Improved technologies for high rice productivity are critical to attain food security and reduce poverty in the face of increasing competition for land, labor, and water as well as the challenges posed by global warming.

Millions of poor small farmers grow rice in Asia and Africa under diverse unfavorable conditions such as areas affected by drought, submergence, salinity, problem soils, insects, diseases, and other pests. Unfortunately, farmers often have to contend with various adverse factors simultaneously.

With the support of its donors, IRRI, in partnership with national programs, leads in the development of suitable rice technologies for these diverse conditions by using modern scientific approaches and tools. IRRI continues to focus its work to develop improved rice germplasm that is high-yielding and tolerant of abiotic and biotic stresses. And, with the Global Rice Science Partnership (GRiSP), the Institute directs its efforts likewise to improve crop management, reduce postharvest losses, and improve the nutrient content of rice grains.

IRRI, in partnership with the Chinese Academy of Agricultural Sciences (CAAS), is implementing a major project to develop "Green Super Rice" (or GSR) for Asia and Africa. These rice varieties are expected to be both high-yielding and environment-friendly as they incorporate several traits for pest and disease resistance.

Improved varieties resulting from these efforts, however, will not have their desired impact unless farmers ultimately adopt these varieties. Hence, it is important to understand the social and economic contexts of rice production in these countries to attain efficient results.

Thus, this 130-page book provides socioeconomic contexts for rice production in key countries in Asia such as Sri Lanka, Cambodia, and Pakistan where the GSR project is taking place. This book is based on a detailed analysis of farm-level data such as farmers' resource endowments, their livelihood strategies, rice production practices, technology adoption patterns, and household income structures, among others.

Information in this book will provide important insights for underpinning technology development and dissemination and will also serve as a benchmark for future impact assessments. ■

To purchase printed copies of these and other books, contact riceworldbookstore@irri.org.

A little grain of rice with a big mission

by **Alaric Francis Santiaguel**

The journey of a little grain of *palay* named Gabby Ghas continues

CHRIS QUINTANA

More than being entertaining, a well-told story may serve as an agent of change and cultural appreciation. *The Adventures of Gabby Ghas* is a story remarkable for its potential in communicating a strong message about the value of rice and rice farming.

Written in 2006 by Virna Karla Sebastian, Erika Thea Ajes, and Aya Arce, the book won in the English category of a story-writing competition conducted by the Asia Rice Foundation and Alpha Phi Omega Service Sorority, in collaboration with the Philippine Department of Education.

The story follows Gabby Ghas, a plucky rice grain, in his search for his place in the world. In the course of finding his purpose, he encounters other rice seedlings, weeds, insects, and other creatures. Eventually, Gabby Ghas ends up on a family's dinner table, where he realizes that his destiny is to provide nourishment for people.

Beyond the storybook pages

Gabby Ghas has become an ambassador of sorts for the Asia Rice Foundation. The foundation was put together by the alumni of the International Rice Research Institute and the University of the Philippines in Los Baños, Laguna. The Asia Rice Foundation aims to support cultural and educational advocacy efforts and promotes awareness of and public appreciation for the role of rice within the diverse Asian cultures.

"Gabby Ghas will bring the importance of rice to the consciousness of young people," said Dr. Benito Vergara, chairman of the Asia Rice Foundation.

"The book is an excellent means of making young people learn more about rice and appreciate more the role of rice farmers," said Carmen Paule, chair of the Asia Rice Foundation short story competition.

Since its original publication, the story of Gabby Ghas has been told and retold to many pupils while thousands of copies of the book have been purchased and distributed in public schools. "Recently, the Department of Education ordered 6,000 copies of the book for its library project," Dr. Paule added. "We are greatly overwhelmed."

From Gabby to Gabo

Dr. Mira Sinco, president of Foundation University in Dumaguete City, Philippines, felt the need for a version for students in the Visayan region of the country. Thus, the story of Gabby Ghas, previously published only in English, was translated into Cebuano, a widely spoken language in the region.

In October 2012, *Ang mga Sugilanon ug ang Panimpalad ni Gabo Ghas*, the Visayan version, was launched. It is co-published by the Asia Rice Foundation, the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), the Philippine Rice Research Institute, and the Department of Agriculture-Bureau of Agricultural Research.

"Though this may not be the usual fare in SEARCA's publications, we saw it as a way of introducing to our youth the value and culture of eating rice and, invariably, the appreciation of agriculture and the value chain from which this important commodity comes," said Gil Saguiguit, Jr., SEARCA director.

A multilingual rice

Department of Education Secretary Armin Luistro suggested having the book translated into the 12 major languages of the country.

Dr. Saguiguit also raised the idea of translating *The Adventures of Gabby Ghas* into Bahasa Indonesia as a first step in expanding its readership to other countries in the Southeast Asian region.

"I'm on my way to see the world!" Gabby Ghas said at the beginning of his adventure. With the help of friends in the real world, this tiny rice grain with a big mission is certainly making great strides.

Mr. Santiaguel is a writer at IRRI.

To order copies of the English version of the book, please visit asiarice.org.

RiceToday around the world

TRUE BLUE READERS. The forever friends from IRRI-Philippines have all the good vibes running throughout their China spring vacation as they strike a pose with their magazines and shirts at St. Paul's Ruins, Macau (*left to right*, Patrick Garcia, Ellen Silab, Stephanny Garcia, Francisco Elazegui, Fanny Garcia, Minda Fernandez, Marietta Baraoidan, and Boyet Cura).

WORLD WIDE VIEWS. Mr. Alfie M. Torres, researcher of the World Agroforestry Centre, poses in Copenhagen with the first 2012 issue of *Rice Today* when he attended a training seminar called "World Wide Views on Biodiversity" in March last year.

SIMPLY BREATHTAKING. The beauty of the Victoria Nile in northern Uganda can perhaps be felt in the facial expression of Robert Anyang, regional program officer of public-private partnership and market access, Sasakawa-Global 2000. He's holding a copy of *Rice Today* while standing on the Karuma Bridge.

WACKY! Liew You Choo and Heng Guan Hou, who are from organic importer The Sukha House, hold two of the best 2012 covers of *Rice Today* at the 2012 Asian Masters event in Singapore.

Waakye: A popular dish from Ghana made with rice and beans

by **Eugenia Manful**

Ghana's popular rice and beans dish

R.RAMAN, AFRICA RICE (3)

With a fascinating historical heritage, rich cultural diversity, extraordinary scenic beauty, and friendly people, Ghana is a charming blend of old and new. Ghanaian cuisine has a wide variety of traditional dishes, such as the popular Waakye (pronounced waa-chay), a rice and beans combination, which is both delicious and nutritious.

Waakye was earlier popular mainly in northern Ghana but has now gained national status and is loved by grownups and children alike. It can be prepared at home, but, in Ghana, it is more popular as a street food. It is also eaten in Nigeria, Togo, and Benin, where it is prepared in slightly different ways.

Waakye is usually served for breakfast or lunch with a typical Ghanaian spicy pepper sauce. It can be a meal in itself or it can be eaten with boiled eggs and/or with a stew of fish, chicken, beef, or vegetables.

The dish requires about 15 minutes of preparation and an hour and a half of cooking time.

Mrs. Manful lives with her family in Tema, a town located 25 km east of Accra, Ghana's capital. She works as a chief revenue officer under the Ghana Revenue Authority. She loves to cook traditional dishes from her country for her friends and family, especially for her husband, John Manful, plant breeder at the Africa Rice Center.

Ingredients

2 cups rice
1 cup red beans or black-eyed peas, or any kind of beans or peas
4 dry sorghum leaves (or 1 teaspoon of baking soda)
Salt to taste
10 cups water

Preparation

1. Wash and soak the beans in water for 3–4 hours.
2. Drain the beans and place them in a large pot of water.
3. Bring the mixture to a boil and let it cook for about 45 minutes.
4. Wash the sorghum leaves.
5. Cut the leaves 3 to 4 inches, toss them in with the boiling beans, and allow them to cook together.
6. If sorghum leaves are not available, add a teaspoon of baking soda to give the Waakye its characteristic color.
7. Remove the sorghum leaves from the beans after 5 minutes.
8. Wash the rice and add to the beans in the pot, along with more water.
9. Allow the mixture to cook for 15–20 minutes (or until the beans are tender and the rice is cooked and all liquid has been totally absorbed).
10. Be sure that the mixture does not burn and keep stirring while it cooks.
11. Season with salt.
12. Serve the dish with pepper sauce and boiled egg and/or a stew of fish, chicken, beef, or vegetables.

Serves 4.

Bon appétit!

Watch Mrs. Manful demonstrate how to prepare this delicious dish in a 6-minute video on YouTube at http://youtu.be/okXqTQbbm68 or listen to a podcast at http://snipurl.com/waakye2.

MRS. MANFUL serves Waakye with pepper sauce, fried fish, grilled chicken, and boiled egg.

GM RICE growing in a confined field trial at IRRI.

IRRI

THE STATE OF PLAY: genetically modified rice

by **Adam Barclay** and **Sophie Clayton**

People often argue passionately for or against genetically modified (GM) crops. Rice Today's *aim here is not to take sides in a debate that has often generated more heat than light, but rather to look at the facts—what is actually happening in relation to GM rice with a separate focus on work underway at the International Rice Research Institute (IRRI).*

GM crops have been grown commercially since the 1990s. The global coverage of GM crops in 2011 was 160 million hectares in 29 countries (Fig. 1), reports the International Service for the Acquisition of Agri-biotech Applications. And, they predict that, by 2015, at least 20 million farmers in more than 40 countries will be using the products of biotechnology, including GM crops, on around 200 million hectares.

This article specifically focuses on GM rice—that is, rice that has had a gene or genes from another species or rice variety introduced into its genome using modern biotechnology techniques. This GM rice exhibits the traits conferred by the introduced gene or genes.

As of December 2012, commercialized GM rice had not yet become a reality—which means, farmers aren't growing it and consumers can't eat it yet.

The GM Crop Database of the Center for Environmental Risk Assessment shows that two GM rice varieties (LLRice60 and LLRice62, both with herbicide resistance) were approved in the United States in 2000. Subsequent approval of these and other types of herbicide-resistant GM rice occurred across Canada, Australia, Mexico, and Colombia. However, none of these approvals resulted in commercialization.

In 2009, China granted biosafety approval to GM rice with pest resistance, but no commercial rollout has taken place.

Nevertheless, R&D on GM rice continues to advance in both the public and private sector around the world. GMO Compass notes that Argentina, Australia, Brazil, China, France, India, Indonesia, Italy, Iran, Japan, Mexico, the Philippines, Spain, and the United States have all been involved with GM rice. Bangladesh and South Korea are also engaged in research on GM rice.

Researchers are working on GM rice with higher yield; increased resistance to pests, diseases, and herbicide; better tolerance of drought and salinity; improved nutritional value and health benefits; and higher nitrogen-use efficiency.

Research on GM rice at IRRI

IRRI's approach to its GM rice R&D is based on a premise that genetic modification has the potential to safely deliver to rice farmers and consumers a number of benefits that cannot be achieved through other breeding methods.

Genetic modification is used as a research tool—to understand gene function—even when there is no intention to develop a GM rice variety, and to develop new GM varieties with added beneficial traits that cannot be found within the rice gene pool.

"Compared with other major crops such as corn (maize) or wheat, rice has an extraordinarily diverse genetic resource base that spreads across at least 24 different species of rice," explains Dr. Eero Nissilä, head of IRRI's Plant Breeding, Genetics, and Biotechnology Division. "This means there is already a very large pool of useful rice genes that breeders can use to develop new varieties of rice with improved traits.

"In fact, less than 5% of our rice breeding focuses on delivering GM rice varieties," he adds.

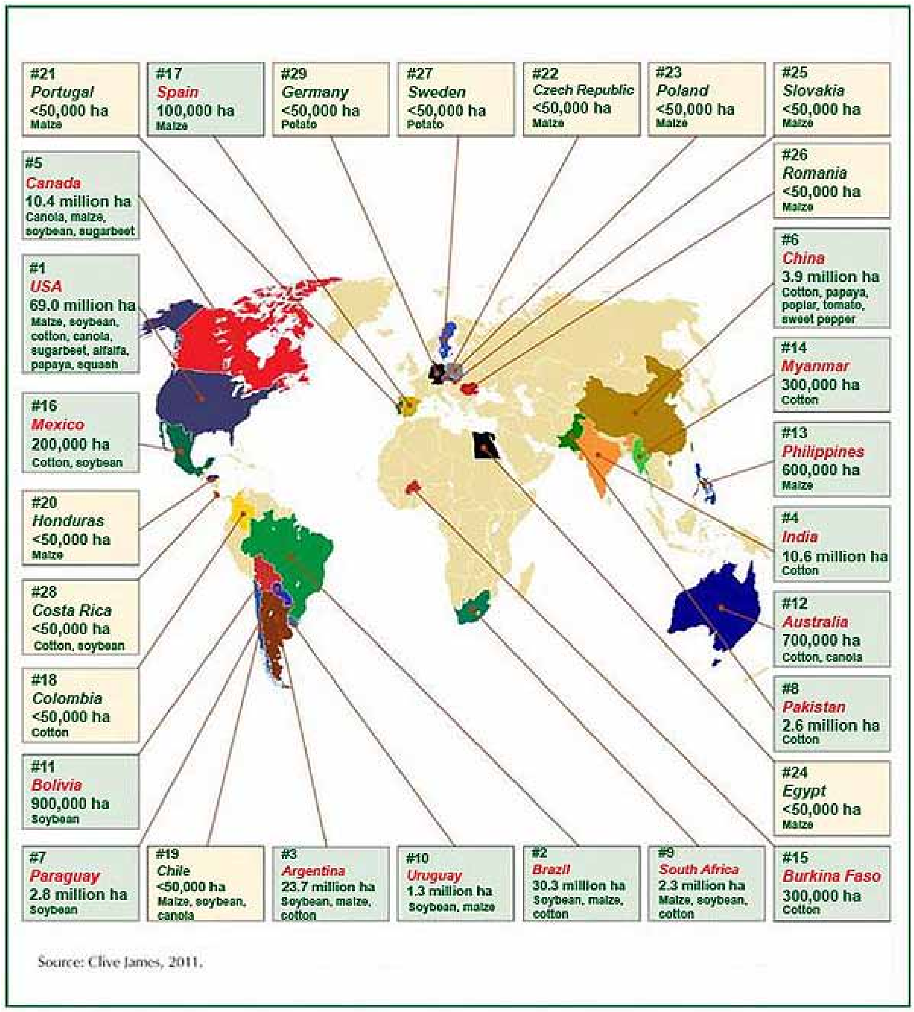


Fig. 1. Map showing the 29 countries that grow biotech crops, by rank according to area (2011).
Source of map: ISAAA Brief 43-2011: Executive Summary: Global Status of Commercialized Biotech/GM Crops: 2011 (www.isaaa.org/resources/publications/briefs/43/executivesummary/default.asp).

Golden Rice

The best-known and most advanced example of IRRI's research on GM rice is that of Golden Rice. Unlike other rice, this contains beta carotene—a source of vitamin A (See *Golden grains for better nutrition* on pages 14-17 of *Rice Today* Vol. 10, No. 4).

By working with a mix of leading agricultural and health organizations, IRRI is helping to further develop and evaluate Golden Rice as a potential new way to help address vitamin-A deficiency. Work on Golden Rice is most advanced in the Philippines, where it is led nationally by Dr. Antonio Alfonso of the Philippine Rice Research Institute.

"We've completed some initial field tests in different locations to evaluate and select breeding lines that potentially would meet farmers' and consumers' expectations, to see how Golden Rice grows in different environments, and to compare any environmental impacts of Golden Rice with those of other rice varieties," said Dr. Alfonso.

GOLDEN RICE is being further developed and evaluated as a potential new way to tackle vitamin-A deficiency.

ISAGANI SERRANO

DR. EERO Nissilä and Dr. Inez Slamet-Loedin are using genetic modification in their rice breeding and research to help develop new rice varieties.

ISAGANI SERRANO

Turbocharged C_4 rice

IRRI's most ambitious attempt to genetically modify rice is its C_4 rice project. The project, which brings together a mix of international partners, is attempting to make rice much better at photosynthesis, the process of turning sunlight into grain (see *New rice plant could ease threat of hunger for poor* on page 8 of *Rice Today* Vol. 8, No. 2).

Rice uses a C_3 photosynthetic pathway, which is much less efficient than plants such as maize that use a C_4 pathway. Rice already has all the components required for C_4 photosynthesis, but they are distributed "differently" within rice cells. By rearranging the photosynthetic structures within the leaves using genetic modification, it is theoretically possible to switch rice over to C_4 photosynthesis—potentially increasing productivity by 50%.

