Rice Today

www.irri.org

International Rice Research Institute

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Rice for peace

A genetic odyssey

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contents

Rice Today
Vol. 9, No. 4

On the cover:
This reproduction of an oil-on-canvas painting by Filipino artist-photographer Dante Palmes (dcpalmes.atspace.com) depicts the upland rice harvest near Chiang Mai, Thailand. It is based on a photo the artist took himself while on assignment for *Rice Today* to illustrate *Winning the upland poverty war* on pages 14-18 of Vol. 9, No. 1. Mr. Palmes' work is also featured in our special insert wall calendar for 2011, where he depicts harvesting and threshing times in the Philippines.

Rice Today is published by The Rice Trader Inc. (TRT) in association with the International Rice Research Institute (IRRI).

TRT, for 20 years, has brought subscribers crucial, up-to-the-minute information on rice trade through its weekly publication, *The Rice Trader*. Acknowledged as the only source of confidential information about the rice market, this weekly summary of market data analysis has helped both the leading commercial rice companies and regional government officials make informed decisions, which are critical in today's market.

IRRI is the world's leading international rice research and training center. Based in the Philippines and with offices in 13 other countries, IRRI is an autonomous, nonprofit institution focused on improving the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes, while preserving natural resources. It is one of the 15 nonprofit international research centers supported, in part, by members of the Consultative Group on International Agricultural Research (CGIAR – www.cgiar.org) and a range of other funding agencies.

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Rice Today welcomes comments and suggestions from readers. *Rice Today* assumes no responsibility for loss of or damage to unsolicited submissions, which should be accompanied by sufficient return postage.

The opinions expressed by columnists in *Rice Today* do not necessarily reflect the views of TRT or IRRI.

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Never an empty bowl:

ENSURING ENOUGH RICE FOR FUTURE GENERATIONS

The Green Revolution is generally believed to have saved one billion lives over 6 decades, making it arguably the single-most-effective philanthropic initiative in human history. (*New York Times*, 9 March 2008)

On 27 September 2010 in New York City, the International Rice Research Institute (IRRI), the Asia Society, and the Ford and Rockefeller Foundations held a special dinner and symposium to recognize and celebrate the 50th anniversary of IRRI and one of the most important philanthropic initiatives in Asia during the 20th century.

Founded in 1960 by the Rockefeller and Ford Foundations, IRRI played a critical role in advancing the Green Revolution in the Asian region. The increases in agricultural production that followed and the abundance of affordable rice that became available to millions of people helped lay the foundation for a period of unprecedented economic growth throughout Asia that has lifted more people out of poverty than at any other time in modern history.

At the same time, IRRI and the Asia Society released a new and significant report on Food Security and Sustainability in Asia, prepared by a joint task force co-chaired by Dan Glickman, former U.S. secretary of agriculture, and Dr. M.S. Swaminathan, India's leading food security expert (and former IRRI director general). The report examines the multiple factors contributing to Asia's growing food insecurity and lays out a strategy for the future that emphasizes the critical importance of rice as a source of nutrition, livelihood, and environmental sustainability. With Harvard economist and Asian food security expert Dr. C. Peter Timmer as the lead author, the report will be released across Asia over the next few months, including a special event at the International Rice Congress in Hanoi on 9 November.

In this report, the authors note that food security in Asia is currently facing serious problems—more than half a billion inhabitants of the region go hungry each day. The future seems even more daunting—population growth, dwindling land and water resources for agriculture, and huge uncertainties from climate change present scientists and policymakers with additional challenges. Moreover, the report states that, traditionally, improvements in rice technology and in farm productivity have been the main avenues to overcome problems related to food security. Indeed, rice availability and food security have long been synonymous in Asia, especially in the political arena. Despite rapid economic growth, sharply reduced poverty, and extensive diversification of the typical Asian diet, the dominance of rice remains a reality in the region's food security. As such, the task force's report focuses on the role of rice in sustaining Asia's food security and aims to provide a thorough assessment of the potential for continuing gains in rice productivity.

It's very clear that rice will remain fundamental to the region's growth, prosperity, and stability for the foreseeable future. At IRRI, we believe that it is imperative to encourage a new generation of philanthropy in Asia that supports rice science and innovation for the benefit of the entire region. Indeed, in keeping with the recommendations of this report, IRRI has organized a 50th anniversary fund-raising campaign to convince today's Asian philanthropists to invest in this vital work. For more on the IRRI campaign and its philanthropic initiatives in Asia, please visit www.irrifund.org. For those in the United States, you can visit the Web site of Give2Asia at www.give2asia.org/, where the IRRI campaign is displayed prominently.

I encourage you to spread the word about these important activities and I look forward to your continued interest in, and support for, international rice research.

Robert S. Zeigler

Robert S. Zeigler
Director General

Hidden Treasure*

I'm delighted to be able to use this issue of *Rice Today* to welcome everyone to Phuket for The Rice Trader World Rice Conference 2010. Rice industry players from around the world are gathering in Phuket, Thailand, on 12-14 October to receive their annual dose of market updates and to discuss the spectrum of issues that dominate the rice trading business. This event will also hold the second rice tasting contest, which will add an interesting retail dynamic that, more importantly, reveals select varieties of rice that are treasured around the world. It is an honor for The Rice Trader to host this international event as it is a reunion of friends, industry leaders, peers, and, most significantly, it as an opportunity to examine some very important questions that currently expose the fragile supply that provides a blanket of food security to the world.

It is in the busiest and quietest times that I find the most wisdom these days. Perhaps, this is a secret to life, as one travels and learns from the days that fly by.

For 50 years now, scientists have been working to keep the world fed, with each milestone contributing to the collective achievement. The Green Revolution in the 1960s spawned demand—as well as the next generation's need for another revolution. This is just a cycle of life, with the belief that the genius that scientists have shown in increasing our food supply comes with time and an ever-expanding population's intellectual resources. The ingenuity that the human race demonstrates, however, is often matched by the many challenges that unfold over time, whether the population is 7 billion or 10 billion. But, I believe that we will rise to the occasion.

This means that sometimes things get out of line. Are we investing in the future of our children or living in a way that will negatively impact the coming generation? The problem we see is that high and low prices are equally bad, as often occurs in the midst of a crisis. It can then take decades for another effect to occur, which could cause prices to level off. The current market, since 2007-08, is interesting in that the runup, falloff, and what looks like the start of another runup have, in fact, kept investments at bay largely because of the uncertainty and volatility in global markets (both financial and commodity) that have led to a lack of clear direction for the future.

There are also more questions than answers today, with the lessons from 2008 suggesting that most market players would prefer to make commercial decisions based on actual rather than possible events and news. Risk is a key feature and few in the market want to take any risk at present. Russia's recent decision to ban wheat exports—together with the news of floods in China and Pakistan that have possibly reduced output and, consequently, exportable rice—has left analysts re-calculating the global food balance, even as India looks well placed to reveal a strong output rebound. The global wheat trade is four to five times the size of rice trade (125 million tons of wheat are traded, while only 25–30 million tons of rice are typically traded globally); hence, the changing global food balance adds more volatility, especially to rice. The lightest shift to or away (as buyers, such as Africa, adjust to prices) therefore greatly affects rice export volumes. In fact, one could say that a price increase or decrease in wheat has a four to five times larger effect on rice. China is one good example. Recent floods (and the drought before that) have already left an imprint on trade, given China's increased purchases of corn (maize) and other grains. China's large grain buffer stocks have added a stabilizing effect, but not all countries can boast such an emergency reserve. The current global grains situation continues to play out, with new supply and export figures affecting the volumes and prices of all grains and cereals in the months ahead.

Risk is leading the rice trade away from making any important trade decisions as most would prefer to act based on actual events rather than face up to bullish rice markets. Thailand's nearly 6 million tons of stocks come into focus as the expected government releases are factored into the market. Furthermore, damage estimates in Pakistan and the harvests across Asia also reveal the true extent of export availability (in terms of size and timing of availability), which somehow provides a better knowledge of the risks ahead. In the U.S., long-grain availability has responded well to global demand at what looks like a very competitive price. Japonica rice is more bullish—made especially clear by the supply concerns in Egypt and the lack of any significant exports from Australia. To make the situation more interesting, the demand for japonica rice is expected to double the largely U.S. supply, revealing the possibility of blending as a solution for more price-sensitive buyers. Overall, markets are walking on edge, teetering between the belief there is not enough rice and the idea that the upcoming harvest season will bring new arrivals soon. Time will tell.

Jeremy Zwinger

Jeremy Zwinger
Publisher

* The opinions expressed here are those of the author and do not necessarily reflect the views of the International Rice Research Institute.

Hotter nights threaten food security

Rice production will be thwarted as temperatures increase in rice-growing areas with continued climate change, according to a new study by an international team of scientists.

The team found evidence that the net impact of projected temperature increases will be to slow the growth of rice production in Asia. Rising temperatures during the past 25 years have already cut the yield growth rate by 10–20% in several locations.

Published in the *Proceedings of the National Academy of Sciences*, the report analyzed 6 years of data from 227 irrigated rice farms in six major rice-growing countries in Asia, where more than 90% of the world's rice is produced.