In 2012, the C_4 rice project got an injection of financial support valued at US$14 million over 3 years from the Bill & Melinda Gates Foundation, the UK government, and directly from IRRI.

"This is exactly the sort of innovative scientific research that the [UK] Prime Minister was calling for at the Hunger Summit at Downing Street," said Lynne Featherstone, UK Parliamentary undersecretary of state for international development. "This new funding will enable IRRI to begin producing prototypes of this 'super rice' for testing. This could prove a critical breakthrough in feeding an ever-growing number of hungry mouths."

The research still has a long way to go, but the scientists have already identified crucial genes needed to assemble C_4 photosynthesis in rice, and they now aim to produce C_4 rice prototypes for testing.

Iron-clad rice

IRRI senior scientist Dr. Inez Slamet-Loedin is leading two other projects on GM rice. Like Golden Rice, the first of these aims to combat the problem of "hidden hunger," or micronutrient malnutrition, worldwide.

"We use genetic modification when we see a unique opportunity to incorporate a new trait . . . that could have significant benefits for rice farmers and consumers."

Eero Nissilä, head of rice breeding, IRRI

Dr. Slamet-Loedin and her team are developing iron-rich rice. This has the potential to prevent the iron-deficiency anemia that afflicts more than 1 billion people globally, particularly poor women and children (see *Iron-clad rice* on page 46 of *Rice Today,* Vol. 10, No. 3). Iron deficiency and iron-deficiency anemia contribute to increased maternal mortality, stifle children's cognitive and physical development, and reduce people's energy.

In its experimental work, IRRI has added two genes to the popular rice variety IR64. One of these is a gene named "ferritin" from soybean, which codes for iron storage. Rice has its own ferritin gene, but adding another increases the plant's iron-storage capacity. Ferritin from soybeans is a major source of iron for vegetarians. Crucially, it provides iron that is highly bioavailable—that is, can be easily absorbed and used by the body. The other gene, which comes from another rice variety, helps transport iron to the grain.

"Adding a ferritin gene will increase iron-storage capacity," explains Dr. Slamet-Loedin, "but you also need to increase the amount of bioavailable iron reaching the grain—hence, the need for the transporter gene, which allows iron in the leaf, where it is abundant, to be moved to the grain, the part of the rice that is eaten."

As a bonus, she says, the use of a transporter gene will also increase zinc in the grain.

In 2012, IRRI and the Colombia-based International Center for Tropical Agriculture (CIAT) each performed the first confined field trials of iron-rich GM rice outside of Japan, to look at iron content in the grain and to check the performance of rice in different conditions.

Non-GM rice varieties that are relatively high in iron have concentrations of 5–8 parts per million. Dr. Slamet-Loedin's team targets an iron concentration of 13–14.5 parts per million in rice grain. Given average rice consumption, this could provide 30% of women's and children's estimated iron requirements. Early trials at IRRI revealed an iron content of 11–13 ppm, on the cusp of the target. Further growing, bioavailability, and food and environmental safety tests are still needed as the team works toward iron-clad rice.

Confirming gene function

Dr. Nissilä explains that one of the most important uses of genetic modification at IRRI is in identifying useful genes and confirming the trait they are responsible for. By using genetic modification, researchers can take a rice gene that they suspect may be responsible for a favorable trait, and insert it into another rice plant to see whether the trait of interest is also transferred. If it is, then they know that is the gene they want to target in their conventional breeding programs—which will result in a regular, non-GM rice variety that includes the beneficial gene and associated trait.

For example, IRRI used genetic modification to confirm the major gene responsible for phosphorus uptake—*PSTOL1* (see *Rice gene boosts phosphorus uptake* on page 6 of *Rice Today* Vol. 11, No. 4). However, the original rice plant with the *PSTOL1* gene was not genetically modified and future varieties bred to include the *PSTOL1* gene will not be GM.

Institutional Biosafety Committee at IRRI

An Institutional Biosafety Committee (IBC) is responsible for ensuring that IRRI complies with local and international regulations and guidelines in the conduct of its experiments that involve GM crops or other products. In the Philippines, where IRRI undertakes research on GM rice, the composition and responsibilities of the IBC are determined by the Biosafety Committee of the Department of Science and Technology (DOST-BC).

IRRI's IBC is composed of three IRRI scientists, two scientists from the University of the Philippines Los Baños, and four representatives from the local Los Baños and Bay communities around IRRI headquarters. It works under the Philippine regulatory framework, which was first established in 1990. DOST-BC oversees IRRI's IBC and, through the IBC, all research on GM rice at IRRI. No GM organisms can be used in IRRI's research without prior authorization from DOST-BC.

"We must assure that research on GM rice is both safe and effective, and that is possible only through a team of dedicated, independent people who are able to assess the environmental, health, and social implications of the science, and enforce biosafety measures that prevent the unintentional release of GM material," says Dr. Ruaraidh Sackville Hamilton, head of IRRI's IBC.

"The Philippines was the first country in the ASEAN (Association of Southeast Asian Nations) region to introduce a biosafety regulatory system, and it remains one of the most robust anywhere, and one of the very few with broad representation that includes civil society," he added.

Drought-hardy rice

Dr. Slamet-Loedin is also leading IRRI's efforts to identify useful drought-tolerance genes that could lead to the development of either GM or non-GM drought-tolerant rice varieties (see *Overcoming the toughest stress in rice: drought* on pages 30-32 of *Rice Today* Vol. 8, No. 3). This is more challenging than nutrient-enriched rice because drought itself is complex as well as the way it affects rice crops. For example, any new variety must be tested in drought conditions of varying severity and length, and at different times during the growing season (drought hitting during the reproductive stage of rice tends to have the worst impact), as well as in different soil types. Furthermore, any new drought-tolerant variety needs to perform well in nondrought conditions too.

This project has support from Japan's Ministry of Agriculture, Forestry, and Fisheries and is a joint effort among the Japan International Research Center for Agricultural Sciences (JIRCAS), which has provided funding; RIKEN, a large public research organization in Japan; and CIAT, which is helping with testing.

Promising GM breeding lines with improved drought tolerance have already been developed. Some of these lines include extra rice genes and some have genes from a tiny plant called *Arabidopsis*. Over the past few years, the performance of these lines has been tested in drought conditions using screenhouses. In 2011 and 2012, it was time to move the testing outdoors and IRRI and CIAT completed confined field tests of the lines at rainfed lowland sites in the Philippines and upland sites in Colombia, respectively.

Dr. Slamet-Loedin says that to get a rice variety that tolerates drought

GENETIC MODIFICATION helps identify genes that could build drought tolerance—although the final rice variety does not have to be genetically modified.

ISAGANI SERRANO

at different stages during its life cycle as well as different types of drought, "stacking" all the genes for drought tolerance into a single variety could get the best results.

Building expertise on GM rice

The intention of IRRI's current research on GM rice is that, one day, new GM lines will be passed on to researchers in national agencies for further development and, if approved, eventually to farmers and consumers.

Alongside the development of this research goes training in biotechnology and genetic modification techniques for rice scientists. This gives them specialized skills to conduct biotechnology research and to build up their expertise and understanding of the area, so that they can respond research opportunities back in their home countries and institutes, and meet their own local needs.

In September 2012, IRRI ran the "Advanced Indica Rice Transformation Course"—the first time ever that the Institute provided training on the genetic modification of rice. Indica rice—the rice most widely produced in South and Southeast Asia—is a broad group of many different types of rice that are usually grown in hot climates.

TRAINING PARTICIPANTS from around the world learn how to use biotechnology and to genetically modify rice at IRRI.

ISAGANI SERRANO

Nine public- and private-sector participants attended the training from China, Colombia, India, Indonesia, Nepal, the Philippines, and the U.S. They got hands-on experience and learned about biosafety issues and international guidelines for biosafety management in research.

Says one of the trainees, Ms. Ritushree Jain, an Indian national who is doing her PhD at the University of Leeds in the UK, "After this training, I hope that I will be able to make a construct and put some genes into rice plants and especially in indica varieties, which are more susceptible to drought and nematodes. A lot of rice cultivation is affected by drought stress and nematode infestation and these are big problems.

"My hope is that I will be able to find some genes to integrate into Indian rice varieties and develop something new that will help," she adds.

Mr. Barclay served as a science writer at Green Ink (www.greenink.co.uk) when he wrote this article. He is now a communications manager at CRC CARE. Ms. Clayton is the public relations manager at IRRI.

For a related podcast on IRRI Radio associated with this article, go to https://soundcloud.com/irri-radio.

GM RICE is not yet available to eat but one aim of research on GM rice at IRRI is to improve the nutritional value of rice for consumers in the future.

IRRI

"My hope is that I will be able to find some genes to integrate into Indian rice varieties and develop something new that will help."

Ms. Ritushree Jain, biotechnology trainee

Upon the 100,000th cross

by **Ma. Lizbeth Baroña-Edra**

With the 100,000th time rice has been crossed by IRRI breeders, a milestone is marked in the Institute's breeding history. The event allows for reflection, appreciation, and anticipation of how breeding saved lives in the past, and will save more in the future.

Before scientists ever started crossing different rice plants, farmers had inadvertently been at it for centuries.

By the mid-1800s, scientists were catching up, with Gregor Mendel's research on inheritance and genetics paving the way for more advanced approaches to plant breeding into the 1900s.

IR100,000—aptly named as a product of the 100,000th cross made at IRRI.

CHRIS QUINTANA

These scientific discoveries couldn't have been timed better. By the middle of the 20th century, fear of famine loomed when population growth seemed to have outstripped food production. Rice and wheat—two of the most important food crops in the developing world—benefited from international efforts to improve their productivity using a science-based breeding approach.

The pivotal "semi-dwarf"

IRRI's hand in helping the rice-eating world through breeding better varieties of rice began shortly after the Ford and Rockefeller Foundations established the Institute with the help of the Philippine government in 1960. IRRI scientists sought to replicate in rice what had been done in wheat in Mexico, and successfully bred IR8—a semidwarf variety that journalists dubbed "miracle rice" because it could produce twice the amount of rice grains that tall varieties produced. IR8 has been credited with averting a humanitarian crisis that would have plunged the world's poor into abject hunger (see *Breeding history* on pages 34-38 of *Rice Today* Vol. 5, No. 4).

Since then, more than 900 IRRI varieties have been released in 78 countries, across five continents. Some of these were bred to be resistant to insects or diseases, and they can withstand poor soils. Two popular breeding lines, IR64, released in 1985, and IR72, released in 1988, have both high yield and good grain quality.

"Fifty years ago, it was a different scenario in terms of tools available to create better rice varieties," said IRRI's head of plant breeding, Dr. Eero C. Nissilä. "Today, we have modern breeding tools that help us do the work in less time."

IRRI breeding was there

The progression of new rice varieties has reflected the challenges that farmers have faced over the years.

In the late 2000s, after decades of tracking down the gene that provides tolerance of flooding in rice, and after infusing this gene into popular varieties, IRRI released its flood-tolerant line.

Today, millions of hectares of rich rice farmlands in the delta regions of Asia have benefited from "scuba" rice—the rice that can withstand more than 2 weeks of total submergence.

IN LATE 1962, Peter Jennings, IRRI's first breeder, made the eighth IRRI cross—which led to the selection of IR8, setting the Green Revolution on its course. The parents were Peta, a tall, vigorous variety from Indonesia, and Dee-geo-woo-gen (DGWG), a dwarf variety from China.

IRRI

An independent study of Indonesia, Vietnam, and the Philippines by the Australian Centre for International Agricultural Research showed that IRRI's breeding program has helped increase rice yield up to 13%, giving these countries an extra $1.46 billion worth of rice each year.

What makes IRRI breeding exciting?

Today, IRRI scientists are working on rice that responds to specific needs of farmers in a particular region or ecology. An example is rice that can survive under stagnant water. This is a problem in rice-growing areas near delta regions such as those in Vietnam (see *Appeasing "nine dragons" enraged by climate change* on pages 22-23).

Another example is rice that is tolerant of salinity. Salt-tolerant varieties have already been released in the Philippines and Bangladesh.

"Work is also under way to create "2-in-1 rice"—rice with combined tolerance of flood and salinity," said Dr. Glenn Gregorio, deputy head of IRRI plant breeding. "The goal is not only to confer tolerance of flood and salt in popular varieties but also to make sure that they have good eating quality."

Trends in farmers' practices, observed in decades of household data gathered across Asia, are also finding their way into IRRI's breeding agenda. An example is the increasing practice of direct seeding.

"Irrigated rice is an input-intensive undertaking as farmers have to pay laborers to transplant rice," said Dr. Nissilä. "Farmers thus resort to direct seeding—a trend that has been observed in farmers' fields. Once again, IRRI plant breeders see an opportunity to help. IRRI is now developing rice that germinates in anaerobic conditions, and we have been making good progress in this."

To facilitate the spread of these improved rice types in areas that need them, IRRI is also creating breeding research hubs in South Asia as well as East and Southern Africa, so that upcoming lines can be tested in regional conditions. These hubs are facilities where IRRI breeding lines are evaluated in conditions unique to the region, in collaboration with national partners.

Also, to facilitate the efforts in breeding to respond to farmers' needs, IRRI is creating product profiles for rice, per various rice ecologies, regions, and consumer needs.

"Rice is very cultural, and quality—not just yield—is also a major consideration in different rice preferences," said Dr. Nissilä. "These product profiles will also help enhance our precision breeding, putting more value in our resources and efforts."

IR100,000

Last 29 November, IRRI celebrated its 100,000th cross. But, what's so special about the 100,000th cross?

"It tells us how much we've gone through in our commitment to feed the world," mused Dr. Gregorio. "More importantly, we hope that, by highlighting such a milestone, we renew enthusiasm toward plant breeding and the fact that it has benefited so many people globally."

In breeding jargon, the 100,000th cross was between IRRI 151 (NSICRc214), a high-yielding popular variety with good grain quality, and IR09M105, a high-micronutrient rice.

"We hope to be able to get the best traits from both parents and create a variety that provides what farmers really need: more grain, with good quality, and high in micronutrients for human health," said Dr. Gregorio.

Reflecting on how the world would have been without the work on improving rice varieties, Dr. Nissilä said, "In Asia, highly populated rice-eating countries such as China and India would not have been able to develop the way they have. The world would have been a much more difficult place to live in. It is as simple as that."

Ms. Baroña-Edra is a public relations specialist at IRRI.

See a related video on YouTube at http://youtu.be/vSPjWLysdzo.

For a related podcast on IRRI Radio associated with this article, go to https://soundcloud.com/irri-radio.

IRRI

MARRIAGE RESPECTS NO **BOUNDARIES**

by **Rizal M. Herrera**

What really happens when cross-breeding rice

Innocent-looking rice plants also engage in courtship and marriage.

The rites are simple, devoid of an elegant and expensive entourage.

The bride, the superstar of the occasion, is not in the usual wedding gown. She is simply a dark green rice plant with flowers stripped off its anthers, the male counterpart of the species.

When rice flower buds are still empty of their stored starch, both male and female parts are in the flower, producing self-fertilized seeds. To prevent self-pollination, castration by removing the male parts by tweezers is a requisite. Only at this point will the rice plant be transformed into an instant bride.

Before the cool evening is over, the bride is locked in a plastic bag to protect her from intruders. She is in seclusion, awaiting her "prince charming" during the long, haunting night. At daybreak, as the sun kisses the rice flowers and the morning dew shies away to join the rain clouds, the innocent bride sees hope for rejoicing—a break from her solitary confinement. Overjoyed to meet the groom, she sneaks through the transparent glassine bag, but, to her disappointment, she finds no one.

The sun radiates more of its inexhaustible energy, unmindful of the dark clouds blocking its efforts to force the sleepy groom out of its capsule. After a long extended wait, "here comes the groom;" not the bride, excited, puzzled, and eager to know who her life partner will be. The groom, who comes from an elite group, is as proud as ever to sire a celebrity noted for the family's capacity to give high grain yield.

The ceremony begins without church bells, but barely introducing the groom as a golden yellow pollen grain, released by the burning sun from its hideaway. With a mute "I do," the bride receives him with wide-open arms.

The newlyweds are veiled and bound together, and the traditional wedding ring—simply a brightly colored merchandising tag with a piece of silvery string and a lead-coated paper clip—is pulled out. Inscribed on the tag are the common names of the newlyweds. This is their marriage contract, a contract signed by both parties without an expiration date.

The ceremony is finally over—no wedding cake, doves, or bountiful food for the invited guests. The honeymooners do not go to a five-star hotel. They are left in a dark corner of the greenhouse after being covered with glassine bags, locked with a paper clip. But, this union will be the start of something big—generations of rice varieties that are not hindered by boundaries.

Mr. Herrera was among the first breeders to make crosses at IRRI in the early 1960s (photo above). He arrived at IRRI in 1961 as a research aide and retired 36 years later in 1997 as a senior assistant scientist.

CHRIS QUINTANA

IRRI PLANT breeder Dr. Glenn Gregorio (*left*) discusses the 100,000th cross with former IRRI plant breeder Mr. Rizal Herrera.

MARTIN GUMMERT

Eclipsing the sun: flatbed dryers

by **Martin Gummert** and **Trina Leah Mendoza**

Millions of Asian farmers struggled with poor-quality sun-dried grain until a mechanical flatbed dryer adaptable to the tropics was developed in the Philippines in the 1970s

At first, the flatbed rice grain dryer did not take off in most countries because of the high-cost kerosene-fueled burner. Its 1-ton drying capacity per batch was too big for small farmers and too small for the commercial sector.

It was only in Vietnam where the technology was successfully adapted, thanks to a version modified by Nong Lam University (NLU). By 2005, around 4,000 dryers with 4- to 8-ton capacity were installed in the Mekong Delta, all using rice husk as fuel. Neighboring Lao PDR, Cambodia, and Myanmar had no dryers at that time. Indonesian dryers mostly installed by the government were not being used. And, only a few dryers based on the Vietnamese design were used in the Philippines.

The International Rice Reasearch Institute (IRRI) began working with NLU, national partners, and private stakeholders in 2006 to introduce the flatbed dryer in Southeast Asia.

Myanmar

Dr. Myo Aung Kyaw from the Pioneer Postharvest Development Group (PPHDG) and Mr. Tin Oo, a manufacturer, participated in an IRRI-organized dryer manufacturing training by NLU in 2006.

After the training, they installed the first pilot unit in Myanmar, which sparked the production and installation of dryers at rice mills and with farmers' groups. By 2012, more than 70 dryers had been installed by the PPHDG, 80 by Mr. Tin Oo, and 150 by others who had copied the design.

The Pioneer postharvest team confirms that 13,700 farmers are benefiting from the dryers that they have installed, and about 35,000 farmers are already benefiting from more than 300 dryers in the country.

Indonesia

In the tidal lands of South Sumatra, low-quality discolored rice was common because of delays in handling and drying. This was caused by shortages in labor and poor postharvest facilities. Then, AGRINDO, a machinery manufacturer in Java, introduced a kerosene-fueled flatbed dryer in South Sumatra in 1995. Unfortunately, users abandoned the dryer because of rising fuel costs.

In 2003, a rice-husk-fired dryer with 3.3-ton capacity was developed by the Indonesian Center for Rice Research in Sukamandi, and introduced in South Sumatra by the Assessment Institute for Agricultural Technology in Palembang. IRRI helped by transferring a bigger and more efficient fan to a local manufacturer in Palembang. Come 2010, around 200 dryers were installed in South Sumatra, mainly by rice millers. Four local workshops are now producing dryers there, with one shop in Palembang already making good-quality dryers.

In 2012, IRRI provided additional training on blower testing and manufacturing of an improved rice husk furnace.

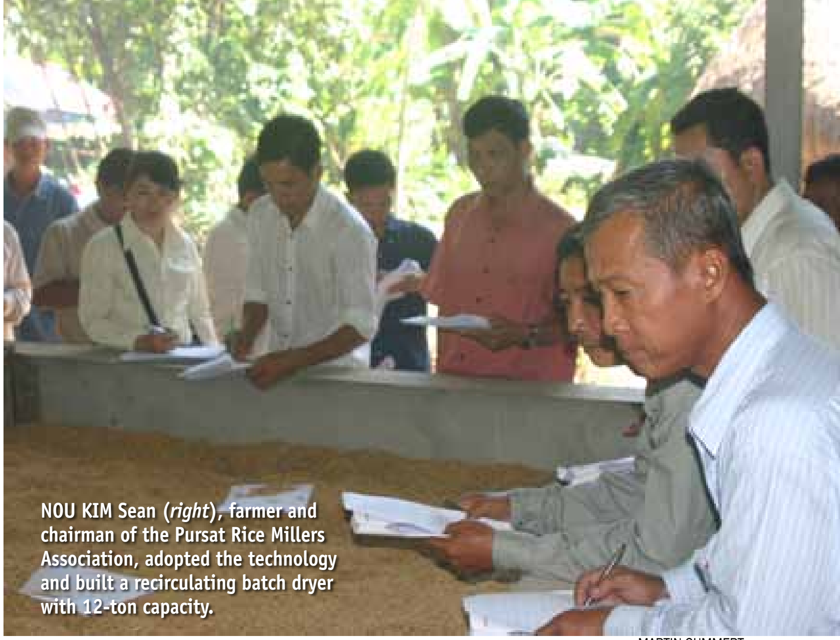
The Philippines

Most Filipino farmers rely on the sun to dry their grain, but now they face quality problems because of unpredictable weather.

In the past few years, the Philippine Rice Research Institute (PhilRice) worked with NLU to bring

PHILIPPINE RICE Research Institute engineers demonstrate the reversible flatbed dryer to farmers in Agusan del Norte, Philippines.

TRINA LEAH MENDOZA



NOU KIM Sean (*right*), farmer and chairman of the Pursat Rice Millers Association, adopted the technology and built a recirculating batch dryer with 12-ton capacity.

MARTIN GUMMERT

in the second-generation flatbed dryer with reversible airflow from Vietnam to the Philippines.

IRRI supported a participatory verification of the initial units of these dryers through the Irrigated Rice Research Consortium (IRRC) and an Asian Development Bank (ADB)-funded postharvest project. And, the Philippine Department of Agriculture funded 10 units installed at PhilRice stations.

These dryers are now distributed to end users through PhilRice and a postharvest learning alliance. Both serve as platforms in which the dryers can be evaluated in a business model context with end users and supporting institutions such as nongovernment organizations, local government units, and IRRI.

Cambodia

The need for mechanical dryers in Cambodia sprang from the proliferation of combine harvesters in the country.

Now, with around 2,000 combines being used, large amounts of grain harvested need to be dried. Sun drying is no longer suitable (see *Machines of progress*, Vol. 9, No. 3, pages 38 to 41 of *Rice Today*). Thus, the ADB-IRRI project transferred the flatbed dryer from Vietnam to a local manufacturer in Cambodia.

From one demonstration unit installed with a farmers' group in 2007, Cambodia now has hundreds of flatbed dryers. The private sector has realized the benefits of mechanical drying and several companies have invested in the technology. Nou Kim Sean, a rice miller who partnered with the project, has now designed a recirculating batch dryer—the next level of the technology. In 2012, IRRI tested the dryer and assisted him in coming up with an improved second version.

Key ingredients

Previous attempts to introduce mechanical dryers for rice have failed because of unsuitable technologies, high fuel costs, and markets that accepted sun-dried paddy without a price penalty.

However, increased harvest volumes and markets becoming more quality-conscious pushed the need for mechanical dryers in Southeast Asia over the last decade.

Within a few years, neighboring countries adopted the dryers because of the dryers' adapted design, the use of rice husk as fuel, as well as the facilitation of technology transfer and support to local manufacturers.

Each country had local champions who drove the technologies even beyond project horizons. Multistakeholder platforms such as learning alliances helped in linking actors across sectors, capturing the learning, and making it available for others.

All these were key ingredients that helped move flatbed dryers from Vietnam across Southeast Asia.

Mr. Gummert is a postharvest expert and Ms. Mendoza is a communication specialist at IRRI.

For a related video about the flatbed dryer in Cambodia, see http://youtu.be/ldsReKPINOE

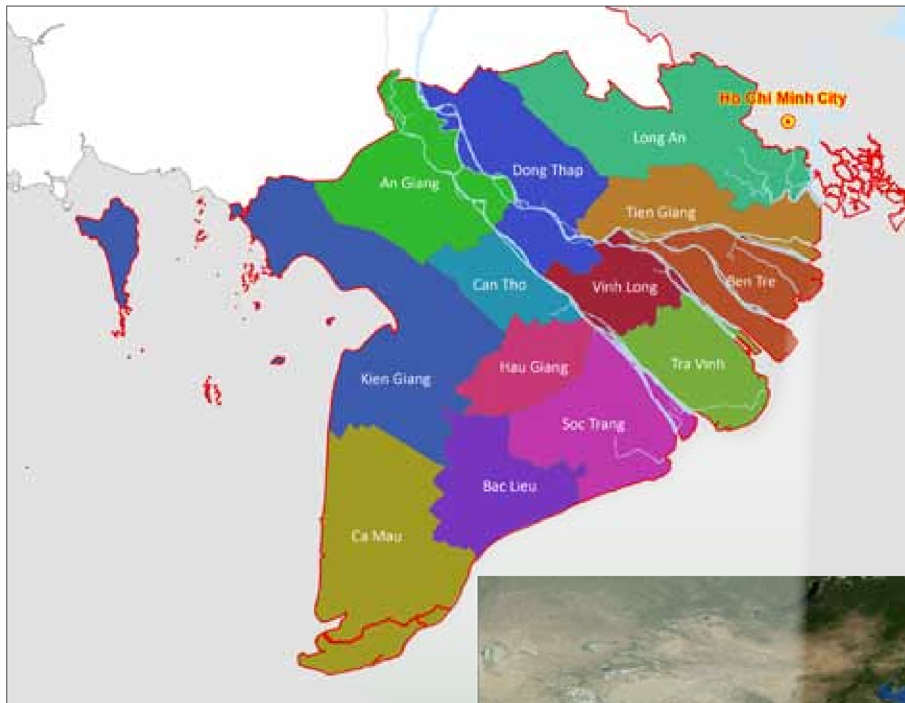
AN IRRI technician assists in installing a privately owned flatbed dryer with rice husk-fueled furnace at the foot of Mt. Sierra Madre in Cagayan Valley, Philippines.

TRINA LEAH MENDOZA

Appeasing "nine dragons" enraged by climate change

by **Sophie Clayton** and **Paula Bianca Ferrer**

One of Southeast Asia's top rice exporters finds ways to deal with the wrath of climate change



MAP BY: NEL GARCIA

Vietnam's Mekong Delta.

Vietnam's mighty Mekong Delta comprises nine river mouths that give it its local name, "Cuu Long," or "nine dragons." Every year, it supplies Vietnam with around 20 million tons of rice, which is about 50% of the country's total production. But, the significance of the rice supply from the Mekong Delta goes beyond Vietnam's own 91 million rice consumers.

In 2011, more than 6 million tons of the Mekong Delta's rice production were exported, making Vietnam the second-largest rice-exporting country in the world. The country's rice production could be critical to rice-importing nations, especially African countries, as it provides a pool of "cheap" rice that is traded globally alongside the more expensive premium rice coming from other major exporters such as India and Thailand.

Under threat of climate change

Poking out into the South China Sea, the Mekong Delta is exposed to sea-level rises along its extensive coastlines on its western, southern, and eastern boundaries. It is also the drainage point for the nearly 5,000-kilometer-long Mekong River and the entire Mekong Basin of 795,000 square kilometers.

Changes in rainfall distribution across the Mekong Basin and increases in extreme rainfall occurrences will affect river discharge, or the amount of water that flows through the riverbed, and alter hydrological patterns, including the magnitude, frequency, and duration of high and low flows within the Mekong Delta. Thus, the risk of flooding will grow across the delta's vast rice-growing areas.

Rice farmers in the Mekong Delta are no strangers to coping with floods. However, in 2011, flooding came earlier and was worse than normal, according to Dr. Nguyen Hieu Trung, dean of the College of Environment and Natural Resources at Can Tho University in Vietnam.

Sea-level rise is predicted to further block the river discharge into the sea, thus increasing flooding and aggravating salt-water intrusion in rice-growing areas. And, as rainfall patterns change, low or late rains at the start and end of the rice cropping season may result in drought, which could limit the productivity of rice farms.

Getting CLUE'd up

"If the world wants our farmers to keep producing rice, then we must help them prepare for climate change," said Dr. Trung.

Aiming to help farmers adapt their rice farming practices to climate change, the CLUES project (*Climate change affecting land use in the Mekong Delta: Adaptation of rice cropping systems*) could not have come at a better time.

Supported by the Australian Centre for International Agricultural Research, its goal is to help rice farmers in the Mekong Delta. It brings together a mix of international and national research and development partners, including the International Rice Research Institute (IRRI) as project leader, Australia's Commonwealth Scientific and Industrial Research Organisation, the International Water Management Institute, Can Tho University, Cuu Long Delta Rice Research Institute, Southern Institute for Water Resource Planning, Institute for Agricultural Sciences in South Vietnam, and the Departments of Agriculture and Rural Development in Mekong Delta provinces along a transect from the coastline to the inner sections of the delta.

"The CLUES project is the first of its kind in that it focuses on rice production and climate change in a region-specific context," said Dr. Reiner Wassmann, CLUES leader and head of climate change research at IRRI.

"We started CLUES in 2011, but the work builds on a strong history of collaboration with our partners in Vietnam with whom we have been working for many years," he added.

Deploying good varieties

One focus of CLUES is to help Vietnam speed up the development and deployment of rice varieties with improved tolerance of submergence and salinity.


IRRI (2)

DR. NGUYEN Thi Lang of the Cuu Long Delta Rice Research Institute (CLRRI) shows a variety they use in their breeding trials.

Dr. Nguyen Thi Lang, head of the Genetics and Plant Breeding Division at the Cuu Long Delta Rice Research Institute, explained that, ideally, they want to breed new rice varieties that combine submergence and salt tolerance, resistance to local diseases, and the capacity to grow well on acid-sulfate soil, which is a locally occurring soil type.

From March 2011 to July 2012, CLUES partners conducted extensive field trials in three provinces within the Mekong Delta (Bac Lieu, An Giang, and Hau Giang) and Can Tho City. These trials were used to select suitable rice cultivars with improved tolerance of salinity, submergence, stagnant flooding, and acid-sulfate soil. By November 2012, Vietnam had officially released 15 new rice varieties for commercial production that incorporated some of these traits.

When it gets salty and dry

The CLUES team is also working with the German Agency for International Cooperation (GIZ) on the project *Adaptation to climate change through the promotion of biodiversity in Bac Lieu Province* to help local farmers manage saline and dry conditions.

In July 2012, CLUES and GIZ teams organized a participatory varietal selection activity for Bac Lieu farmers.

Mr. Nguyen Van Trung, 44, a farmer in Bac Lieu, used to grow normal varieties, but now that he has seen these new varieties, he said that he would like to try them.

In addition, the GIZ team, headed by Mr. Joachim Hofer, has initiated a CLUES training course on alternate wetting and drying (AWD)—a water management technique that reduces water use by 15–30% without yield losses. After the course, about 200 farmers used AWD during the autumn-spring season of 2011 and 2012 in Bac Lieu. With AWD (see *Saving water: alternate wetting and drying* on page 17 of *Rice Today* Vol. 8, No. 3), farmers can save 2 to 4 million dong (US$96 to $192) per hectare on fuel costs plus retain their yields, if not get a little more.

Moreover, AWD can successfully reduce greenhouse gas emissions from rice production when used with good nutrient management. Now, CLUES is also looking for smarter ways to assess the differences in greenhouse gas emissions with different management techniques in growing rice.

Climate change may be fast taking hold of Vietnam's "nine dragons," but, hopefully, it won't drastically impair rice production given the promise of newer varieties and smarter technologies.

"If the world wants our farmers to keep producing rice, then we must help them prepare for climate change."

Dr. Nguyen Hieu Trung, dean of the College of Environment and Natural Resources, Can Tho University in Vietnam

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Ms. Clayton is the public relations manager while Ms. Ferrer is a public relations specialist at IRRI.

See related video clip on sea-level rise and rice production on YouTube at http://youtu.be/_XVC407evTg.

James Johnson

These rice experimental fields in Los Baños, Laguna, Philippines, have been the location for IRRI's breeding work in meeting the needs of farmers for varieties that are high yielding; tolerant of drought, flooding, and salinity; and resistant to diseases, among other important traits. More than 900 IRRI lines have been released in 78 countries, across five continents, since IRRI's first batch of crosses in 1962. Recently, IRRI bred its 100,000th cross—a celebrated milestone in its breeding history.

Rice booms in Turkey

by **Guy Manners**

With its sound and enabling policies, Turkey's rice research and production have nowhere else to go but up

TARI (3)

Turkey has the third-highest average rice yield in the world (behind Australia and Egypt), which reflects sustained investment in research and extension over the past 33 years.

Rice production in Turkey has risen sharply since the mid-1990s and rice is now the fifth most widely grown cereal, behind wheat, barley, maize, and rye. The area of rice grown is less than one-eightieth of that for wheat; thus, rice is still not a major crop or a major food item in Turkey (an average person eats 7–8 kilograms of rice per year compared with 200–250 kilograms for wheat). But, Turkey is a striking example of how a country can create a policy environment conducive to crop breeding and successfully reach out for help in overcoming key constraints to increasing yield.