"We found that as the daily minimum temperature increases, or as nights get hotter, rice yields drop," said Mr. Jarrod Welch, lead author of the report and graduate student of economics at the University of California, San Diego.

This is the first study to assess the impact of both daily maximum and minimum temperatures on irrigated rice production in farmer-managed rice fields in tropical and subtropical regions of Asia.

"Our study is unique because it uses data collected in farmers' fields, under real-world conditions," said Mr. Welch. "This is an important addition to what we already know from controlled experiments.

"Farmers can be expected to adapt to changing conditions, so real-world circumstances, and therefore outcomes, might differ from those in controlled experimental settings," he added.

Around three billion people eat rice every day, and more than 60% of the world's one billion poorest and undernourished people who live in Asia depend on rice as their staple food. A decline in rice production will mean more people will slip into poverty and hunger, the researchers said.

"Up to a point, higher day-time temperatures can increase rice yield, but future yield losses caused by higher night-time temperatures will likely outweigh any such gains because temperatures are rising faster at night," said Mr. Welch. "And, if day-time temperatures get too high, they too start to restrict rice yields, causing an additional loss in production.

"If we cannot change our rice production methods or develop new rice strains that can withstand higher temperatures, there will be a loss in rice production over the next few decades as days and nights get hotter. This will worsen increasingly as temperatures rise further toward the middle of the century," he added.

In addition to Mr. Welch, other members of the research team are Professors Jeffrey Vincent of Duke University and Maximilian Auffhammer of the University of California, Berkeley; Ms. Piedad Moya and Dr. Achim Dobermann of the International Rice Research Institute; and Dr. David Dawe of the United Nations Food and Agriculture Organization.

Source: www.irinnews.org

Insects threaten Thai rice again


IRRI

BROWN PLANTHOPPER infestation in Thailand is expected to peak in December 2010.

Experts warn that a significant increase in the numbers of brown planthoppers, a rice pest, in central Thailand threatens production.

"The current situation is not good," said Dr. K.L. Heong, an insect ecologist from the International Rice Research Institute (IRRI). "Looking at the number of hoppers caught in light traps over the last 2 months, it's clear that a massive immigration has occurred."

Light traps are used to measure populations of migrating hoppers within a 9.1–15-m radius. On an average night, a light trap will catch 10–20 hoppers. During migration peaks (twice a year), this can rise to about 2,000 per night.

Heong recently spent 3 days visiting fields, farmers, and agricultural experts in Suphan Buri, Chainat, and Ang Thong provinces, where he saw traps with up to 40,000 hoppers and "nymphs hatching all over the place." Anything above 10,000 is alarming, Heong said.

"This will peak around December 2010," Heong warned. "I expect 30% losses in most rice fields."

According to Heong, extensive pesticide use by farmers is the primary reason for the infestations. Pesticides have a limited effect on planthoppers but kill off their natural predators, including several species of spiders. The insects have a high migratory ability and fast reproduction rates, exacerbating the threat.

The Rice Department is working to encourage local farmers to reduce spraying, Kukint Soitong, a senior expert in the department, confirmed. "We have to change farmers' chemical use," he said, "but it's not easy."

Source: www.irinnews.org

BRIEFLY

Seed bank "icon" under threat

The world's first seed bank, home to Europe's largest collection of fruit, berries, and seed crops, is facing destruction because of pressure from property developers.

The historic Russian seed trust contains more than 5,000 seeds, 90% of which are from crops that are said to no longer exist anywhere else in the world.

Pavlovsk Experiment Station covers hundreds of hectares of land on the edge of the Russian city of St. Petersburg. It was established more than 80 years ago by Nikolai Vavilov, the scientist credited with creating the concept of seed banks to breed new varieties when food production is threatened.

When Leningrad was seized during World War II, scientists reportedly starved themselves to death rather than eat the seeds placed under their protection.

John Lovett, a board member of the Global Crop Diversity Trust (GCDT), says that Pavlovsk was the world's first seed bank.

SEED BANKS around the world have become crucial in preserving biodiversity to meet the challenges in food security.

IRRI

"In the 21st century, there are about 1,500 genebanks around the world," he explains. "We're talking about the first.

"Vavilov was one of the first people to identify the centers of origin of cultivated plants and he set about collecting the material from which our cultivated plants had evolved.

"And that takes us right through to the work of the GCDT, which, in the 21st century, is assembling—as complete as possible—a unique collection of the world's genetic resources to be put in the global seed vault on Svalbard."

But, as demand for land to build houses in St. Petersburg increases, the agricultural research site is under threat. One-fifth of the station, owned by the Kremlin, has been given to the Russian Housing Development Foundation.

Scientists are now fighting in court to have the land protected. The director of the GCDT, Cary Fowler, has issued an urgent appeal to the Russian government to stop the development. He says it "would destroy almost a century of work and irreplaceable biological heritage."

Source: www.abc.net.au

Flood-hit Pakistan faces economic catastrophe

Pakistan faces economic catastrophe after floods in July and August 2010 wiped out farmland and ruined infrastructure. The country is estimated to lose billions of dollars that will likely set back its growth by years.

The country's worst-ever humanitarian disaster has ravaged an area roughly the size of England, affected 20 million people, exacerbated a crippling energy crisis, and raised fears of social unrest.

Agriculture accounts for 20% of Pakistan's gross domestic product. President Asif Ali Zardari said it would take 2 years to provide farmers with crops, fertilizers, seeds, and food. Experts, however, argued that it would take even longer.

The World Bank, which has announced a US$900 million loan for Pakistan, expects the economic impact to be huge, indicating that direct damage was greatest in housing, roads, irrigation, and agriculture. It estimated crop loss at $1 billion, saying the full impact on soil erosion and agriculture could be assessed only when the water recedes around mid-September.

"We have lost around 20% of our cotton crops," Ibrahim Mughal, who heads the independent Agri Forum organization, told Agence France Press. "The destruction of maize, rice, sugarcane, vegetable crops, and fish farms is enormous as well."

Damage to cotton, rice, sugarcane, and maize will hit the export sector, the main source for Pakistan's foreign exchange reserves. Textiles and agriculture account for about three-quarters of Pakistan's $21 billion export target this year.

Food prices are already rising and there are fuel shortages in some areas.

Source: AFP via www.google.com

Asia to create emergency rice reserve

More than a dozen countries across Asia are preparing to create a massive emergency rice reserve. The plan is designed to protect the region's two billion people from environmental disaster and runaway inflation.

The proposal emerged in mid-August 2010 after Russia imposed a ban on wheat exports that is expected to last until 2011. Calls for a region-wide rice reserve have been amplified by warnings from crop scientists that grain markets may be poised for an era of near-permanent volatility.

The idea behind the strategic rice reserve plan is twofold. It will primarily act as an immediate source of relief if harvests are bad or destroyed by natural disaster. But, it will also keep governments from hoarding or imposing export bans at the first sign of price inflation.

The emergency reserve scheme, if approved by the agricultural ministers of China, Japan, South Korea, and the 10 members of the Association of Southeast Asian Nations, would create an 800,000-ton strategic store by 2012, to be administered from Bangkok, Thailand.

Source: www.theaustralian.com.au

Awards and recognition

David Mackill, principal scientist in Plant Breeding, Genetics, and Biotechnology Division (PBGB), has been given the Award of Distinction by the College of Agricultural and Environmental Sciences of the University of California-Davis (UC Davis). The award is the highest recognition given to individuals whose contributions and achievements enrich the image and reputation of the college and enhance its ability to provide public service.

Dr. Mackill received his BS degree in plant science in 1976, MS degree in agronomy in 1978, and PhD in genetics in 1981 from UC Davis.

Victoria Lapitan, former IRRI scholar and now PhilRice scientist; **Ed Redoña**, senior scientist in PBGB; **Darshan Brar**, head of PBGB; and **Toshinori Abe**, Yamagata University professor, received the 2010 Outstanding Research and Development Award in the basic research category from the Philippine Department of Science and Technology and the National Academy of Science and Technology.

The winning research, *Mapping of quantitative trait loci (QTL) using a doubled-haploid population from the cross of indica/japonica cultivars of rice,* was carried out by Dr. Lapitan under the JSPS RONPAKU (doctoral dissertation) Fellowship Program (2006-09), with the guidance of Drs. Abe, Redoña, and Brar. The paper was published in *Crop Science*, pages 1-9, Vol. 49, 2009.

Samarendu Mohanty, senior economist and head of IRRI's Social Sciences Division, received the Outstanding Agricultural Economist award from the Western Agricultural Economics Association, a professional society of agricultural economists from all universities west of the Mississippi River in the U.S.

Dr. Mohanty was awarded this prize during the joint annual meeting of the Agricultural and Applied Economics Association, the Canadian Agricultural Economics Society, and the Western Agricultural Economics Association on 27 July in Denver, Colorado.

A.K. Tripathi, A. Pattanayak, and **S.V. Ngachan** received the prestigious Fakhruddin Ali Ahmed Award for research in tribal areas from the Indian Council for Agricultural Research in Umiam, Meghalaya, India, on 16 July 2010.