Area, yield, and production

For the past 50 years, the area of rice grown in Turkey has varied between 40,000 and 100,000 hectares. This variation is largely explained by water availability and rice prices. The area harvested has increased markedly since the early 2000s. All of Turkey's regions produce rice, but the western and northern regions of Marmara and Black Sea, which have the best climate and water availability, account for over 92% of total area and production.

Meanwhile, rice yield has followed a generally upward trajectory, from 3.4 tons per hectare in 1962. The increase in yield has accelerated since the late 1990s, coinciding with the expansion in area.

The combined effect of increasing area and yield on national rice production has been considerable. From the 1960s to the 1990s, the average annual production was 260,800 tons. But, it has increased steadily since 1996 and, in 2011, some 900,000 tons of paddy were produced from 99,400 hectares—an average yield of 9.05 tons per hectare.

The country now meets more than 90% of its domestic demand for rice. Many rice-producing countries would be happy to import just 10% of their rice, but not Turkey. Backed by the government, rice research and development practitioners are determined to see the country fully self-sufficient in rice grain and seed as soon as possible.

The role of research

The government of Turkey took the lead in increasing the country's rice production, creating an "enabling

MAP BY: NEL GARCIA

policy environment" with the twin aims of promoting and protecting rice production. It met the first aim by funding the development of irrigation infrastructure, and then reducing the cost of the electricity needed to run it. It met the second by paying premiums for domestic rice (US$50 per ton in 2006).

Research was—and remains—a key factor behind Turkey's impressive yield increases. This has focused on breeding, agronomy, and seed production. Much of this work has been carried out at the Trakya Agricultural Research Institute (TARI) in the Marmara region and some at the Black Sea Agricultural Research Institute in the Black Sea region. Dr. Necmi Beşer, TARI director, has no doubts about the role that TARI and its partners are playing: "The most important research has been developing high-yielding varieties," he says. "Fifteen years ago, Turkey grew mainly foreign varieties; now, nearly 100% of the rice grown in Turkey is Turkish varieties."

Before the 1990s, TARI introduced rice varieties from other temperate countries, for farmers to plant and for use in breeding programs. In 1990, Turkish rice production was dominated by introduced varieties. But, in the second half of the 1990s, Turkish-bred varieties (mostly bred from crosses among introduced varieties) were released.

One of these was Osmancık-97, released in 1997, a high-yielding semidwarf variety that has desirable traits of a translucent kernel, a high milling yield, and tolerance of endemic diseases. Farmers, industry, and consumers greatly appreciated this variety, and, within a decade, Osmancık-97 accounted for 80% of domestic production.

TARI researchers also demonstrated the value of using high-quality certified seed. The government supported this and rice farmers took it up eagerly, quickly recognizing its benefits. Today, TARI produces all of the foundation seed[1] for all of the varieties grown in Turkey. This is sold to private companies and state farms, which use it to produce the certified seed that they sell to farmers. Thus, there is good collaboration from variety improvement to seed marketing to farmers. In fact, the country is already more than self-sufficient in seed production and is exporting its seed surplus.

The semidwarf varieties developed by TARI opened the door for the mechanization of rice production. Farmers began to use new machines, such as combine harvesters and seed dryers. Among the more sophisticated implements now used are laser-guided land-levelers, which small-scale farmers can rent. These machines flatten the soil, which helps with crop establishment and more efficient water management and fertilizer and pesticide use—all of which increase yield.

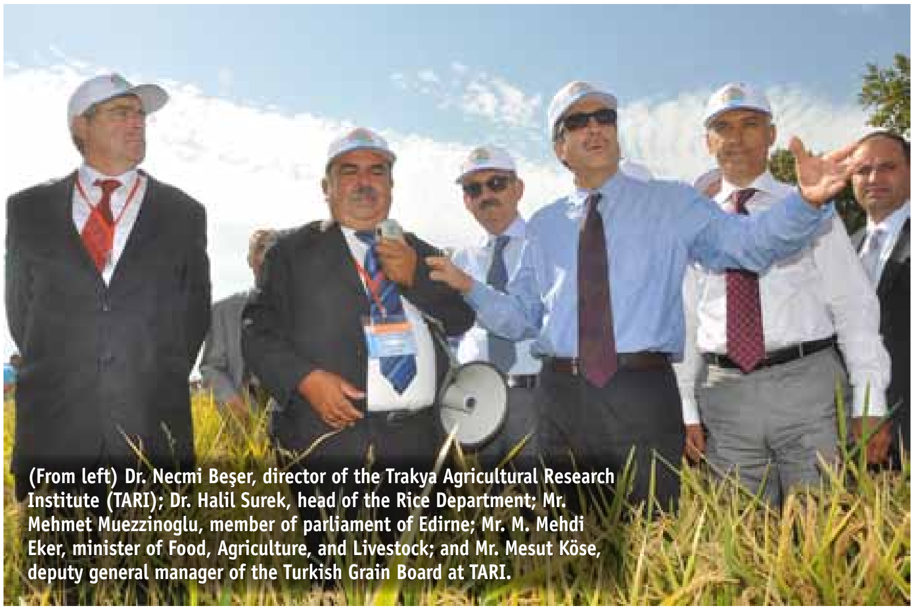
TARI spent 20 years optimizing fertilizer use in Turkish rice cultivation. Its recommendations for the timing and rate of applying nitrogen and phosphate fertilizers mean that farmers can now apply the optimum amounts at the right time. This maximizes the plants' use of these minerals and, consequently, farmers' yield and profit.

The large uptake of these recommendations is largely down to a dynamic extension program that has targeted rice farmers with visits, seminars, conferences, demonstrations, television programs, field days, leaflets, and advice dispensed with inputs.

Challenges to rice production

Fungal diseases such as bakanae, blast, and helminthosporium have long afflicted Turkish rice, and blast[2]

[1] Foundation seed is the progeny of breeder seed (seed that comes directly from plant breeders).
[2] Blast is a disease that causes white or gray-green lesions or spots on the shoot and causes the plant to produce fewer seeds.



(From left) Dr. Necmi Beşer, director of the Trakya Agricultural Research Institute (TARI); Dr. Halil Surek, head of the Rice Department; Mr. Mehmet Muezzinoglu, member of parliament of Edirne; Mr. M. Mehdi Eker, minister of Food, Agriculture, and Livestock; and Mr. Mesut Köse, deputy general manager of the Turkish Grain Board at TARI.

has been a serious problem since the 1990s, devastating the crop in Marmara in 1997.

"Of all the challenges that stand between us and self-sufficiency in rice, blast disease is the worst," says Dr. Beşer.

In 1995, blast affected 25,000 hectares of the 85,000 hectares of rice grown that year, causing 20–25% yield loss in affected areas. Area affected and yield losses were even greater in 1997. Blast thrives in damp conditions and the damage it inflicts is greatest in years with increased rainfall and cloud cover, and in fields that receive high amounts of nitrogen fertilizer and no crop rotation (rice is grown in the same field year after year). Under such conditions, blast can completely destroy a rice crop. "Osmancık-97 tolerates blast—that is, it still produces a yield despite infection—but, we desperately need more and better blast-resistant varieties," says Dr. Beşer.

Enter the Temperate Rice Research Consortium (TRRC), a small network of national research programs from across the world's temperate rice-growing areas.

The TRRC, which is supported by the Rural Development Administration of South Korea and the International Rice Research Institute (IRRI), brings together developed countries—Australia, China, Japan, South Korea, and the United States—with developing countries—Bhutan, Chile, Indonesia, Kazakhstan, Nepal, the Philippines, Tanzania, Uruguay, and Uzbekistan. "Rice researchers in temperate countries are typically isolated," says Dr. Russell Reinke, TRRC coordinator. "The consortium provides an annual meeting for those 50–60 persons to discuss and share ideas and breeding materials."

Turkey joined the TRRC in 2009, two years after its creation. The TRRC has three working groups, which look at yield and quality, dissemination of genes with disease resistance, and cold tolerance. Turkey is primarily involved in the first and second of these. One line of research is increasing resistance to blast (see box).

Although blast is the biggest headache for rice producers, Turkey's efforts to achieve rice self-sufficiency face many other challenges. The most important of these is the shortage of water for irrigation as a result of low rainfall, rivers with low water flow, and untapped potential (shortage of dams). TARI has been working to increase the efficiency of irrigation, including the use of drip irrigation; meanwhile, the government still sees scope for building more dams to expand irrigated areas.

Lessons for other countries

So, what can other countries learn from Turkey's experience? Perhaps the first lesson is that the rice sector can expand and improve rapidly

COMBINE HARVESTERS are used in Turkey's rice production.

Making rice resistant to blast

A major hindrance to dealing with blast disease is the lack of resistance among japonica rice varieties, which are grown in temperate countries such as Turkey. In 2007, Dr. Kshirod Jena, IRRI's senior rice breeder and former TRRC coordinator, and his team (then based in South Korea) discovered a new broad-spectrum blast-resistance gene.

To make the gene available to the rice-breeding community, Dr. Jena and his team transferred the resistance gene—dubbed *Pi40*—into two South Korean japonica varieties using a DNA marker-assisted backcrossing strategy (breeding the progeny of the original cross with the South Korean japonica parental variety).

In November 2010, IRRI and TARI launched a project to transfer *Pi40* into two popular Turkish varieties, Osmancık-97 and Halilbey, using conventional and genetic marker-assisted breeding techniques. Dr. Jena and his team used the two South Korean japonica breeding lines as the source of the *Pi40* gene.

In 2011, TARI planted material carrying different blast-resistance genes, including *Pi40*, at 12 test sites in Turkey. "Only eight of the sites were affected by blast, but even at these sites the *Pi40* gene-carrying lines were all resistant to the disease," says Dr. Beşer. "We also have early-generation segregating material from the crosses based on Osmancık-97 and Halilbey, made for us at IRRI, which have the *Pi40* gene. We are evaluating these for desirable agronomic characteristics. Meanwhile, backcrossing to the Turkish parental varieties is continuing at IRRI."

The latest generation of materials is ready for DNA and field evaluation in 2013. The DNA (marker) tests will show which lines have the *Pi40* gene, while the field evaluation will confirm field resistance to blast and the retention of the Turkish varieties' plant type. The goal is to have new varieties so similar to Osmancık-97 and Halilbey that they cannot be differentiated, except when blast infects the susceptible parent varieties.

If, or rather when, the *Pi40*-carrying versions of the Turkish varieties are available to farmers across the country, farmers as a whole will save the US$5 million that is spent annually on fungicides to prevent and control blast, and the Turkish environment will benefit from not having these chemicals "pumped" into it. ■

when a government supports it. This is not new—we can look, for instance, at the response of some African countries to the rice price crisis in 2007-08[3]—but it is a useful reminder of the government's role, especially at a time of austerity when cash-strapped governments are looking to make cuts. Government intervention can take several forms: infrastructure development (particularly irrigation), support for research and development, direct subsidies and premiums, and import tariffs (up for imported rice, down for farm machinery).

Where suitable land remains, area expansion is almost always a fast track to increased production. If this can be combined with increased yield (as in the case of Turkey), so much the better. However, it is important to ask what is *not* being produced as a consequence of rice spreading to new areas, and whether rice makes the best use of scarce resources, especially water. And, if completely new land is brought into cultivation, what is the loss to biodiversity and other natural capital?

Making connections is also important; remember, you are not alone! Whatever your role in the rice value chain—agronomist, extension agent, farmer, processor, trader––other people out there are also doing the same job. You just have to find them and connect.

For Turkey's rice researchers, this happened through the TRRC and IRRI. Turkey's success in rice production could not have happened without these relationships. IRRI's role is to provide international public goods for the benefit of all, especially in Asia and Europe.[4] For Turkey, the timing of collaboration was fortuitous—Dr. K.K. Jena, IRRI rice breeder, had just discovered *Pi40* (blast-resistance gene)—but years of research lay behind that discovery. And, even if *Pi40* were to fail, there is still a wealth of knowledge on blast and blast resistance to be tapped once again if, or rather when, resistance breaks down.

In September 2011, Turkey was one of a group of countries that, along with IRRI, established the Regional Rice Research and Training Center for West and Central Asia (RRRTC-WCA) in Iran. At its first meeting a year later, the Center's international management team elected TARI's Dr. Beşer as its first president, and prepared the terms of reference for the Center. This training center will focus on advanced research and the training of researchers and practitioners. Areas covered will include crop improvement, crop and resource management, and climate change. In particular, the Center will develop and test (across its mandate region) rice resilient to extreme climate changes—tolerant of drought, heat, and salinity. Turkey will play a leading role in this initiative as it is one of only two member countries with substantial rice research capacity—the other being Iran. (See *Country highlights: Iran and IRRI* on page 36).

Guy Manners is a science writer with Green Ink (www.greenink.com.uk).

The author would like to thank Dr. Beşer, Dr. Jena, Dr. Reinke, and IRRI Deputy Director General for Research Dr. Achim Dobermann for their help with this article.

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[3] Africa Rice Center. 2011. *Lessons from the Rice Crisis: Policies for Food Security in Africa*. Cotonou, Benin: Africa Rice Center.

[4] For Africa, the main source of assistance is the Africa Rice Center (AfricaRice); for Latin America, it is the International Center for Tropical Agriculture (CIAT).

A CLOUD-PIERCING 24/7 Eye in the sky

by **Roman Skorzus, Cornelia Garcia, Alfie Bacong, Francesco Collivignarelli, Alice Laborte,** and **Andy Nelson**

Recent advances in remote sensing are quite exciting. A case in point is the availability of high-resolution synthetic aperture radar (SAR) sensors on board satellites, such as the COSMO-SkyMed (CSK) constellation. These sensors can deliver precise and timely information about the status of rice crops to users in any part of the world.

SAR sensors differ from optical sensors. They can operate regardless of cloud cover and daylight, which guarantees observations of rice crops even during the monsoon or rainy season.

Regular observations at high resolution—with pixel size of only 3 meters—mean that all stages of a rice crop can be monitored at the field level and these images can provide useful information on crop management, crop production, and crop losses from natural calamities.

Figure 1 shows a composite of three SAR images between June and July 2012 of rice fields in Leyte, Philippines, from the RIICE project (Remote sensing-based Information and Insurance for Crops in Emerging Economies).

By assigning a color to each image, we can combine the red, green, and blue images into one *color composite* to show different rice planting dates. The blue field shows the area covered with water on 25 June and 11 July, meaning that planting occurred in mid- to late July. The red field is one that was under preparation and flooding in July and then was planted in early August. Gray areas are those where there is no change—light gray or bright areas are built-up or urban areas, gray tones are natural vegetation or other natural land cover, and black is permanent water. The inset map shows the level of detail that can be achieved with individual plots clearly visible.

Different dates of rice planting over a small area indicate irregular irrigation in general, which has implications for pest and disease management and can potentially lead to higher management costs and/or lower yield.

With these maps, we can suggest priority areas for irrigation maintenance or rehabilitation, and give advice on how and where to promote more effective and efficient crop management.

Changes in rice area from one year to the next or crop damage due to calamities such as drought, flood, and typhoons can be monitored with SAR imagery, which can provide governments, disaster response agencies, and crop insurance companies with accurate and timely information.

For long-term goals such as rice self-sufficiency, reliable statistics about rice area (Fig. 2) can support national and regional decision making. IRRI is collaborating with Philippine Rice Research Institute (PhilRice), GIZ (German Agency for International Cooperation), Allianz, and sarmap to develop rice information systems for such stakeholders.

Acknowledgments: We thank e-GEOS for the provision of COSMO-SkyMed imagery and the RIICE consortium partners—PhilRice, sarmap, GIZ, Allianz, and the Swiss Agency for Development and Cooperation (SDC)—for conducting and supporting this work. All images were generated with RICEscape (sarmap). See more information on the RIICE project at www.riice.org.

Mr. Skorzus is an IRRI M.S. thesis scholar and GIZ intern and Ms. Garcia is a researcher and cartographer in IRRI's GIS laboratory. Mr. Bacong is a science research analyst at PhilRice. Mr. Collivignarelli is a remote-sensing specialist for sarmap. Dr. Laborte is a postdoctoral fellow and GIS specialist. Dr. Nelson is a geographer and head of the GIS laboratory at IRRI.