Dr. Tripathi and his associates were recognized for their contributions to the recently completed upland project *Rice Landscapes Management in Uplands for Improved Food Security and Environmental Sustainability*. The project, which was implemented in India, Lao PDR, Nepal, and Vietnam by IRRI under the Consortium for Unfavorable Rice Environment framework, was funded by the International Fund for Agricultural Development.

Jagdish Ladha, principal scientist at IRRI-India and coordinator of the Rice-Wheat Consortium, was selected to receive the Soil Science Society of America (SSSA) 2010 International Soil Science Award. The award recognizes outstanding contributions to soil science on the international scene.

Gurdev S. Khush, IRRI rice breeder and principal scientist from 1967 to 2001, received the Doctor of Science (*honoris causa*) degree from Jawahar Lal Nehru Agricultural University, Jabbalpur, India, on 24 June 2010. This is Dr. Khush's 11th honorary doctorate degree. Earlier ones include those from his alma mater, Punjab Agriculture University, Cambridge University in the United Kingdom, and The Ohio State University.

Dr. Samarendu Mohanty (*third from left*) shows off his award.

Keeping up with IRRI staff

IRRI welcomed internationally recruited senior scientists **Woon-Goo Ha, Benoît Clerget, Fulin Qiu,** and **Axel Tonini**; visiting research fellow **Youngyun Mo**; postdoctoral fellow **Akshaya Kumar Biswal;** and returning postdoctoral fellows **Alice Laborte** and **Sunil Jhunjhunwala**. **Lenie Quiatchon, Conrado Dueñas,** and **Evelyn Liwanag** were promoted to assistant scientists.

Mila Ramos retired as chief librarian on 15 August 2010. She joined the IRRI Library staff in 1965 and gave IRRI 45 years of uninterrupted and dedicated service. She served as library head since 2000.

In memoriam

On 12 June 2010, **S. Sankaran** passed away at his home in Salem, India. Dr. Sankaran was a postdoctoral researcher at IRRI in 1982 working on weed management in upland rice under varying moisture regimes. He received four gold medals from state and national scientific institutions for his postgraduate research and publications.

Ha Dinh Tuan, deputy director general of the Northern Mountainous Agriculture and Forestry Science Institute, passed away on 8 August 2010. Dr. Tuan was a committed scientist who contributed much to upland work in Vietnam. He was instrumental in the successful completion of two recent upland projects at IRRI that were funded by IFAD and the Challenge Program on Water and Food.

Tin Hla, former adviser and national coordinator of IRRI activities in Myanmar, passed away on 27 August 2010. He worked for IRRI for 9 years and was extremely helpful in ensuring the success of all IRRI-sponsored activities in Myanmar through his insightful advice and wisdom gained from his long service in the government. He was very passionate in ensuring that IRRI-Myanmar collaborative projects and their technologies were properly integrated in the programs of the government so they could be sustainable.

TRAINING COURSES AT IRRI

Rice Breeding Course

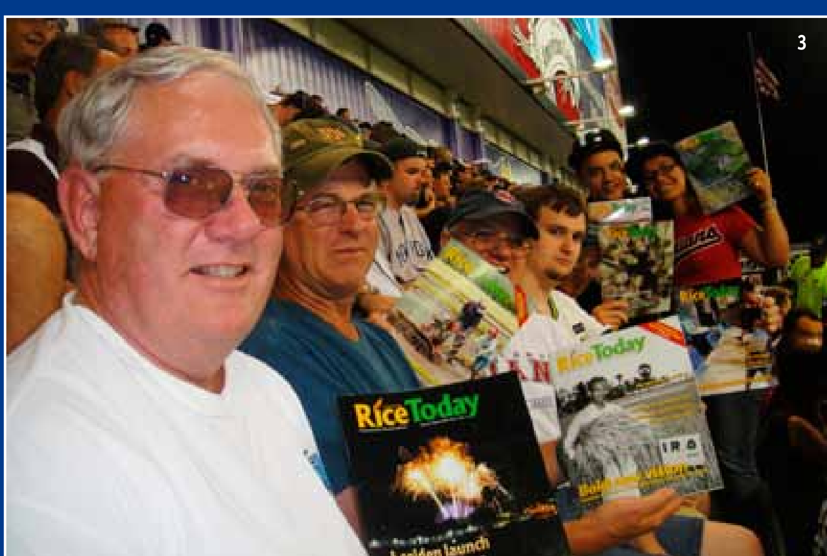
IRRI Training Center, Los Baños, Philippines
5-20 October 2010
This course aims to develop the next generation of rice breeders adept in using modern tools to enhance the precision and efficiency of their breeding programs. It will provide the theoretical background on modern breeding methods and techniques, including the use of biotechnology; planning and information management tools and experimental techniques and software; the opportunity to share experiences with other rice breeders; and the latest updates on areas relevant to rice breeding and the worldwide exchange of rice genetic resources. Breeders and agronomists working on variety development or testing in the public and private sector are highly encouraged to attend.

Upland Rice Variety Selection Techniques

IRRI Training Center, Los Baños, Philippines
2-9 November 2010
This course targets JICA (Japan International Cooperation Agency) collaborators. It aims to enable the participants to effectively evaluate varieties of upland rice suitable to African countries. Specifically, this course hopes to help participants acquire basic knowledge in the theory and practice of low-input cultivation and management techniques of upland rice in tropical conditions, obtain fundamental knowledge in varietal evaluation and selection in upland rice, understand the research activities and resources of IRRI, and construct an action plan for rice varietal selection.

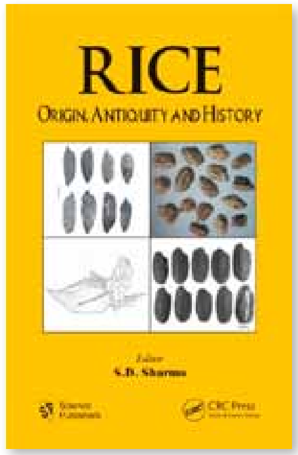
For more details, contact Dr. Noel Magor, head, IRRI Training Center (IRRITraining@cgiar.org) or see **www.training.irri.org.**

RiceToday around the world



1. **APPLE MAGIC. IRRI associate scientist Jun Ulat tests the revolutionary iPad and flips through *Rice Today* at the Apple Store on Boylston Street, Boston, Massachusetts, United States.**
2. **WORLD WONDER. IRRI beauties (*front row, left to right*) CJ Jimenez, Leslie Norton, Namrata Singh, Katie Wuori, (*back row, left to right*) Cecile Julia, and Celeste Celis sport their *Rice Today* shirts as they visit the Taj Mahal in India.**
3. **TO THE ball game. *Rice Today* readers bring out their copies of the magazine during a Major League baseball game between the Cleveland Indians and the New York Yankees at Cleveland, Ohio, on 28 July 2010. *From left to right:* Mike Kohlsdorf, Roy Mowen, Bill Havelec, Lee Mowen, Jerry Hettel, Matthew Hettel, and Maria Hettel. Note the New York Yankee fan behind them who apparently is sad that he doesn't have a *Rice Today* even though his Yankees were winning the game, 11-4.**

Rice: Origin, Antiquity and History

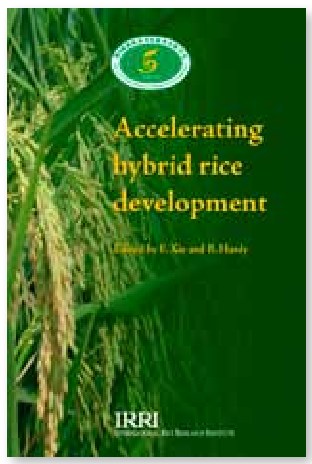


Edited by S.D. Sharma
Published by Science Publishers, Enfield, NH 03748, USA (2010) Price US$89.99

Prior to this book, the only available book that delved into the antiquity and history of rice in different parts of the world was *Rice: Then and Now*, which was written by Robert E. Huke and Eleanor H. Huke and published by IRRI in 1990. This new publication, *Rice: Origin, Antiquity and History*, provides a more detailed account of the introduction of rice cultivation in various parts of the globe. Its significance is highlighted by the fact that it fills an important gap in rice literature, which has undoubtedly increased in the past 5 decades.

The book was written with general readers in mind. Therefore, not only rice researchers but also anthropologists, sociologists, economists, and historians can appreciate this book. For purchasing information, go to http://snipurl.com/13cd08.

Accelerating Hybrid Rice Development



Edited by F. Xie and B. Hardy
Published by International Rice Research Institute

This 698-page publication represents the Fifth International Symposium on Hybrid Rice (HR5). It continues the series that started in 1986. HR5 brought together 430 hybrid rice scientists from 21 countries and two international organizations, the International Rice Research Institute and the Food and Agriculture Organization of the United Nations.

HR5 focused on hybrid rice and food production; improvements in breeding methodologies and products; applications of biotechnology in hybrid rice breeding; improving hybrid rice grain quality; technology of hybrid seed production; physiology and management for high yield and high resource-use efficiency; hybrid rice economics, public-private partnerships, and intellectual property management; and country reports. View and download a pdf file from Google Books at http://snipurl.com/12zzay.