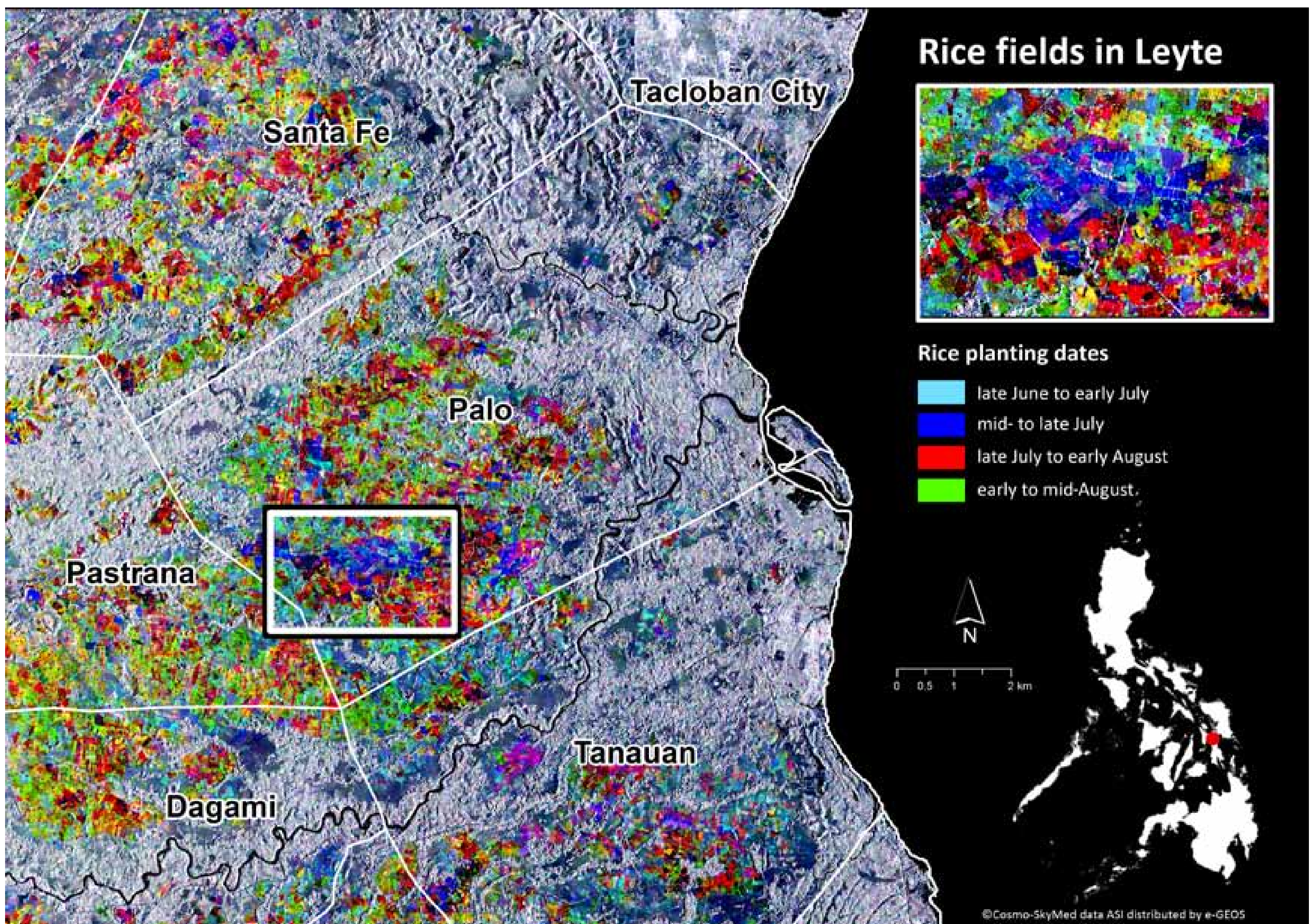


Figure 1

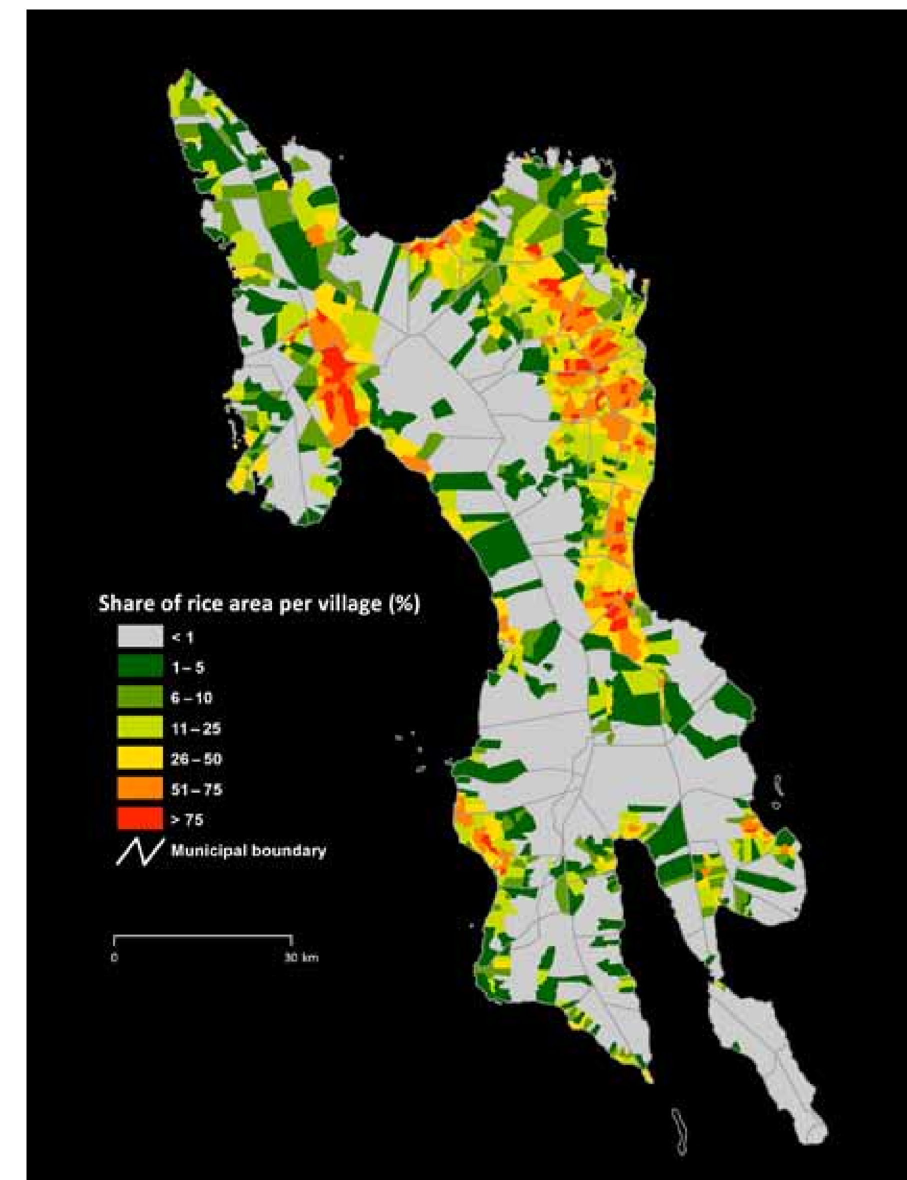


Figure 2

Green fuel from rice

by **Paula Bianca Ferrer**

What to do with straws, husks, and other rice residues when these waste by-products keep on piling up

GASIFIER SYSTEMS could provide a cleaner, greener way to harness the energy potential of rice husks in the future.

STEPAN HAEFELE (2)

Farmers typically grow two or three crops a year. Since they don't have enough turnaround time before beginning the next planting season, they resort to the quickest and easiest solution to get rid of the rice "waste," that is, the residue—by burning. This releases methane, a greenhouse gas that remains in the atmosphere for 9–15 years and contributes to global warming. On top of this, exposure to smoke and soot causes respiratory problems among farmers and townspeople alike.

Waste not, want not

"Rice straw and husks offer an immense potential to create bioenergy, an alternative renewable source of power," said Dr. Stephan Haefele, senior researcher at the International Rice Research Institute (IRRI). He and his scientific team have been exploring ways to turn rice residues into useful and valuable by-products to support more efficient, productive, profitable, and sustainable rice farms.

"Rice residues can produce bioenergy and at the same time reduce the negative effects of rice production systems on the environment; they could also be a source of extra income for farmers," said Dr. Haefele.

Moreover, rice residues and production systems have several decisive advantages over many other bioenergy crops, he explained. Unlike crops grown exclusively for biofuels, using rice residues to generate energy would not divert land use away from food production. It has also been shown that, even if all rice residues are removed, the quality of rice soils is unaffected. Residue removal for energy production directly reduces the emissions of greenhouse gases caused by field burning or by residue incorporation into the soil. Also, the high cropping intensity in irrigated rice systems ensures a constant residue supply and keeps transportation time to processing centers short.

Backyard fuel

In 2011, Dr. Haefele and his collaborators analyzed the energy and carbon life-cycle of existing gasifiers that turn rice residues, without burning them, into gases that can be used as an energy source. Such gasifiers are increasingly common in Cambodia, where rice millers want to make use of the husks that pile up in their backyards.

Each ton of husk gasified can save about 1 ton of greenhouse gas emissions (CO_2) compared to current uses. The energy needed to build and operate a gasifier was produced by the gasifier within 245 days of operation. And, it took only 109 days of gasifier operation to save as much carbon as was emitted to build and establish it. Looking at the rice production system, a 1-hectare irrigated rice field can produce 12 tons of husk and straw per year, which can be converted to clean energy in a medium-sized gasifier equivalent to about 1,800 liters of diesel.

More power to farmers

"These results show the potential of residues as an energy source, and as an option to make rice cultivation even more sustainable," said Dr. Haefele.

"We now intend to investigate rice straw. Quite a lot of research has been done on rice husks but little is known about the use of rice straw. We will try to answer how best to collect straw, how to store it, and whether pretreatments, such as leaching, drying, and/or briquetting, are necessary.

"For the most promising systems, we plan to conduct a life-cycle analysis and to develop complete business models," he added. "We are also testing what effects biochar—a by-product from straw and husk burning—has on soil quality in various rice production systems, and determine its optimal uses and look at how to participate in emerging carbon markets."

Ms. Ferrer is a public relations specialist at IRRI.

The first palay

retold by **Alice Flinn-Stilwell**
illustrated by **Sherri Maigne Meneses**

This Philippine folklore about the origin of rice has been told in various ways in many a gathering as it was passed from generation to generation.

Long ago, when the world was new and peaceful, trees grew tall and strong, flowers bloomed, oceans and swift rivers rippled under sunny skies, and animals roamed in abundance.

All people were hunters and gatherers. They moved from place to place, living under leafy shelters or in dry caves. Food was easily available. Fish were easy to catch, fruits and tubers were plentiful, and they could always trap an animal to roast.

Makisig and Liwayway lived happily. Life, like the world around them, seemed idyllic. Being newly married, they wanted time to be alone, so they moved their camp away from the clan and closer to the sea.

Late one afternoon, Makisig returned from collecting shellfish from the rocks near the shore.

"Liwayway, I like this place," he said.

"Me, too!" Liwayway replied, taking the laden basket from him.

The setting sun caught the crests of the waves and turned them from golden orange, then red, until the sun disappeared below the horizon of the South China Sea. The fragrant warmth of the night enveloped the contented couple.

Liwayway soon became pregnant. They were both delighted and they decided to stay in their own place, where Makisig cut bamboo to build a stronger shelter.

But then, the expected rains did not come. The sun continued to shine every day, the soil dried and cracked, the leaves on the trees turned brown and fell, and animals left in search of food.

Makisig had to walk farther each day searching for something to fill their food basket. He knew good food was important for his wife and their coming child. Sometimes, he ate only a few berries, saving the more succulent ones for Liwayway.

One hot afternoon, Makisig trudged a long way. He found nothing to eat. He searched in a small valley, but found nothing. He trudged on up a steep hill to find only yellowing grass. Exhausted, he lay down under a small scrubby tree.

He lay with his eyes closed, tired, worried, but enjoying the respite from walking. After a while, a light cooling breeze fanned him. Feeling refreshed, he opened his eyes.

"I must be dreaming," he thought, "the grass is dancing."

He shut his eyes and rested again. Then he heard sounds like music. The dry grass rustled rhythmically, and seemed to say, "Makisig, we want to help. We have something for you. Pick our grains. We are good food and delicious."

Makisig peered through half-opened eyes, then looked again more closely. He stared in disbelief. The grass was bowed down with grains. He struggled to his feet and picked a drooping stalk.

"Smells good!" he said aloud.

The breeze rustled the grass again, and seemed to say, "Pound the grains lightly with a stone to remove the golden brown husk. Boil the pearly white parts. The grains are good."

Makisig doubted that this dry hard grain could taste good. But, his basket was still empty, so he filled it with heads of this grass and set off home.

"We can only try," he thought.

As he reached their bamboo shelter, he worried.

"Did I imagine it all?" But, his basket was full, so he told Liwayway the whole story. They removed the husks, and the white grains were soon bubbling in a clay pot over a fire.

What the grasses told Makisig was true. The hard grains softened, and also became much larger. They put the hot grains on banana leaves to cool, added a few small fish, and sat down to a feast.

"Mmm, delicious!" said Liwayway.

"And how good to feel full," murmured Makisig.

They slept well that night.

Makisig returned the next day to cut as much grain as he could carry. The wind whispered again. "Plant the best grains in the valley, in muddy soil. If it doesn't rain, carry water from the river. The plants will grow lush and green and will give you more grains—plenty for you and Liwayway, and for the new child. In time, there will be enough to share with your clan. Call the grains *palay*!"

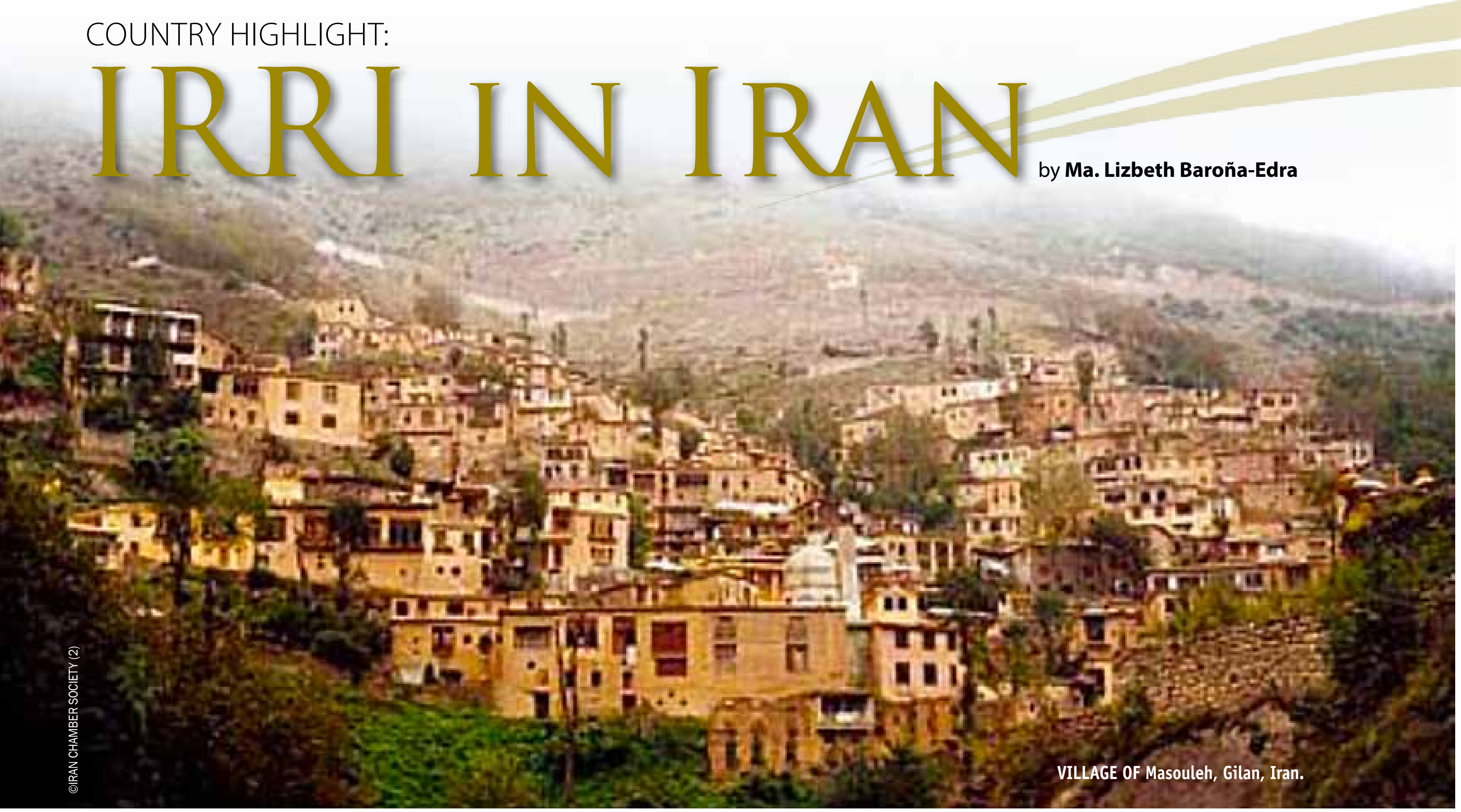
Makisig and Liwayway never went hungry again, nor did their clan. Soon, all were growing this wonder grain.