The Hybrid Rice Collection

This collection contains the proceedings of the four previous International Hybrid Rice Symposia (more than 1,400 pages of material), plus the *Two-Line Hybrid Rice Breeding Manual* and the terminal report of the IRRI-Asian Development Bank project Sustaining Food Security Through the Development of Hybrid Rice Technology. For information on obtaining a copy of the CD, send an email to irripub@cgiar.org.

Words! Words! Words!

The International Rice Research Institute (IRRI) has updated its online Rice Thesaurus (http://snipurl.com/10sioc) and it now features 680 new rice and rice-related terms, mostly in the fields of plant physiology, cultural practices, and rice grain, generated from the current literature on rice research. The grand total of terms is 3,807.

"The number of new scientific and technology terms grows very quickly," says Mila Ramos, recently retired chief librarian and head of IRRI's Library and Documentation Services (LDS). "The search and generation of new rice and rice-related terms involve scanning recent rice and rice-related publications and journal articles on rice."

Among the sources of additional terms are *Advances in genetics, genomics and control of rice blast disease* [Wang, Guo-Liang; Valent, Barbara (editors)]; *Planthoppers: new threats to the sustainability of intensive rice production systems in Asia* [Heong, K.L.; Hardy, B. (editors)]; *Climate change and crops* [Singh, S.N. (editor)]; *Gene flow between crops and their wild relatives* [Andersson, M.; de Vicente, M.C. (editors)]; and *Abiotic stress adaptation in plants* [Pareek, A.; Sopory, S.K.; Bohnert, H.J.; Govindjee (editors)].

New terms were also generated in the process of establishing the hierarchical relationships of terms, particularly in the USE and USED FOR hierarchies, which relate synonymous terms. Each term in this thesaurus carries a subject tree showing hierarchical relationships as indicated by

- BT or broader term (general concept) and NT or narrower term (specific concept)
- rt or related term (associative term)
- USE (refers the user from a nondescriptor to a descriptor)
- uf or used for (indicates that the descriptor was used for a nondescriptor)

The concepts on the different aspects of rice production were considered in building the hierarchical relationships of terms, especially the related terms.

Moreover, according to Ms. Ramos, a crucial part in the process of updating the Rice Thesaurus is the standardization of the new terms. LDS consulted standard thesauruses such as AGROVOC,[1] CAB Thesaurus,[2] and NAL Thesaurus[3] as guides in ensuring the consistency of the terms. For differences in terms used in the standard thesauruses, the common and current usage of the terms in the rice literature were considered and preferred. Scanning the Rice Bibliography database was useful in determining the choice of terms. The same consideration was adapted in the case of terms not found in AGROVOC, CAB, or NAL thesauruses.

The project began in 2006 as a convenient reference for rice scientists and students. Funding for this thesaurus was provided by Communication and Publications Services and LDS.

[1] AGROVOC Thesaurus is a multilingual, structured, and controlled vocabulary designed to cover the terminology of all subject fields in agriculture, forestry, fisheries, food, and related domains (e.g., environment, sustainable development, nutrition, etc.).
[2] The CAB Thesaurus is a controlled vocabulary that is used to index descriptor fields.
[3] NAL Thesaurus is an online tool for browsing agricultural and biological concepts and terminology.

The seed keepers' TREASURE

by **Alaric Francis Santiaguel**

Challenged and threatened by development intruding on their lands and traditions, the seed keepers of the Philippines' Cordillera region fiercely held on to their native rice varieties. Now, the world is discovering the precious gems in their possession: heirloom rice.

For thousands of years, the indigenous tribes of the mountainous Cordillera region in the northern part of Luzon Island in the Philippines placed their fate in the hands of chosen women. They are the "seed keepers" and they are tasked with harvesting the life force of their rice.

Seed keepers select the grains to be saved and sown for the next planting season, thus playing a crucial role in the turnout of the next rice harvests. Before harvesting begins, they scour the field and take great care in picking the panicles with the best form and structure. The prized seeds are then planted and nurtured in specific areas in the rice paddy isolated from other plants. These are propagated until the seed keepers have accumulated enough stocks to share with farmers.

Through the millennia of crop domestication and selection, the seed keepers were, and still are, instrumental in shaping the characteristics of their rice varieties. Only the most vigorous, acclimated, and healthy seedlings make the cut—which means they are the most suited to withstand pests, diseases, and the environmental conditions of the region.

Heirloom harvest

After being handed down in an unbroken link, from generation to generation, more than 300 of these native rice varieties achieved a venerated status as tribal heirlooms. Heirloom rice is a spiritual bridge to the ancestors who built considerable knowledge through trial and error and fashioned unique technologies from experiences collected over the centuries. It has become as much a part of the region's culture and identity as the resplendent rice terraces that the people's forebearers carved out of the mountainsides.

What actually separates native varieties of rice from heirloom rice is hard to identify. "What makes a family belonging something treasurable?" asked Nigel Ruaraidh Sackville Hamilton, an evolutionary biologist and head of the International Rice Research Institute's (IRRI) T.T. Chang Genetic Resources Center. "If it's something that's been handed down from your great-grandparents, it gains some meaning to

CHRIS QUINTANA (2)

CREAM OF the crop. Seed keepers such as Editah Dumawol (*inset*) carefully scour the rice fields for robust panicles heavy with grains. Only those that meet the seed keepers' standards are set aside for future planting.

you. Some emotional meaning that has a particular value in your way of living.

"I would think of it as a community judgment," he added. "It's not really the individual farmer. It needs a bigger scale than just a farmer. But we're talking about just opinions here. This is a concept that's developing in many countries, recognizing that something is special about some old varieties that you don't get in new varieties."

Genetic reservoir

But heirloom rice has intrinsic values to outsiders as well. The seed keepers were the original rice plant breeders. The enormous diversity of rice they developed in the Cordillera region is like a big box of genetic tools that serve as a crucial line of defense against the threat of insects and diseases.

"When we bring rice into the genebank and make it available for breeding, the value in that comes in specific genes," said Dr. Sackville Hamilton. "Maybe the aroma gene, maybe something special about the texture, the taste, the resistance to diseases, and many different attributes. We can generate a value that's good for farmers out of the material in the genebank, just by virtue of its genetic properties. We can combine these genetic properties into other varieties and make, we hope, better varieties."

But these native rice varieties were not always viewed this way.

Out with the old, in with the new

"When IRRI started, in the 1960s, the mentality was: we need more food," Dr. Sackville Hamilton explained. "IRRI knows how to produce more food, higher yields, with more fertilizer, with dwarf genes, all those kinds of things. We developed the technology that replaced the technologies that farmers had at the time."

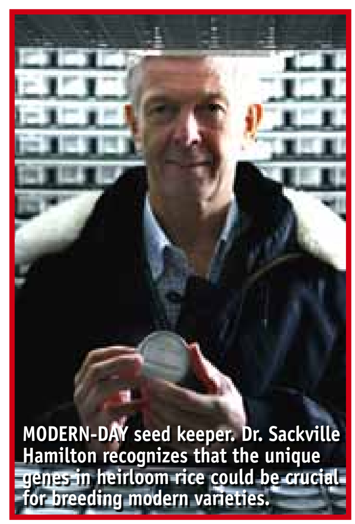
But every community had its own culture, its own way of growing rice, and its own varieties. So, Dr. Sackville Hamilton said that by adopting IRRI's early technologies, "We just threw away their old technology and replaced it with the new technology."

The new technology included new high-performing rice varieties and vegetables. The Banaue terrace farmers in Ifugao Province, impressed by the new varieties, swapped their heirloom rice varieties for nonindigenous, high-yielding rice varieties, which can be planted and harvested twice a year, and also for temperate vegetable crops promoted by the Philippine government through the Green Revolution.

The high price of change

But the new rice varieties and vegetable crops required expensive inputs such as fertilizers and pesticides. Years of heavy use of pesticides and commercial fertilizers diminished the fertility of the soil.[1] It also "accelerated the poisoning of the rice terraces,"[2] thus destroying agrobiodiversity and making traditional rice paddy cultivation of fish, shells, and clams no longer feasible.[3]

The spiraling cost of pesticides and chemical fertilizers had put farmers in debt.[3] When the farmers were forced to stop using agrochemicals because of their high prices, the yield capacity of the rice in the Banaue terraces suffered drastically. Robert Domoguen, chief information officer, Department of Agriculture in the Cordillera Region, reported in 2008 that farmers who tried to plant high-yielding varieties in their fields stopped doing so when they observed that, without chemical fertilizers, the succeeding crops grown in the same paddies produced low yields.[4] He added that modern varieties also required pesticides to protect them during diseases and pest infestation.



ISAGANI SERRANO

MODERN-DAY seed keeper. Dr. Sackville Hamilton recognizes that the unique genes in heirloom rice could be crucial for breeding modern varieties.

[1] Carling J. 2001. The Cordillera indigenous peoples, their environment and human rights. Paper presented at the Asia Society.
[2] UNESCO Bangkok. 2008. The effects of tourism on culture and the environment in Asia and the Pacific: sustainable tourism and the preservation of the World Heritage Site of the Ifugao Rice Terraces, Philippines. Bangkok (Thailand): UNESCO Bangkok. 90 p.
[3] Baguilat Jr., Teodoro. 2005. Conservation and land use: using indigenous management systems in Ifugao, Philippine Cordilleras. Paper presented at the Conférence Internationale Biodiversité: science et gouvernance Atelier 13—Diversité biologique, diversité culturelle: Enjeux autour des savoirs locaux.
[4] Domoguen, Robert. 2008. Best practices on agricultural crops production and resource management in the highlands of the Philippines Cordillera. Philippines: Department of Agriculture, High-Value Commercial Crops (HVCC) Programs. 184 p.

LOUISA CHU

VICKY GARCIA

TWO WOMEN, one passion. Vicky Garcia (*left*) and Mary Hensley (*far right*) teamed for the ambitious undertaking of bringing heirloom rice back from obscurity and introducing it to the world.

The increasing hardship eventually triggered a mass migration as many farmers sought greener pastures. The abandoned and unproductive Banaue rice terraces, a United Nations Educational, Scientific, and Cultural Organization World Heritage Site, slowly started to deteriorate through erosion and poor maintenance.

A recipe for poverty

Interestingly, however, the rice terraces in the neighboring provinces of Kalinga, Mountain Province, and the very remote areas of Benguet, where government efforts to modernize agriculture failed to make an impact, remained vibrant. This is not to say that the people in these areas were significantly better off.

Although their devotion to their heirloom rice spared them from the toxic chemical blight, it didn't shield them from the economic difficulty many far-off subsistence agriculture communities face. Isolated from the rest of the country, the peoples of the Cordillera grow only enough food to feed their families or for trade within the community.

Situated outside a cash-based economy, the people in these areas did not have other sources of currency to pay for their other needs. They had no access to modern health services and education. In this perfect recipe for poverty, many also found the lure of a better life outside the region simply irresistible.

Corrosion of indigenous knowledge

The seed keepers watched helplessly as their children and grandchildren moved out and abandoned their ways. Their greatest fear was that heirloom rice would fade into oblivion as more people left the community.

Over the years, much of the tribes' expertise and wisdom have already disappeared. And, with further neglect, most of what was left could also be lost soon. Only through continued use in the fields can heirloom rice be preserved.

The conservation of heirloom rice is more than just an exercise in nostalgia. "We don't know about all the culture," said Dr. Sackville Hamilton. "All the knowledge associated with them [the varieties] gets lost once we put them in the genebank.

"If we can find a way to provide better livelihoods, in which farmers can use heirloom varieties, then those varieties will remain," he added.

Rice renaissance women

The answer to the seed keepers' prayers came from two women who used their limited personal resources and passion for preserving heirloom rice cultivation. One of them, Mary Hensley, a Peace Corps volunteer in the Cordillera in the 1970s, was enamored of *Tinawon* and *Unoy*, two heirloom rice varieties possessing an intense aroma and flavors she could not forget.

When she returned to the region in 2002, she was determined to put heirloom rice in the gourmet spotlight like basmati and jasmine rice. The terraces and the native rice of the Cordillera are too important, she said. So, she resolved that something must be done or the terraces, the native rice, and the cultures of the Cordillera would pass beyond the tipping point.

Her timing was impeccable. The world's appetite for earth-friendly, nutritious foods was growing. And so was the backlash against harsh modern agricultural practices in industrialized countries where most food crops are grown on large, monoculture corporate farms.

Heirloom rice varieties, on the other hand, are highly suitable for organic farming and leave a smaller carbon footprint. "Rice terrace farming in the Cordillera is different," according to Mr. Domoguen. "It follows traditional practices that rely on organic production strategies and inputs. The crop is grown naturally twice a year without using chemical fertilizers and pesticides."

In 2006, Ms. Hensley started to market the heirloom rice in North America through her company, Eighth Wonder (see www.heirloomrice.com). Saddled with a minuscule marketing budget, the company's effort to raise awareness has been slow. "We do it one store at a time, telling the background story of the rice with its connection to the culture and the historic terrace landscape," she said.

Ms. Hensley shared that most consumers try it initially because of its story, but it is the characteristics of heirloom rice that win them over. Like so many other heirloom foods, the rice is very tasty and has its flavor, aroma, and texture qualities intact.

"Buyers are almost always impressed with the very beautiful color and size of the grains," she said. "People have e-mailed to say that their children love eating this rice while others have said it's hard to go back to eating other varieties of rice."

Professional chefs are also becoming avid converts. Michael Holleman, corporate chef at Indian Harvest, a leading supplier of rice, exotic grains, and legumes to many top restaurants in the U.S., described the varieties as "easily the most flavorful, aromatic, and unique varieties of rice I have ever had the pleasure of cooking."

Victor Béguin, chef and owner of La Bonne Table, a culinary school and catering service provider based in New Hampshire, U.S., was taken in by the wonderful aroma and mild flavor of tinawon. "When cooked, it produces a very good texture and does not break down or become starchy," he said. "It's a very savory rice with more flavor and a denser texture than other short-grain, arborio, or valencia rice varieties. It must be the mother of all arborio types," he added.

Because consumers are willing to pay extra for these varieties, the healthy profit margin allows Eighth Wonder to buy heirloom rice from Cordillera terrace farmers at a higher price. This becomes an economic incentive for maintaining traditional knowledge.

Culturally conscious development

Ms. Hensley teamed up with Vicky Garcia, founder and executive director of Revitalize Indigenous Cordilleran Entrepreneurs (RICE), and created the Heirloom Rice Project in 2004. This project provides organizational support to commercially produce and export heirloom rice without disregarding the people's way of life. It incorporates the culture, needs, and aspirations of the people into the production process, because preserving traditional ways is not only about financial rewards. More importantly, it is also about respect.

"Our process is participatory," Ms. Garcia explained. "Of the more than 87 varieties of heirloom rice in the project areas, only 17 were chosen for their export potential. But we do not require farmers to plant only specific varieties that we want." Some fields are planted with rice varieties for export. Others are planted with the varieties of farmers' choice for their own consumption.

Key to a brighter future

Money from the export of heirloom rice is breathing life back into the languishing tribal communities by transforming them into thriving agricultural centers. Some of the people who left the region for jobs elsewhere are coming back, reuniting with their families, and renewing their covenant with their land. The health centers and schools they once dreamed of are now part of the landscape, according to Ms. Garcia.

The philosophy of heirloom rice is also spreading to other areas in the region where these varieties are critically endangered after farmers opted for modern varieties. Now, there is growing interest in reviving the rice of their ancestors in their fields.

Heirloom rice isn't merely a link to the past any more. It is now key to the Cordillera's brighter future.

Ready for the world

Ms. Hensley and Ms. Garcia are convinced that heirloom rice is ready for the next level. "Their [these people's] knowledge of traditional terrace agriculture and the plant breeding that has resulted in these varieties should be legally protected," said Ms. Hensley. So, she contacted Slow Food Foundation for Biodiversity, an international organization based in Italy that promotes sustainable, environment-friendly agriculture, respects the cultural identity of local people, and advocates animal well-being.

Ms. Hensley nominated three varieties of heirloom rice to Slow Food's Ark of Taste, an international catalog of heritage foods in danger of extinction. These are the *Imbuucan* from Ifugao, the *Ominio* from the Mountain Province, and the *Chong-ak* from Kalinga. In July 2010, Slow Food Foundation approved the inclusion of the three varieties of heirloom rice in the Ark of Taste.

Inclusion in the Ark means that these rice varieties meet the Foundation's standards for taste quality, environmental sustainability, and respect for the cultural identity of the producers, Ms. Hensley stated. All products listed in the Ark are recognized to have real economic viability and commercial potential.

This sets the stage for the world debut of the Cordillera's heirloom rice at Slow Food's Terra Madre Conference in Turin, Italy, in October 2010. This biannual conference, which attracts more than 5,000 food producers, chefs, food writers, and students from over 130 countries, focuses on sustainable, earth-friendly agriculture and the preservation of biodiversity and indigenous knowledge. Ms. Garcia and five Cordillera terrace farmers will attend the conference as invited delegates.

The other treasure of the Cordillera

With the listing of the first three varieties, the Cordillera terrace farmers are a step closer to giving heirloom rice a legal status under protected Geographical Indications. This is a special type of intellectual property protection for names of regional foods and other agricultural products to distinguish them in the market and help preserve traditional cultures, geographical diversity, and production methods.[5]

Geographical Indications not only ensure that customers are not confused or misled by copied products made by other brands, but that the genuine producers can also benefit from the goodwill of internationally recognized brand names. If they succeed, *Imbuucan, Chong-ak, Ominio,* and possibly other heirloom rice varieties cannot be used on products that haven't been traditionally grown in the Cordillera terraces. No other place on the planet can claim it produces these varieties. For example, the grains from *Imbuucan* varieties cultivated, harvested, and processed outside the Cordillera region cannot be called *Imbuucan* rice. This would make heirloom rice an economic engine for the region and a means for preserving the fragile biodiversity of the terraces and the cultural identity of the indigenous people.