Ms. Flinn-Stilwell is a writer based in Hobart, Australia. This story is part of her forthcoming book, Rice–a grain with many stories, *a collection of 28 legends about rice and the many customs associated with this amazing grain. Ms. Meneses is a communications associate at IRRI.*

COUNTRY HIGHLIGHT:

IRRI IN IRAN

by **Ma. Lizbeth Baroña-Edra**



©IRAN CHAMBER SOCIETY (2)

VILLAGE OF Masouleh, Gilan, Iran.

Rice research and training activities are intensifying in the West-Central Asia region (see *Rice booms in Turkey*, pages 26-29), as rice demand is projected to increase by 33% in 2020.

Iran belongs to this region and it is well on its way to meeting this projection. The country now has the biggest area of rice production in this region at 626,000 hectares. Most of this is located across the Caspian belt in Gilan and Mazandaran provinces, and the rest is located in 13 other provinces with distinct and varying agroclimatic zones.

Berenj, Persian for rice, is one of the staples consumed in Iran, along with wheat, sugar, honey, and fruits. The average Iranian consumes about 34 kg of rice annually, and most consumers prefer rice that has high grain quality and is aromatic. In 2010, Iran produced about 2.3 million tons of rice, with an average of 4.8 tons per hectare.

The International Rice Research Institute (IRRI) and Iran are embarking on projects that seek to develop better rice varieties. Specifically, these projects are

Iran: fast facts (2010)

Population:	74.7 million[1]
Total rice production:	2.3 million tons[2]
Average rice yield:	4.8 tons per hectare[3]
Area planted to rice:	626,000 hectares[3]

[1] Word Bank (2011).
[2] World Rice Statistics (2010).
[3] Rice Research Institute of Iran (2009).

developing molecular markers to eliminate chalkiness in rice kernels to improve rice quality. Partnerships also seek to produce salt tolerance to help the salt-affected rice areas in the country and help create resistance to sheath blight disease, as well as develop high-yielding rice with long grain and aromatic quality (often called Sadri rice).

Working with IRRI

Even before trends showed an increase in future demand, Iran and IRRI had been working together. The year 1976 marked the start of collaboration following a memorandum of agreement between the Iranian government's Research Organization of Agriculture and Natural Resources, Ministry of Agriculture and Natural Resources, and IRRI.

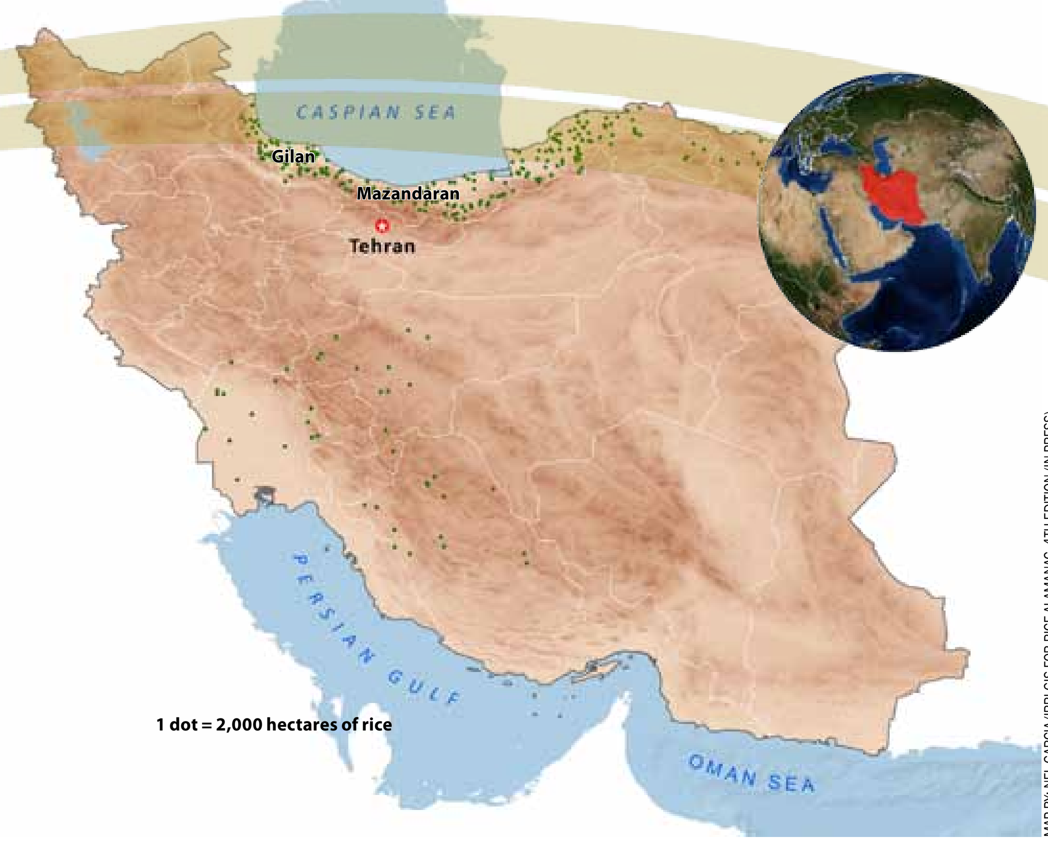
In 1990, a one-year work plan was signed for scientific and technical cooperation between Iran's Ministry of Agriculture and IRRI. IRRI scientists have since visited Iran to monitor existing projects in the country and several work plans have also been signed to support these collaboration and capacity-building partnerships.

In a visit to IRRI in April 2010, deputy minister of the Jihad-e-Agriculture of Iran, Dr. J. Pourhemmat, made an agreement with IRRI Director General Robert Zeigler to open the Regional Rice Research Training Center-West Central Asia (RRTC-WCA) at the Rice Research Institute of Iran (RRII) in Rasht.

This cooperation focuses on strategic rice research and training. This is together with Governor of Gilan Province R. Ghahremani, RRII's Director General Dr. K.A. Shahdi, and the Agriculture Biotechnology Research Institute of Iran (ABRII)'s Dr. M. Khayam Nekooyi.

In September 2010, IRRI's head of research, Dr. Achim Dobermann, and a team of IRRI scientists composed of Dr. Jauhar Ali, Dr. Melissa Fitzgerald, Dr. Casiana Vera Cruz, and Dr. Arvind Kumar visited RRII to strengthen rice research cooperation and promote collaborative ties with Iran.

Dr. Shahdi said that he was looking forward to leaving behind past obstacles that had hindered greater rice production in Iran. "We are committed to the best in rice research now and into the future," he added. "Rice is the one thing in common between many nations of different cultures, races, and religions—it brings us together."



MAP BY: NEIL GARCIA/IRRI GIS FOR RICE ALAMANAC, 4TH EDITION (IN PRESS)

Exchanges

Iran is also seeking to understand the diversity of traits of Iranian rice, and to develop site-specific management best practices for the irrigated rice system in northern Iran. The country also wants to establish a regional climate change research facility to do multidisciplinary work and to study the impact of climate change on rice.

Through the International Network for Genetic Evaluation of Rice (INGER), Iran has received 11 varieties for further research and breeding. Iran has also contributed 21 rice varieties for conservation to the International Rice Genebank, while IRRI has released 1,035 samples to the country.

Fifty-three Iranian scholars pursuing doctorate and master's degrees, interns, and fellows have been trained at IRRI. Moreover, 101 have gone through IRRI's short training courses.

Since 1976, Iran has contributed around $2.8 million to CGIAR to support international agricultural research, including IRRI's research.

IRRI has also been honored by awards given by Iran. The first was in August 2000, when Dr. Gurdev Khush, IRRI's then principal plant breeder, received a Plaque of Appreciation and a Gold Medal from Dr. Issa Kalantari, who was then Iran's minister of agriculture. In February 2004, Iranian President Mohammad Khatami gave Dr. Khush the Khwarzimi International Award for Agriculture.

The working partnership between IRRI and Iran has been important and productive in advancing rice research and development. Dr. Shahdi believes that advanced global challenges couldn't be tackled without the consensus of the whole world on using cooperative strategies.

Ms. Baroña-Edra is a public relations specialist at IRRI.

TERRACED RICE fields in Iran.

Global rice trade faces uncertainty in 2013

by **V. Subramanian**

All eyes are on the rice policies of Thailand and India, China's growing imports, and global rice production in the face of climate change

The Rice Trader's 4th annual World Rice Conference revealed that the global rice market was hinged on political decisions that would dictate rice exports, while climate change added volatility to rice production output and price trends.

About 450 delegates gathered in Bali, Indonesia, in September 2012 to look at these issues and at what experts thought would shape global markets.

Leading concerns of 2012

Important economic and political developments have been rocking India and Thailand, making them the major players in 2012. Deep concern for these countries arose because of India's recent return to nonbasmati exports (and concerns over a late monsoon and impact on rice output) as well as Thailand's rice mortgage scheme, which critics deemed more "populist" than economical. China, on the other hand, turned out to be a significant buyer in 2011-12, and a force that arrived when many importers such as the Philippines and Bangladesh were reducing, if not stopping, rice imports. IRRI senior economist Dr. Samarendu Mohanty pointed to rice consumption and the need for an additional 116 million tons of rice by 2035 to feed the global population as he took a long-term look at rice demand.

He also discussed how the U.S. drought, the Indian monsoon, and climate change in general caused swift changes in supply.

Extreme weather affected global grain production more in 2012 than the 2008 crisis. However, rice markets were less affected by this tide of price increases that arrived on the back of severe drought in North America (comparable to the drought of 1988-89) compounded by food crop output limitations faced in Russia, the Black Sea region, South America, and Australia.

TRT (3)

CAMBODIAN Jasmine rice wins the Best-Tasting Rice Contest in 2012. Sarak Duong (*first on the left, front row*), associate operations officer for sustainable business advisory of the International Finance Corporation, receives the award on behalf of Golden Rice (Cambodia) Co. Ltd., from Jeremy Zwinger (*far right*), TRT CEO and president.

Thai surplus

Dr. Mohanty said that the bigger concern in global supply and demand was coming from Thailand's possible losses in export sales due to its uncompetitive prices.

Korbsook Iamsuri, president of the Rice Exporters Association of Thailand, revealed what many in the audience suspected: that Thailand could soon lose its prestigious position as the world's largest exporter, most likely to India, or Vietnam.

Although the Thai mortgage scheme is not new, the global situation—particularly with India's return—presented fresh challenges for Thailand. Quality problems (due to the degradation of stocks held over a long time) and the lack of price competitiveness were key worries.

With the competitive situation in mind, Ms. Iamsuri presented two possible scenarios: the current scheme, if left untouched, could leave Thailand in jeopardy; or, if the scheme is modified to allow a role for stakeholders and the Thai market to adjust and compete for specialty markets (such as parboiled rice), Thailand could retain a larger market share. Thailand could otherwise supply markets only if large supply shocks (associated with a swiftly changing weather system) affect rice markets.

Threat to Indian exports

India's rice exports constantly depend on government or political decisions, such as the one in 2008 that saw three long years of a nonbasmati rice export ban, said Tejinder Narang, advisor to Emmsons International.

MORE THAN 400 participants attended the TRT World Rice Conference 2012. Benjamin Lu of Lui Hing Hop Co., Ltd. (Hong Kong), and Chandra Hartono Jokowidajaja (*3rd from right and 2nd from right*) and Wanniwat Kitireanglarp (*right*) of Ponglarp Co., Ltd. (Thailand), smile brightly on the first day of the event.

The reality was that India's domestic economy, particularly food inflation concerns, tended to strongly affect the rice market through political decisions. Notably, Mr. Narang revealed that India's Food Security Bill, which will subsidize food for 65% of the population, would be the deciding factor for the long-term viability of Indian exports.

India, in the meantime, is expected to continue exports for most of 2013.

Indonesia boosts food security efforts

Sutarto Alimoeso, director of Indonesia's food agency Perum Bulog, emphasized Indonesia's efforts in attaining food security.

Global issues such as rising demand and rising energy cost pushed the agency to adopt a multilateral approach to food security that will meet national objectives through rice reserves and price stability. This is evident in the agency's local rice procurement that rose from just 1.9 million tons in 2010 to 3.41 million tons in 2012. The program supports 17.4 million households and must consider global developments while keeping an eye on national objectives.

Price trends

Jeremy Zwinger, president and CEO of The Rice Trader, said, "What we have in 2012 is a global grain market that not only mirrors the crisis in 2008." He said the market surpassed the 2008 record prices of corn (maize), wheat, and soy, while rice lagged behind the global grain market. North and South American markets saw a modest price reaction to tight supplies while Asia's market has ample supplies, which are weighing down the price.

CHEF MICHAEL Cross (*right*) stands undefeated as the Lord of Rice in 2012. He first won the recognition in 2011.

Mr. Zwinger added that 2012 was also different in that there was economic weakness seen in the Eurozone, U.S., and even the sturdy Chinese market to potentially temper demand and any speculative money from finding its way to rice markets.

Mr. Darren Cooper, senior economist of the International Grains Council, also reported on global grain market developments. He described the grain and oilseed markets as having "diverged from the global commodities complex" since June 2012.

Mr. Cooper also revealed that rice markets did not follow this high-price trend only because rice market fundamentals now do not support such a rising price. Although stocks were seen as ample, he asked, "How much of this supply is actually available to the market?"—revealing what could be an important element that affects price volatility and availability of rice.

Rice and the whims of climate

Elwynn Taylor, extension agronomist at Iowa State University, focused on climate change and its potential impact on global rice and agricultural production. He warned of the likelihood of El Niño and how temperature is on the rise, which could signal a risk of drought in several parts of Southeast Asia.

Mr. Taylor's forecasts revealed a volatile outlook for rice production in 2013: although India's production is expected to improve in 2013, global corn and rice supplies are likely to decrease, while wheat production is seen as stable.

China and other key players

In the midst of all these discussions, Hu Wenzhong, senior analyst at National Grain and Oilseeds Information Center in China, bared a rising trend in Chinese imports.

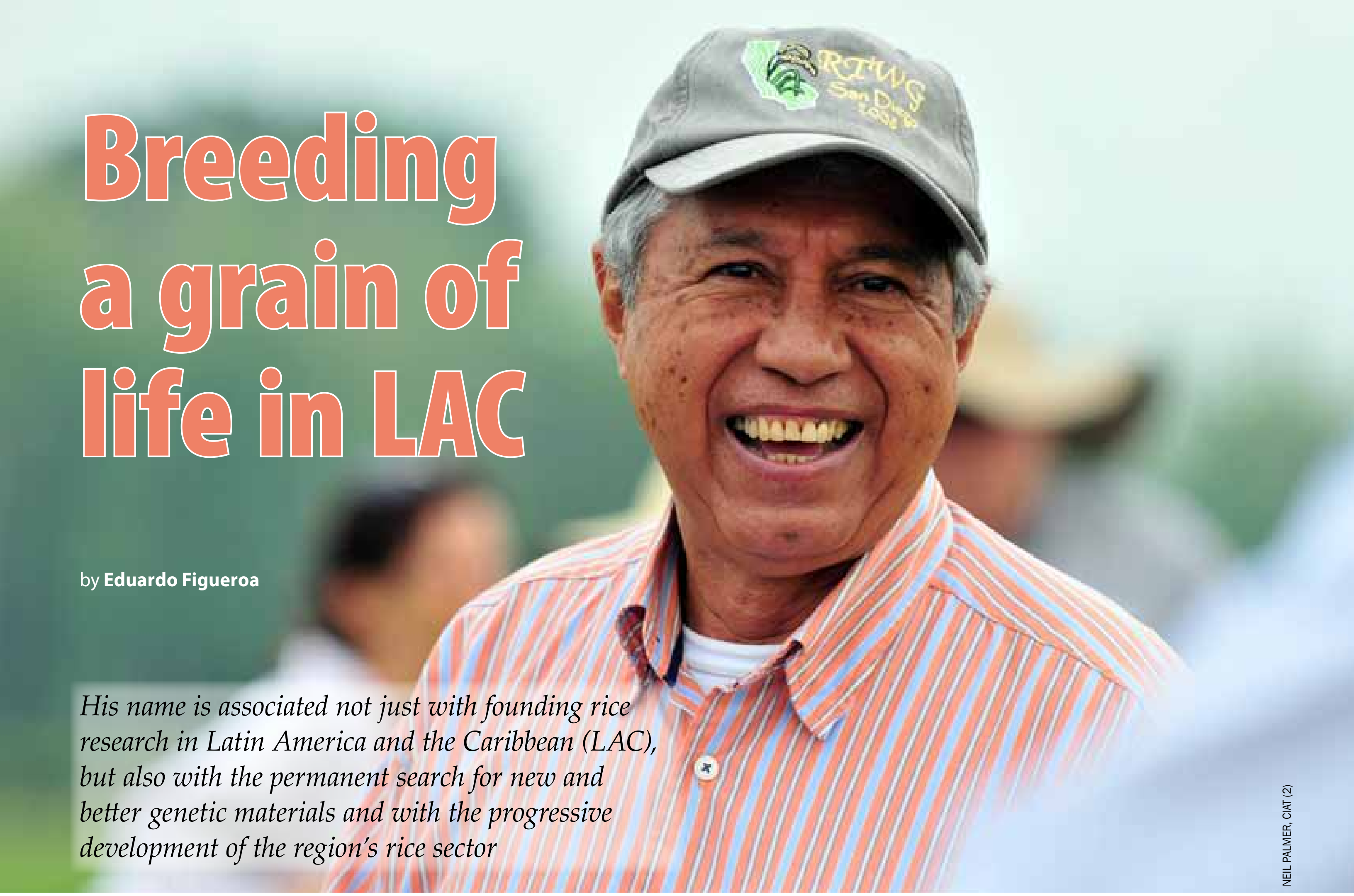
It made sense for China to take advantage of cheaper prices with some 1.64 million tons imported into China in the first 8 months of 2012. Ms. Wenzhong said that Thailand has ceased supplying China because Vietnam's and Pakistan's cheaper prices attracted the bulk of Chinese buying.

Thus, 2013 rice markets would be shaped, to some degree, by the following: Chinese and Indonesian buying, Thai decisions on the rice-pledging scheme and mounting stocks, and India's export policy and Food Security Bill.

All these policies and business decisions will also confront an increasingly volatile output as a result of increasing uncertainty in weather. The challenge for 2013 is complete with a stuttering global economy with worry lines seen in Europe, America, and China—to add a financial market dynamic to rice markets in both price and consumption trends.

Mr. Subramanian is vice president of The Rice Trader and rice market analyst based in Singapore. His focus is on rice market activities across Asia, Europe, and Africa.

Breeding a grain of life in LAC



NEIL PALMER, CIAT (2)

by **Eduardo Figueroa**

His name is associated not just with founding rice research in Latin America and the Caribbean (LAC), but also with the permanent search for new and better genetic materials and with the progressive development of the region's rice sector

Several factors influenced César Martínez's lifelong devotion to rice. One was an early mentor's enthusiasm for the staple grain. Another was the importance of rice in the diet of hundreds of millions of people. From these early impressions, Dr. Martínez formed a vision of what he could accomplish for poor households by becoming a rice breeder.

This vision has guided his productive career for 45 years. During most of this time, Dr. Martínez has worked as a rice breeder with the International Center for Tropical Agriculture (CIAT), in Cali, Colombia, where he has served as Rice Program leader over the last four years.

Breaking frontiers

In 1967, after finishing his undergraduate degree at the Palmira campus of the National University of Colombia, Dr. Martínez joined the Rice Program of Colombia's national agricultural research organization.

At that time, CIAT's research was just getting underway. The Center was responsible for international rice improvement in LAC under the leadership of Peter Jennings (see *Luck is the residue of design* on pages 10-11, *Rice Today* Vol. 7, No. 1), who proposed a rice research alliance uniting CIAT, ICA, Colombia's national agricultural research organization, and Colombia's National Rice Growers Federation. The alliance proved so successful that it became the preferred model in forging new alliances with the public and private sector for rice improvement.

Dr. Martínez continued to build his knowledge and skills as a rice researcher, earning a master's degree and Ph.D. at the University of Oregon in the United States, including a stint at the International Rice Research Institute (IRRI). In 1981, after completing his doctoral studies, he joined CIAT as a plant breeder in a project focusing on upland rice—which was a new frontier in the region's rice improvement.

In 1999, following a period of stalled donor support for agricultural development, he accepted a plant breeding post with Monsanto S.A. But, CIAT, reluctant to lose a scientist of his caliber, brought him back to Colombia in 2000 as a plant breeder and, eventually, Rice Program leader.

A pillar of rice research in LAC

One innovative feature of his work over the last decade has involved the incorporation of wild species of rice into the development of improved germplasm, in order to widen its genetic base. Wild species, together with traditional rice varieties, have provided much useful raw material for the development of new rice populations containing genes associated with higher yield, tolerance of diverse stresses, and improved nutritional quality.

"César Martínez has made a huge contribution to the rice sector in Colombia and across Latin America over many years, giving rise to a significant impact," said Rafael Hernández, general manager of the National Rice Federation of Colombia.

"Much of the improvement we've seen in the rice production of this country and region is due to his important work— for which rice growers are extremely grateful," he added.

"César represents in my mind the 'type specimen' of a highly successful rice breeder," said Robert Zeigler, IRRI director general. "He has always focused on developing a useful product but was always willing to try new ideas and approaches."

In collaboration with international and national partners, Dr. Martínez has been recently generating materials for the development of germplasm to match local conditions and needs more closely. This research has contributed importantly to the Latin American Fund for Irrigated Rice (FLAR)—an innovative association of public- and private-sector organizations in 15 countries. FLAR provides members with improved varieties and other new technologies for rice production.

"From the founding of regional rice research," said Gonzalo Zorrilla, FLAR's executive director, "César's name has been associated with the permanent search for new and better genetic materials and with the progressive development of the region's rice sector.

"There's probably not a single rice breeder in Latin America who hasn't benefited through training or visits from César's generosity in sharing his profound knowledge of the rice crop," Mr. Zorrilla added.

Throughout an extensive career, Dr. Martínez and the CIAT Rice Program have confronted many new challenges. "Our approach," he said, "has been to adapt the research strategy as

"Much of the improvement we've seen in the rice production of this country and region is due to his important work— for which rice growers are extremely grateful."

Rafael Hernández, general manager of the National Rice Federation of Colombia

needed, taking into account the views of all concerned."

In the early 1970s, for example, the key challenges were to raise the yield of varieties while developing resistance to diseases such as rice hoja blanca virus and rice blast. Next, farmers needed varieties with still higher yield potential and better grain quality—requirements that were met with the release of varieties such as Oryzica 1 that showed good milling and cooking quality, high yield, and disease resistance.

Dr. Martínez helped develop many more rice varieties such as CICA 4, 7, and 8; Oryzica Llanos 4 and 5; and Fedearroz 2000—which dramatically boosted the region's rice productivity and provided national programs with a firm foundation for continued rice improvement.

"As I look back at the six years I served as CIAT's Rice Program leader starting in 1986," Dr. Zeigler remarked, "César was a cornerstone of our research program, giving CIAT enormous credibility with all of our national program partners from Cuba to Chile."

Looking ahead, César said that a big challenge now is to develop rice germplasm with greater resilience in the face of climate change—specifically higher temperatures and reduced rainfall: "We're already developing materials that respond to these changes while also showing higher yield potential, which is critical for making the region's rice production more competitive globally."

This is the research role Dr. Martínez began to envision as a student—one he has handled with dedication, wisdom, and skill ever since. Although retiring now from full-time work at CIAT, he sees plenty of scope to further contribute to the rice sector. Toward this end, he's preparing to work as an independent consultant, ready to take on the next set of challenges.

An enormous legacy

Though nostalgic about his departure from CIAT, Dr. Martínez feels satisfied with the Rice Program's many achievements. He gives ample credit to a research team, of which he is justifiably proud and that he considers entirely capable of continuing the excellent work.

"César has built up an enormous legacy," Mr. Zorrilla noted, "and the fruits of his 45-year commitment to rice research are evident in the region's strong rice network and in the capable teams that will follow the route he pioneered in search of more and better rice."

Dr. Martínez's message for the new generation of rice scientists reflects the straightforward principles that have guided his own work: "Always keep connected with rice growers to better understand their production problems and to provide the solutions they expect, always show a willingness to share knowledge and invest in training, and always listen to the views of colleagues, so that research strategies reflect the best ideas of the whole team."

DR. CÉSAR Martínez (*far right*) **shows CIAT's experimental rice fields to GRiSP scientists.**

Mr. Figueroa is an associate editor at CIAT.

ISAGANI SERRANO

The future faces of rice science

by **Alaric Francis Santiaguel**

First-ever international conference at IRRI designed for young scientists representing more than 40 countries

In November 2012, young rice researchers mostly working at IRRI received support in professional development through a milestone event, the 2012 IRRI Young Scientists Conference, or "2012IYSC."

"For a long time, many young scientists have been looking for a venue to present their work," said Govinda Rizal, conference chair and president of the Association of Fellows, Scholars, Trainees, and Residents (AFSTRI), which organized the two-day affair.

"For many of the participants, this was their first experience presenting before an audience of international scientists," he added.

Participants had opportunities to review abstracts, chair sessions, moderate meetings, and interact with scientists and peers across different research themes, while first-time presenters were trained.

Start-up scientists

The conference featured more than 80 abstracts of research activities in the fields of crop improvement; crop protection; extension, marketing, and policies; environment and sustainability; genetics and genomics; and innovations and novel approaches.

"The abstracts represent an excellent range of IRRI's research," said IRRI Director General Robert Zeigler. "I was overwhelmed by the breadth and richness of the work.

"Unburdened by managerial responsibilities and ripe with enthusiasm and the latest technologies, time and again, we see our young scientists publishing excellent papers and producing high-quality, even world-class, research," he added.

Surviving in the science arena

One of the most anticipated events at the 2012IYSC was the Best Paper Competition, in which six young scientists vied for the top honor and prize. This was one of the highlights of the conference.

Tobias Kretzschmar won first place (*Gene validation of a major QTL for tolerance of anaerobic conditions during germination*), while Genelou Atienza (*Ubiquitous resistance to rice tungro spherical virus is mediated by a gene for translation initiation factor 4G*) and Taznoore Samine Khanam (*Impact of rice price hike on poverty in Bangladesh*) placed second and third, respectively.

Citations were also given to Ronald Tapia (*Introduction of transport proteins into* Oryza sativa *L. to facilitate installation of the C_4 pathway*), Swati Kamal (*Transformation of rice with C_4 genes and characterization of transgenic plants*), and Yam Kanta Gaihre (*Methane emission and rice yield as affected by elevated temperature, rice straw incorporation, and soil properties in lowland rice paddy soils*).

The participants certainly came away with more than prizes. "IRRI provides me with the opportunity to do fundamental science that is directly applicable to alleviate poverty and ensure food security," said Mr. Kretzschmar, from Germany. "Not many scientists are that privileged."

Ms. Atienza said that she gained confidence in her work after presenting her paper at the competition. "I believe our research made a mark on many of the people who attended the conference," she said. "First, find your passion." She said it was important for scientists to find their passion. In her case, it is making life better for rice farmers and consumers while protecting the environment.

New revolutionaries

IRRI has a rich history of advancing rice science—from high-yielding varieties to ecological engineering. But, to sustain this momentum and ensure the next generation of innovations, the Institute must encourage creativity and target newer scientific tools that hold the potential for rich discoveries.

"Having a rich and thriving population of young scientists and what it means to the future of rice production and techniques cannot be overstated," said Dr. Zeigler. "Without a crop of vibrant, intelligent, dedicated, and caring young scientists, IRRI would not have a future. Indeed, the future of rice research and the progression of rice farmers and consumers out of poverty would also be threatened. That's a tremendous responsibility for IRRI to maintain that flow of community."

Through the 2012IYSC, IRRI aimed to bring new talent and modern training together to start more revolutions.

Achim Dobermann, IRRI's deputy director general for research, strongly agrees with the strategic importance of recruiting young, talented people to rice science and nurturing them.

"A remarkable influx of new brains, new skills, and new energy is what we need if we want to succeed in what we're doing. Young scientists must play a leading role in such efforts and thus help in shaping a new image for modern agriculture," said Dr. Dobermann. "They have the modern skills and knowledge that will be required to tackle some of the grand challenges in biology and agriculture. I am very excited to see this first young scientists conference happening at IRRI."

Cross-fertilization

In the real world, problems seldom come neatly packaged for one discipline to study. Solving a single problem often requires collaborative efforts of different experts.

The 2012IYSC is an effort to improve communication and collaboration between disciplines and create more effective partnerships and more integrated rice science.

"It is always a big concern for me when they do not have enough time to interact with each other and spend most of their time slaving away quietly on their own," Dr. Dobermann revealed. "We need to make sure they become not just specialists or experts in their field but also well-rounded individuals who know about rice, rice science, and many associated things in general."

Dr. Zeigler also encouraged young scientists to step out of their comfort zones and find out what's going on outside their research focus.

"Intellectual cross-fertilization is really a very, very important part of the professional development of young scientists," he said. "When I was a scholar, I spent a lot of time with anthropologists and sociologists even though I was a plant pathologist. That cross-fertilization is extremely important. What we want to do here is foster that."

IRRI will continue to invest in bringing people from Latin America, Africa, Asia, North America, and Europe together and mixing them up in a rich intellectual event, he vowed.

"We were successful in proving that, given the resources, it is possible to organize an international conference at IRRI," Dr. Rizal said. "The 2012IYSC is a strong precedent for future conferences at which young scientists can get some time in the spotlight."

A link between present and future

"This platform will also work as the golden bridge between experienced senior scientists and those following in their footsteps," Dr. Rizal said. "And, it was an opportunity for IRRI managers to get first-hand knowledge where research activities are strongest and where leverage is needed."

History tells us that many young people who spend the early part of their career at IRRI go on to achieve other professional successes and continue to contribute to rice science for development in many varied ways, according to Dr. Zeigler. IRRI alumni work all over the world at leading research institutes, heading national agencies, taking senior roles in government and the business sector, and even returning to IRRI.

"While not all of you will remain working on rice, almost all of you will work on some aspect of research that will contribute to helping alleviate poverty around the world," Dr. Zeigler told conference participants.

Perhaps several years from now, as the current generation of young scientists takes over the helm from their mentors, many will look back at the 2012IYSC and say that this is where it all started.

Mr. Santiaguel is a writer at IRRI.

Also see related video on YouTube at http://youtu.be/ngQZG38peyQ.

JESSIECA CATAPANG (3)

Tobias Kretzschmar

Genelou Atienza

Taznoore Samine Khanam

BRUCE TOLENTINO, IRRI deputy director general for communications and partnerships, presented the three best paper awards.

TRENDS IN GLOBAL RICE CONSUMPTION

by **Samarendu Mohanty**

Rice is a staple for nearly half of the world's seven billion people. However, more than 90% of this rice is consumed in Asia, where it is a staple for a majority of the population, including the region's 560 million hungry people.

The success of the Green Revolution in the early 1960s witnessed a steady rise in Asia's per capita rice consumption from 85 kilograms per year in the early '60s to nearly 103 kilograms in the early '90s. On the other hand, global per capita consumption rose from 50 to 65 kilograms per annum during the same period (Fig. 1). The rising per capita consumption plus the growing population more than doubled global rice consumption during this period from 150 to 350 million tons (Fig. 2).

However, since the early 1990s, strong economic growth in many Asian countries, particularly in China and India, halted the upward trend in global per capita rice consumption as consumers diversified their diet from rice to high-value products such as meat, dairy products, fruits, and vegetables. For the past two decades, global per capita consumption has been flat at around 65 kilograms, with a dip between 2001 and 2004 due to severe drought in China and India. As a result, this lowered global availability by more than 35 million tons, with a subsequent rise in per capita consumption back to 65 kilograms in recent years.

The reversal in the declining trend in per capita rice consumption in heavyweights such as China, India, and Indonesia (Fig. 3) contributed to the recent rise in total global consumption: 50 millon tons in 7 years (Fig. 2).

Household consumer expenditure data collected by India's National Sample Survey Organization (NSSO) also confirm the flattening in per capita consumption in recent years from the declining trend in the '90s in all four regions in India.

In other countries such as Bangladesh and the Philippines, per capita consumption continues to rise across income groups in both urban and rural areas. National representative household consumption survey data collected between 2000 and 2010 from both the Philippines (Family Income and Expenditure Survey) and Bangladesh (Household Income and Expenditure Survey) confirm the trend.

Even high-income groups in both rural and urban areas are found to consume more rice with a rise in income. Unlike the Philippines and Bangladesh, per capita rice consumption is on a downward trend in Thailand, Vietnam, and Malaysia.