But beyond the obvious financial boon, protecting its Geographical Indications would validate the work and dedication that went into keeping heirloom rice alive. And that would truly be a just reward for the Cordillera seed keepers who remained faithful in guarding and keeping their treasures.

ISAGANI SERRANO

CORDILLERA KIDS. Though not all of them will stay and be farmers, the resurgence of heirloom rice cultivation is giving the new generation more options for the future.

[5] Originally developed in France, many developed countries have protected their Geographical Indications that identify a good as originating in a territory and where a particular quality, reputation, or other characteristic of the good is largely attributable to its geographic origin. Examples include Champagne, Cognac, Scotch whisky, Sherry, Napa Valley wines, Kobe beef, Parma and Teruel hams, Grimsby smoked fish, Darjeeling tea, Roquefort cheese, Swaledale cheese, Parmigiano Reggiano, Yorkshire forced rhubarb, and Tuscany olives.

Rice for peace

by **Savitri Mohapatra**

War-torn African nations turn back to rice to rebuild lives and regain peace

R. RAMAN, AFRICARICE

A POURING rainstorm does not stop Project participants of the Japan-funded Emergency Rice Project in Sierra Leone from posing with AfricaRice Deputy Director General for Research, Dr. Marco Wopereis, IRRI Deputy Director General for Research, Dr. Achim Dobermann, and African Rice Coordinator from AfricaRice, Dr. Inoussa Akintayo.

The hills of Rwanda are once again alive with the sound of farmers singing as they harvest their crops. Rwanda, known as "The Land of a Thousand Hills," is the most densely populated country in Africa and nearly 90% of the population depends on subsistence agriculture.

As the country moves on from the horrors of the 1994 genocide, it tries to build a new future for itself based on peace and sustainable growth. But, this is a difficult task because the civil war destroyed most of the seeds, crops, and livestock, and its farmers either fled the countryside or were killed in the strife. With them, knowledge about local crop varieties also disappeared.

The rise of rice

The Rwandan government has identified the improvement of rice production as a cornerstone of Rwanda's fight against poverty and malnutrition. Domestic rice consumption has risen substantially and the country currently imports about 30% of the rice it consumes. Thus, the need for the country to improve its rice productivity is urgent.

The Africa Rice Center (AfricaRice) has been helping rehabilitate Rwanda's rice sector by working closely with the national program in distributing appropriate rice varieties and training national research staff. In order to build new seed supply systems that farmers can rely upon, the AfricaRice has recommended a comprehensive strategy to rebuild the country's rice seed sector.

In addition, AfricaRice and the International Rice Research Institute (IRRI) are carrying out several important joint projects with support from the International Fund for Agricultural Development (IFAD), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), and the Bill & Melinda Gates Foundation. Through these projects, the country benefits from the recent advances in rice science, targeted training of researchers and seed producers, and the exchange of elite germplasm.

Rebuilding Africa

AfricaRice has been helping postconflict countries across Africa (Burundi, Chad, Côte d'Ivoire, Democratic Republic of Congo, Guinea-Bissau, Liberia, Mozambique, Rwanda, Sierra Leone, and Uganda) rebuild their national rice sector by restoring rice agrobiodiversity and strengthening human and institutional capacities.

These efforts have been made in partnership with national research systems, nongovernmental agencies, and farmer organizations with support from the African Development Bank (AfDB), Belgian Development Cooperation, Canadian International Development Agency, GTZ, IFAD, the Japanese government, Swedish International Cooperation Development Agency, United Kingdom Department for International Development, and United Nations Development Programme.

When necessary, AfricaRice has provided infusions of seed of improved varieties, such as WITA and NERICA varieties, and helped restore lost germplasm collections. For instance, in Sierra Leone and Liberia, which have suffered years of civil war, over 5,000 rice varieties were restored to the national programs between 1994 and 2002.

Sierra Leone

With 70% of its population living below the poverty line, Sierra Leone is one of the poorest countries in the world, ranked 180th out of 182 nations in the Human

R. RAMAN, AFRICARICE

◀ **SIERRA LEONE is one of the seven pilot countries of the African Development Bank (AfDB)-funded NERICA project carried out by the African Rice Initiative (ARI). Dr. Inoussa Akintayo, Regional ARI Coordinator (*front left*), and Ms. Chileshe Paxina, AfDB representative (*right*) with project participants.**

B. CISSÉ, AFRICARICE

IN RESPONSE to Liberia's request, the African Rice Initiative provided about 60 tons of NERICA-foundation seeds to the national seed bank for multiplication and distribution to farmers.

Development Index. Rice is a strategic crop for Sierra Leone, where about 120 kilograms per capita of rice are consumed annually compared with 80 kilograms in Asia. Domestic production meets only 70% of the country's requirements.

The AfricaRice intervention in Sierra Leone after the war was mainly carried out through the AfDB-funded NERICA rice dissemination project in partnership with the national agricultural research system. As part of this project, 42 NERICA varieties were tested between 2005 and 2008, from which 10 were selected and seven adopted by farmers for cultivation.

About 415 farmer groups representing 65,500 farmers (including over 21,000 women) were involved in the testing program. More than 140 tons of foundation seeds and 3,880 tons of farmers' seeds were produced. Yield rose from 0.6 ton per hectare in 2005 to 1.8 tons per hectare in 2008.

Liberia

AfricaRice has also been actively helping Liberia, where rice is the staple food and problems in supply have caused deadly riots and civil strife in the past. The country is still trying to recover from more than a decade of civil war. Despite its natural wealth in gems, rubber, and timber, Liberia remains one of the poorest countries in the world.

Liberia produces only about 40% of the rice it needs to feed its population, relying on imports to cover the rest. With support from UNDP, AfricaRice, through its African Rice Initiative (ARI), is rebuilding the capacity of smallholder rice farmers in postconflict Liberia. AfricaRice is also training technicians and farmers on seed production within the framework of the Millennium Village Project.

Through this collaborative project, the ARI is providing technical assistance and guidance across the rice value chain from seed production to harvest and postharvest processing in partnership with the national agricultural research and extension system.

AfricaRice has recently provided about 60 tons of foundation seeds to the national seed bank. The linkages forged by AfricaRice with international development agencies have led to stronger capacity of farmers for seed production and increased rice cultivation. Specifically, the linkages have resulted in the development of a national seed policy with a seed certification framework and a seed strategy, which will include a national seed service and national variety release agency for rice in Liberia.

B. CISSÉ, AFRICARICE

AfricaRice has trained extension workers and farmers in Liberia as part of the Millennium Village Project with support from the United Nations Development Programme.

Uganda

AfricaRice technologies, such as NERICA varieties accompanied with rice training videos, have played a key role in helping displaced farmers in northern Uganda. After more than 20 years, about 1.5 million refugees are gradually returning to their original lands. The Food and Agriculture Organization of the United Nations NERICA project is helping the farmers by introducing rice-based farming systems to increase food security and reduce poverty in Uganda.

A rice initiative

In 2008, the food crisis caused by soaring prices of rice sparked violent riots in several West African countries (Burkina Faso, Cameroon, Guinea, Côte d'Ivoire, Mauritania, Senegal, etc.), illustrating the continent's vulnerability to international rice market shocks.

The Emergency Rice Initiative launched by AfricaRice in the wake of the food crisis in 20 countries across sub-Saharan Africa, with support from Japan, has been able to help more than 58,000 vulnerable farmers get access to quality seed and, at the same time, reinforce or rebuild seed systems.

Similarly, the United States Agency for International Development-supported Famine Prevention Fund Project launched in partnership with IFDC, the Catholic Relief Services, and national programs, in response to the food crisis, is seeking to help about 10,000 farm families in each of the four project countries (Mali, Ghana, Nigeria, and Senegal) to have better access to improved seed, fertilizer, and knowledge on rice production practices.

Hopefully, such concerted efforts to stimulate agricultural growth and reduce hunger can help prevent conflicts and reduce vulnerability among resource-poor people in Africa.

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Carolina Gold and Carolina White rice: a genetic od

The odyssey of Carolina Gold and White spans Asia, Africa, and North and South America, touching the lives of farmers, scientists, slaves, and soldiers who refused to surrender

In 1982, Dr. César Martínez visited a rainfed rice-growing area near Tarapoto, in Peru's upper Amazon Basin. Martínez, then a rice breeder with the International Center for Tropical Agriculture (CIAT), based near Cali, Colombia, came upon a hardy rice variety with heavy heads of beautiful grain grown by subsistence farmers in rainfed plots. Farmers called it Carolino.

Martínez was impressed by the humble variety. "Carolino grew fast, even in those poor, leached-out Amazonian soils," he said. "And it obviously resisted pests because it had no chemical protection." What he didn't know at that time was that Carolino's journey began on the other side of the world—a fascinating saga that is larger than life.

Carolina Gold and Carolina White are sister varieties of rice of the antebellum South that were similar, except that one had a golden husk, while the other was pale.[1] Pearly grains and a nutty taste gave the Carolina rice varieties a special place on the British royal table, and made Charleston the most prosperous city in England's American colonies. During their reign of two centuries, the sisters fostered vast rice plantations in the low country of the Carolinas and Georgia.

Where the journey began

However, the true origin of Carolina Gold is probably Indonesia. It reached Madagascar through Indonesian immigrants who settled on the island in the 1st century AD. It is reported to have immigrated to the New World three centuries ago [around 1685] when a New England ship sailing from Madagascar to New York was forced by a storm to seek shelter in Charles Towne, which is now known as Charleston, South Carolina.

The gentry of Charleston entertained the officers of the two-masted brigantine until the storm passed. Before setting sail, the ship's captain, John Thurber, thought that rice might grow well in the swampy lowlands around Charleston. He gave a "peck," about 5 kilograms, of rice seed that he'd collected in Madagascar to Dr. Henry Woodward, a prominent Charleston physician and local botanist.

The seeds thrived and became known as Carolina Gold and Carolina White. Carolina Gold was, in fact, the first commercially grown rice variety in the U.S. Exports of Carolina Gold and Carolina White generated colossal fortunes for the rice plantations of the low country of the Carolinas and Georgia (see Merle Shepard's reference to this in

THE OLD rice fields in Charleston, South Carolina, once planted to Carolina Gold now covered with marsh grass. The Carolina rice industry collapsed after the Civil War that ended slavery because, without slaves, landowners could not maintain the dams and locks that held back encroaching sea water.

DANIELLE OSFALG

[1] The two varieties were grown in adjacent fields at the International Center for Tropical Agriculture near Cali, Colombia, in 1994. Carolina White was a little taller and, to me, seemed to grow more vigorously than Carolina Gold.

yssey

by **Tom Hargrove**

RENAE MYERS

Pioneer Interview excerpt on page 41).

But the Carolina rice industry depended on black slaves, brought from the "Rice Coast" of West Africa because they knew rice culture. Their ancestors had grown rice for more than 3,000 years.

The end of slavery after the Civil War doomed rice farming on this gold coast. Without slaves, the landowners could not maintain the dams and locks that held back encroaching sea water. Also, hurricane damage worsened because erosive cotton farming had silted the rivers. The Carolina rice disappeared with the collapse of the Carolina rice industry after the Civil War. The last commercial crop of Carolina Gold was harvested in 1927, with only a few seed samples of the Carolina rice preserved in genebanks.

Flight to South America

But the Carolina rice survived its close brush with extinction.

More than 5,000 war-weary and disillusioned Confederate veterans migrated to Brazil after the Civil War and the Confederacy's defeat in 1865. Dom Pedro II, emperor of Brazil, welcomed the Confederate veterans warmly because of the "Brazilian desire to acquire the agricultural skills of the Southern planters," according to Eugene Harter, author of *The Lost Colony of the Confederacy.*[2] The Confederates almost certainly took the seeds with them to South America.

One group—which included Confederates from South Carolina—started a colony at Santarem, along the Amazon in Brazil. Santarem has been a Brazilian rice bowl for decades. Seeds may have spread from Santarem across the Amazon Basin. Rice is also grown as a subsistence crop in the Amazon forest margins of Rondônia and Acre in Brazil, and in the Bolivian Amazon Basin.

Although the names are Spanish now, and have changed from feminine to masculine, the Carolina rice has retained much of its original sturdiness. Carolina White has produced a line of dryland rice that resists drought and diseases, and is slowing the slash-and-burn assault on rain forests in northern Colombia and Panama.

This is the variety that impressed Martínez. "I originally wrote the variety's name as *Carolino Blanco,*" Martínez said. "And blanco means white in Spanish." (Subsequent expeditions to Peru revealed two similar rice varieties known as Carolino Perlas [pearl] and Carolino Khaki [brown].)

Carolino Blanco was a beautiful, regal rice that grew in dry soil, in a slash-and-burn field cleared from the jungle, intermixed with maize, cassava, lots of weeds, and decaying tree stumps. The plants stood more than a meter high, but didn't look like they would lodge, or fall over. The panicles of some plants were just emerging, long and erect.

CIAT librarian Mariano Mejía then searched the literature and found several references to Carolino Dorado (gold) and Carolino Blanco in Peru and Suriname. "Carolino Dorado and Blanco are almost certainly Carolina Gold and White," said Dr. Ronnie Coffman, former plant breeder (1971-81) at the International Rice Research Institute (IRRI) and currently chair, Department of Plant Breeding and Genetics, and director of International Programs, Cornell University.

FROM THE COLLECTION OF TOM HARGROVE (2)

DR. HARGROVE (*left*) and Dr. Carlos Bruzzone, rice breeder with INIA, Peru's agricultural research agency, examine a wild floating rice along the upper Amazon near Iquitos, Peru. A Peruvian examines his Carolina White rice.

[2] Available from Texas A&M University Press.


A MODERN-day foundation seed field at Beaumont, Texas.

ANNA MCCLUNG ©

But Martínez was still cautious. He asked fellow rice breeder Dr. Charles Bollich for seed samples of the original Carolina rice that were preserved in the genebank of the U.S. Department of Agriculture Rice Research Center in Beaumont, Texas.

Martínez grew the Carolina rice, along with Carolino seeds he collected from Peru, on the CIAT experiment farm. Dr. Joe Tohmé, CIAT geneticist, compared "genetic fingerprints" of this rice. "The South American Carolinos are almost certainly the same varieties once grown on the Carolina plantations," Tohmé said.

Return to Africa

Meanwhile, Carolina Gold may have returned to Africa, the land where those who knew her best were enslaved, where it is known as *Mériká*, for America. In *Black Rice*,[3] a book by Dr. Judith Carney of the University of California at Los Angeles, the author speculates that the Carolina rice was re-introduced to Africa with the early 1800s repatriation of black slaves from the United States, especially to the Rice Coast of Sierra Leone and Liberia.

French botanists in Mali, in the early 20th century, reported a rice variety that local people called *Méréki* or *Mériké*. Carney wrote: “This varietal name proved to be a corruption of the name America. The toponym Méréki referred then to the seed’s arrival from the United States. Subsequent research by French botanists shows the grain’s remarkable similarity to, and likely provenance from, the Carolina Gold rice seed. The rice drew its name from America, the continent of human bondage.”

A new beginning

Carolina Gold also made a modest comeback, as a gourmet rice, along the gold coast it once made wealthy. In the early 1980s, Dr. Richard Schulze, an eye surgeon and fervent duck hunter, read that rice attracts migrating ducks. He repaired abandoned rice fields on his 400-acre [160-hectare] Turnbridge Plantation near Hardeville, South Carolina. Schulze kept hearing about the legendary Carolina Gold, and set out to "produce the same rice variety that was grown on our plantation more than 100 years ago." He tracked down seed samples in the USDA genebank in Beaumont.

After several harvests, Carolina Gold made its debut at a country club dinner, organized in its honor. Carolina Gold appeared in special rice dishes such as oyster pilau and veal, rice bread, and rice pudding. The Schulze family donates its harvests to the Holy Trinity Church, Gramville, S.C., which markets Carolina Gold to gourmets.

Carolina Gold and White show how genes of good crop varieties spread. The seeds made a remarkable journey: from Indonesia to Madagascar by boat almost 2,000 years ago, then to the wealthy and slave-driven Carolina plantations. Her seeds seem to have helped war-weary Confederate veterans start a new life along the Amazon in South America. Freed slaves may have taken her seeds back to Africa, which she once called home. Carolina Gold recently started a new life in South Carolina, and her white-hulled sister is a parent of an improved variety for upland rice farmers in Colombia and Panama.

A CAROLINA Gold rice production field in Texas in 1910.

USDA

A shorter article on finding the Carolina rice in South America was published in the now-defunct Diversity *magazine, Vol. 15, No. 3, 1999.*

Dr. Hargrove is a former communicator at IRRI, CIAT, and the International Center for Soil Fertility and Agricultural Development (IFDC).

[3] Available from Harvard University Press.

PART OF the training course is a socio-educational tour for the trainees in Tagaytay City, overlooking Taal volcano.

by Maria Mutya Frio

Developing new talents

IRRI's rice production course balances science theory and practical experience to form a new generation of well-rounded agricultural scientists

Kristal Jones, a former Peace Corps volunteer, recently found herself heading back to Asia, where she had once traveled as a tourist. Now a graduate student at Pennsylvania State University studying rural sociology, Kristal says that working in agroforestry as a volunteer in West Africa sparked her interest in agriculture. This year, she was back in Asia for a training course on rice research and production—literally getting her feet wet, planting rice and learning about the crop.

Appreciating rice production

Recent years have seen tremendous advances in rice science. U.S. funding agencies such as the National Science Foundation (NSF) and the U.S. Department of Agriculture invested heavily in rice genome sequencing and functional genomics to understand rice genes better. Many young graduates have gone through rigorous studies and become well prepared to contribute to agricultural research and development in developing countries, yet they have not been aware of this opportunity to truly experience "rice production" in the field.