Outside Asia, rice consumption continues to rise steadily, with the fastest growth in sub-Saharan Africa (Fig. 4). In the past two decades, per capita rice consumption in sub-Saharan Africa (SSA) has increased by more than 50%. Similarly, rice consumption continues to grow steadily in both the United States and the European Union as consumers

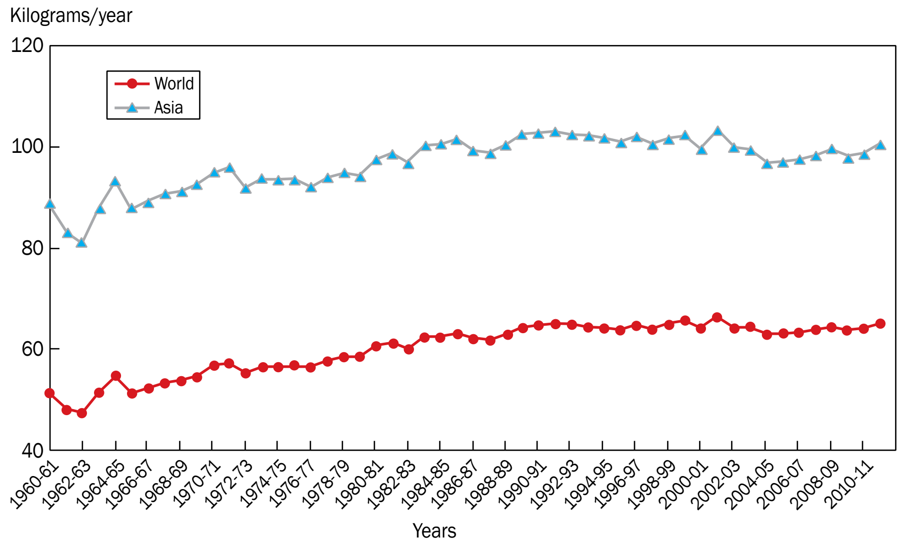


Fig. 1. Global and Asian per capita rice consumption.
Data source: PSD online database (USDA) and FAOSTAT population database (FAO)

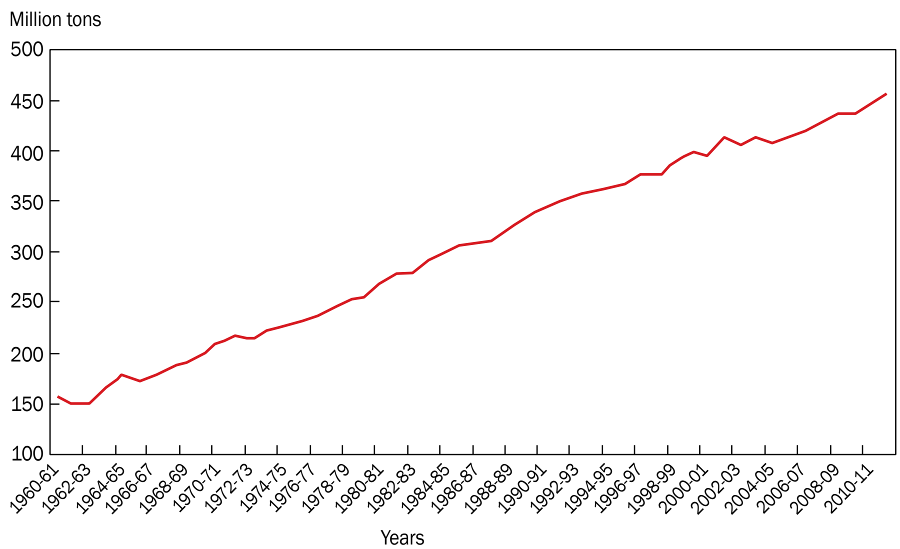


Fig. 2. Total global rice consumption.
Data source: PSD online database (USDA)

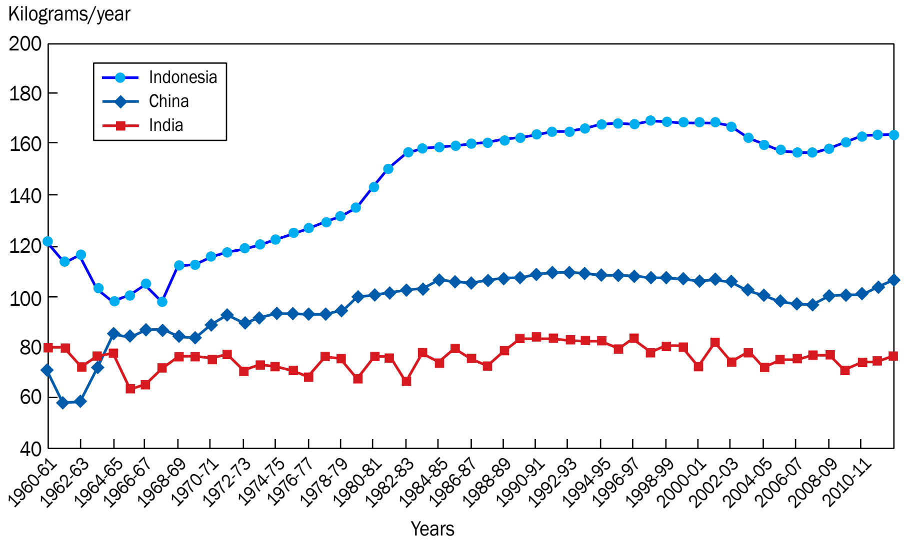


Fig. 3. Per capita rice consumption in the top three countries.
Data source: PSD online database (USDA) and FAOSTAT population database (FAO)

diversify from protein to more fiber-based diets and also because of rising Asian immigrants.

As we look ahead, income growth, urbanization, and other long-term social and economic transformations are likely to influence the composition of the food basket.

Normally, one would expect diversification away from rice to more high-value products such as meat, dairy products, fruits, and vegetables in the diet as income rises. But, the diversification rate in many Asian countries will also be influenced by the extent of government interventions in price control and subsidized food grain distribution.

India is a good example where the government has rolled out an elaborate food subsidy program to provide highly subsidized food grains (rice and wheat) for 65 million below-poverty-line households, including nearly free food grains to 20 million Antyodaya Anna Yojana households, the poorest of the poor households.

Each of the 65 million households receives 35 kilograms of grain every month at 74–86% below the procurement cost. The above-poverty-line families are also given 15–35 kilograms of grain every month depending on availability at less subsidized prices. In 2011-12, the food subsidy bill amounted to nearly Rs. 72,823 crores ($14 billion).[1]

Thus, it would be a mistake to bundle all Asian countries together and project them to behave like Japan and South Korea as they become wealthier. Each Asian country will be unique in the way it diversifies its consumption pattern as income rises. It may be reasonable to assume that diversification away from rice will be slow in many Asian countries and the minimum threshold of rice consumption for each country will be different.

Outside Asia, the current upward trend in rice consumption will continue in the future, with SSA leading the pack. The growth in rice consumption in SSA so far has primarily come from growing preference for rice among urban consumers with rising income. The preference for rice will inevitably begin to grow among the rural population as it becomes wealthier. If this happens, consumption growth for rice will be even stronger in the future than what has been witnessed in the past two decades.

Moreover, an additional 2 billion mouths will have to be fed around mid-century, when the world reaches the 9 billion mark, and this is projected to exceed 10 billion by the end of the century. If global per capita rice consumption follows the trend in the past two decades, then total consumption will grow at the rate of population growth.

Total consumption growth may even exceed population growth if the recent uptrend in per capita consumption in the "big three" countries (China, India, and Indonesia) continues.

The bottom-line message is that, if diversification in Asia is slow and not widespread, then it is almost certain that this will be offset by rising per capita consumption in Africa and the rest of the world and the global population and total global consumption will continue to rise. However, if Asian countries follow a rapid diversification path, the opposite will be true and total global consumption may start declining.

Dr. Mohanty is the head of the Social Sciences Division at IRRI.

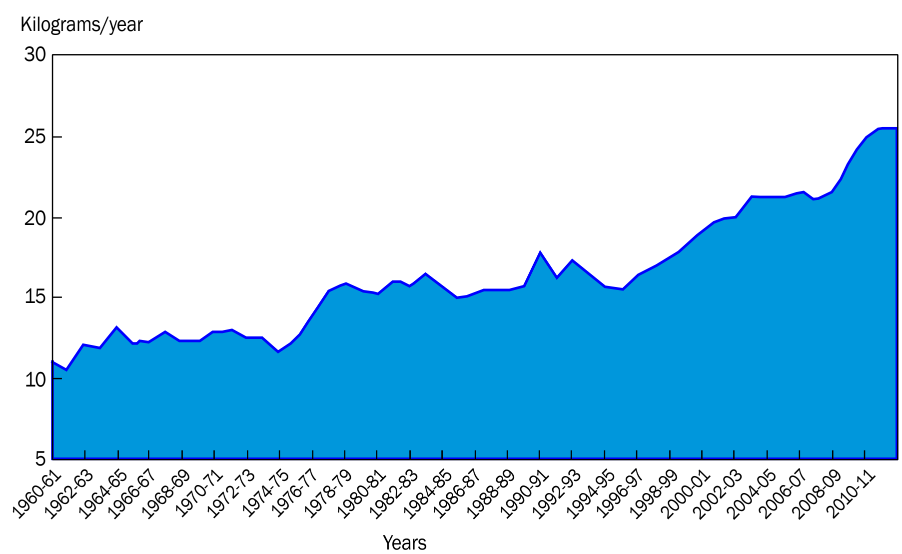


Fig. 4. Sub-Saharan Africa per capita rice consumption.
Data source: PSD online database (USDA) and FAOSTAT population database (FAO)

[1] Sharma VP. 2012. Food subsidy in India: trends, causes and policy reform options. W.P. No. 2012-08-02, Indian Institute of Management, Ahmadabad, India.

A CHEF is whipping up a rice dish during a demo cooking during the *Asian Masters* event.

NATALIE TJEN (2)

SINGAPOREAN high-school students get creative in a Rangoli-making competition.

SCIENCE CENTRE SINGAPORE

A city with a heart for rice

by **Flaminia Lilli**

Although it's a high-tech powerhouse city, Singapore has its culture and future rooted in rice

Singapore is well known for its food culture, which contains a fusion of cuisines from all over the world.

The bustling city-state prides itself on having highly regarded culinary events every year that attract top local and international chefs. These events are very popular among Singaporeans, who are always interested in learning new recipes and participating in cooking workshops.

In November 2012, the IRRI Fund Singapore participated in *Asian Masters*, a major annual culinary event in which celebrity chefs share their savoir-faire with the public in hotels, restaurants, galleries, and boutiques.

IRRI Fund Singapore partnered with Lam Soon and joined the Masterchef Workshop held at Great World City, where a demo cooking and tasting workshop using Lam Soon's Naturel Organic Brown Rice attracted quite a large audience.

This is part of the role of IRRI Fund Singapore: to hold public awareness events on the importance of rice and rice research as well as to attract potential donors. All the money raised by the IRRI Fund goes to the International Rice Research Institute (IRRI) to support its work with hundreds of research and development partners across Asia.

The *Asian Masters* was a perfect avenue to further share IRRI's work with Singapore's public and realize that rice is always a staple close to the heart of any Asian country.

Investing its future in rice

Today's youth are the producers of tomorrow's food. Thus, making them interested in and appreciative of how rice is produced can never be overemphasized.

Students and teachers had a chance to grow rice through Singapore's first-ever Rice Growing Competition launched in June 2012.

IRRI Fund Singapore organized this contest with Science Centre Singapore in conjunction with the 2012 World Food Day. With its theme, "Agricultural Cooperatives—key to feeding the world," the competition sought to equip teachers with content knowledge in life sciences, particularly rice biology and geography, as well as with the skills needed to initiate rice growing as a project in their schools.

Fifteen teachers from 10 schools were given rice seeds supplied by IRRI for them to grow. The amount of rice grains harvested was a key judging criterion of the competition. Other criteria were a 5-minute presentation on the process of cultivating rice crops in school and a creative task involving rice.

The participants presented their projects for final judging on 5 November. The winners of the competition were Dr. Goh Yan Yih's team from the Anglo Chinese School and Ms. Angelene Tan's team from Dunman Secondary School for their acumen in growing rice and doing creative Rangoli art work.

"Singapore is a cosmopolitan city and some of us have never seen a rice field, let alone experience growing a rice plant," shared Lim Tit Meng, chief executive, Science Centre Singapore. "Through this competition, Science Centre wishes to cultivate local appreciation for the rice we eat every day and build awareness of issues related to food security, including an escalating world population."

Each team displayed much enthusiasm and creativity in growing rice. Students from the Anglo Chinese School, led by their teacher, Dr. Goh Yan Yih, grew rice with hydroponic and aeroponic systems, whereas the team from Dunman Secondary School used styrofoam boxes. Eventually, both schools were rewarded with a science study trip to IRRI to be held in 2013.

"We are excited to host the winners of this first rice competition," said Leo Chen Ian, executive director of IRRI Fund Singapore. "Folks from Singapore will get first-hand experience in growing rice and learn about rice ecosystems, at the oldest rice research institute in Asia. This brings appreciation of rice to a whole new level."

Ms. Lilli is the partnership development manager at IRRI Fund Singapore.

The world needs more AGRONOMISTS

BY NOEL MAGOR

There was a time in recent years when it was apparent that an agronomist was a threatened species.

Government funding focused on infrastructure, industry, health, and education—not quite on agriculture. The private agricultural sector in developing countries was in its infancy, and NGOs were more concerned with microfinance than technical assistance that may give farmers new economic opportunities. The IT industry, banking, engineering, and medicine were the professions for those with top scores in high school.

This was not just a developing-country trend. Actually, the agricultural profession has been getting less and less attractive to bright young people around the world. Traditional agricultural schools, in Australia for example, saw reduced enrollments. And, with pressure on university funding, some agricultural schools were merged with the environmental sciences. The status of being a farmer in society overall was low. This has not always been the case, though. I am the son of a farmer; for me, it was a source of pride.

In the early 2000s, I became aware of these changes. As a result, the status of agronomy as a profession also became less popular.

Changing perspectives

Agriculture had become a neglected industry, with declining funds since the late 1980s. Since then, research, public extension services, and infrastructure for agriculture had been in decline.

Come the 21st century, agriculture and agronomy saw more problems. Aside from the 2008 global food crisis and pest outbreaks, climate change made food security more uncertain. Add to this the challenges of a steadily rising population and scarcities of water, land, and a productive agricultural system. All these serve as a wakeup call and represent a turning point in seeing the importance of an agronomist.

What needs to be revived

Agronomy is about crop production. Although a researcher may specialize in weed science or soil science, he/she must become comfortable with all aspects of crop production, including postharvest and the value chain up to the market.

A good turning point for the story of agronomists is how some organizations work to sustain their value.

At the International Rice Research Institute (IRRI), a new training course on agronomy is beginning during the 2013 dry season. It is called "Rice Survivor." In this program, young scientists and extension agents are following the rice crop over the season for half a day per week.

Classes are not formal and the IRRI Rice Knowledge Bank (www.knowledgebank.irri.org) is a reference source and will support production decisions. As much as possible, the trainees are doing most of the operations themselves. They are keeping a journal of all production decisions and discussions. For the dry season this year, four teams are deciding on all aspects of crop management. The practices to be chosen are direct-seeded rice, machine-transplanted rice and traditional cultivation, and manual transplanting. This emphasizes rice management, decision-making, and discovery learning as a team.

Some recommendations

This, itself, is not enough. To meet the challenge of building confidence at the farm level, researchers should have a parallel village experiment for each station experiment as well as an opportunity for farmer focus group discussions. Issues such as land preparation, crop establishment, crop management, and, most importantly, the profitability of growing rice require such an interface.

We also need to look at the attractiveness of a career path, in which a young agronomist can be fast-tracked. In their first five years, a research agronomist should engage 20% of his/her time in extension. The United States land-grant system suggests that this should be the norm for his/her whole career. Also, during the first five years, both research and extension agronomists need a defined project to manage. If a young professional develops a competency early for an extension domain (for example, a rainfed two-rice crop system) and the nuances across that domain, he/she will then develop confidence to work in any ecosystem.

Gone are the days when a department head directed all activities. Young professionals need space and opportunity to develop their own creativity around issues. This will help them see farmers as sources of innovations, and be able to take more leadership roles in research and extension.

Agronomists need skills to work in a multichannel research and extension system along with the government and the entire industry. Farmers, too, should have a strong voice in directing research and extension. For the extension domain, it is a good move that IRRI is exploring the development of a placement program that enables young researchers and extension agents to develop skills to operate in a multiactor system.

Agronomy has been neglected, but the pressure for raising yield ceilings for food security in an environmentally sustainable way requires a new generation of agronomists to take up the challenge.

Dr. Magor is the head of IRRI's Training Center and program leader for Growth of the Rice Sector.

See related video on YouTube about the importance of agronomy at http://youtu.be/lb5d93R0B4M

7th INTERNATIONAL RICE GENETICS SYMPOSIUM 2013

5-8 November 2013
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