Cornell University, a leading university in the U.S., has active links between its plant breeding and genetics initiatives and international development. The challenge, however, is exposing these young people to the science of rice and its application in rice-growing countries. Meanwhile, the International Rice Research Institute (IRRI) has been, for the past 50 years, developing new rice varieties and building the capacity of extension officers and scientists. These two institutions have been linked closely in advancing rice science. In 2005, a meeting among IRRI Director General Robert S. Zeigler, principal scientist Hei Leung, and former associate geneticist at IRRI Susan McCouch, who is now a professor in plant breeding and genetics at Cornell University, developed the idea of an innovative, three-week training course. The course was designed to cover the theoretical aspects of rice research—natural and social sciences—and practical experiences in the field and in the laboratory.

In 2007, IRRI partnered with Cornell University and the NSF to conduct the first training course known as Rice: Research to Production. The program mainly aims to produce a new generation of young scientists—plant scientists, for instance—who are well networked within the international community and have an appreciation of the rice production system as a whole. Moreover, it intends to attract more young students and scientists to a career in agricultural research and development.

It could be argued that this was already an innovative course with exposure to advanced science, complemented with farmer interaction. However, the diverse set of participants composed an important part of the equation. Participants came from both developed and developing countries, and, every year, 9–14 different countries are represented. For young professionals interested in agriculture, this alone was significant. This was made possible through the sponsorship of the Gatsby Foundation in the United Kingdom, the Afro-Asian Rural Development Organization, and specific projects managed by IRRI. This year, 26 participants from 11 countries took part in the training course. The participants reflected a range of disciplines within the natural and social sciences.

"This is an opportunity for young professionals to learn and appreciate how important rice is as a major crop that feeds more than half of the world's

MACARIO MONTECILLO (3)

KRISTAL JONES gets some first-hand experience with the crop she is researching.

population," Dr. Noel Magor, head of IRRI's Training Center, said.

Balance of theory and practice

The training course employs a systems framework that integrates research, crop management, extension, and training and communications. It balances the natural and social sciences of rice research, while giving participants hands-on exercises in the laboratory and in farmers' fields.

The program covers rice breeding, genomics, bioinformatics, genetic diversity, grain quality, and nutrient management, among other topics. It orients trainees on sound agricultural management practices such as integrated pest management and postharvest techniques. Students also get to explore IRRI's Rice Knowledge Bank, an online repository of information about rice in the major rice-producing countries. They are briefed on the global scenario of rice research, particularly highlighting where international networks collaborate, share, and take innovations to end users.

Participants also understand the socioeconomic aspects of rice production and the impact of policy. Global issues affecting rice such as climate change, poverty, the impact of technology, and the role of women in agriculture are discussed. Interactive sessions and lectures are conducted by IRRI's scientists, researchers, and trainers.

"What we have tried to do is make the world of rice research come alive to the course participants," explained Dr. McCouch. "By exposing them to a wide range of ideas and activities during their three-week stay at IRRI, we engage every one of their senses and keep them actively involved in the field, in the lab, in the classroom, and in touch with each other."

Hanh Nguyen, who participated this year, has recently earned her doctorate degree in plant pathology from Cornell University and is currently a postdoctoral fellow in Beat Keller's laboratory at the University of Zurich. Siti Norsuha Binti Misman from Malaysia, who has also earned a master's degree in plant pathology, serves her country as a researcher for the agricultural ministry.

Connecting with farmers

Shortly after the training course this past May, Kristal returned to Africa to conduct research on farmers' involvement in participatory plant breeding, in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

"I learned from this training the importance of communication and the need to connect research to farmers," Kristal said. "I want to know what new knowledge researchers have generated. I would like to see what farmers' perceptions are and how they are adopting changes."

Rice: Research to Production is offered every May-June at the IRRI campus in Los Baños, Philippines.

For more information on the Rice: Research to Production Course, go to http://irri.org or www.ricediversity.org or email Noel Magor, head, IRRI Training Center, at n.magor@cgiar.org; Eugene Castro, course coordinator, at e.castrojr@cgiar.org; or Susan McCouch at srm4@cornell.edu. for information about NSF funding opportunities.

Mud on my feet

by **Lovely Mae Lawas**

A young researcher shares her experience as a participant in IRRI's rice production course

I have been working at IRRI as a molecular biologist for a year now and I represented the Philippines in the Rice: Research to Production course held in May-June 2010. I realized it was an excellent opportunity for me to broaden my perspectives and learn recent advances in rice production technology.

The course was very intensive. Practically everything about rice—from the basics of production to research studies on the biological and social aspects—was tackled. The experts who conducted the training did well in helping us grasp the key points, leaving us to ponder more about critical issues.

Lectures on rice physiology and the crop's growing environment provided very helpful information on rice cultivation. Discussing social issues made me see the real world outside the laboratory. For instance, learning about the trends in rice supply and demand inspired me as a Filipino working in rice science to play a part in helping the Philippines achieve rice self-sufficiency. Certain topics stood out such as global climate change. The case study on Bangladesh particularly made me see how global climate change can adversely affect farmers through drought and flooding, leading to poverty. Most of the case studies were disheartening and encouraging at the same time as they showed that, despite adversity, people can cope. Significantly, the course featured how technology can bring life-changing solutions to such helpless situations.

Another topic that caught my interest was genomics application of single nucleotide polymorphism (SNP) technology. Though I am a molecular biologist, this was something new to me. Learning how to make project plans was also very informative, especially for young scientists like me who may present project proposals in the future.

The hands-on exercises in rice production—from preparing the land to planting until harvesting—gave us a glimpse

LOVELY MAE Lawas takes her turn to plow the field—the old-fashioned way.

of what it was like to work in rice fields and how rice finds its way to our table. I realized the amount of hard work that farmers put in to earn a living.

Getting our feet in the mud to transplant rice seedlings and plow the fields using a water buffalo were not just educational, but also fun. Mimicking breeders while carrying out crosses was also interesting. I didn't exactly know how breeding was done until we did the exercise on panicle emasculation and pollination.

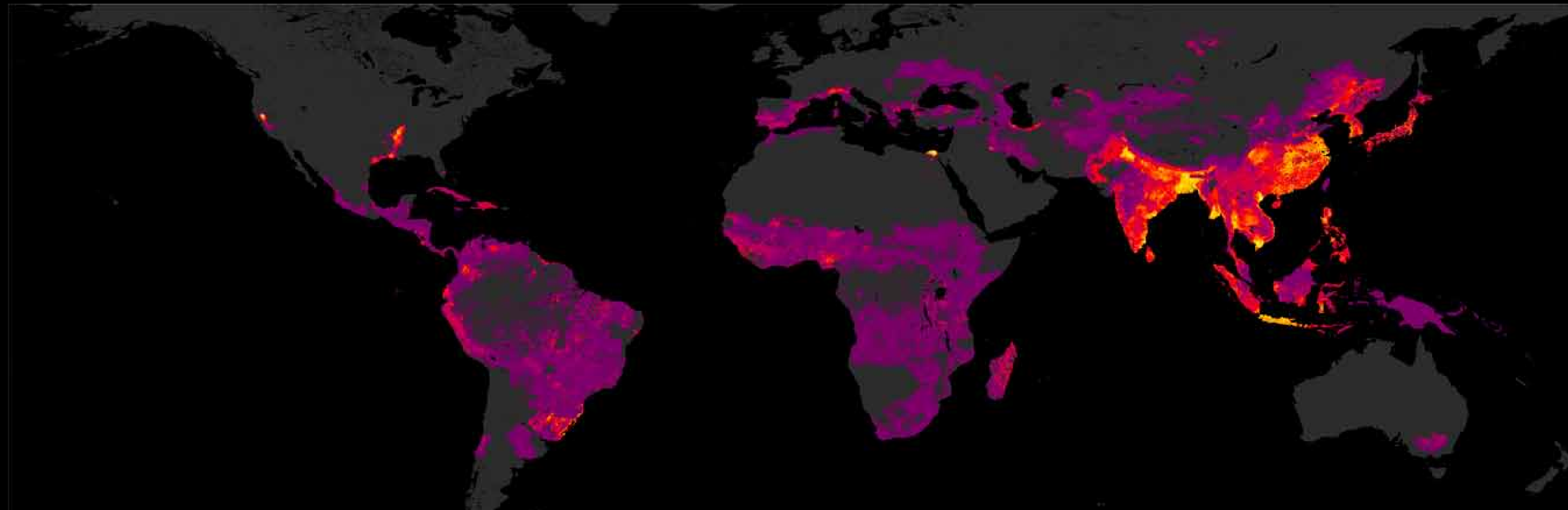
A trip to the Banaue rice terraces in the northern Philippines and the interviews we conducted among the farmers made me aware of the true situation of the country's rice industry. I realized that, while work in the laboratory is important, these studies will be substantial only if they are applied in farmers' fields.

Rice: Research to Production was a fun learning experience that made my first year of work at IRRI more meaningful. I interacted with people of different cultures, backgrounds, and perspectives. This has helped me establish a network of international contacts that will be beneficial if we are to progress in the global rice science community. I applaud everyone who made the course successful and I thank them for sharing their knowledge and for inspiring all of us with their success stories.

The value of rice

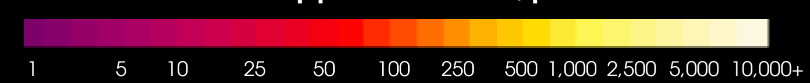
by **Andrew Nelson**

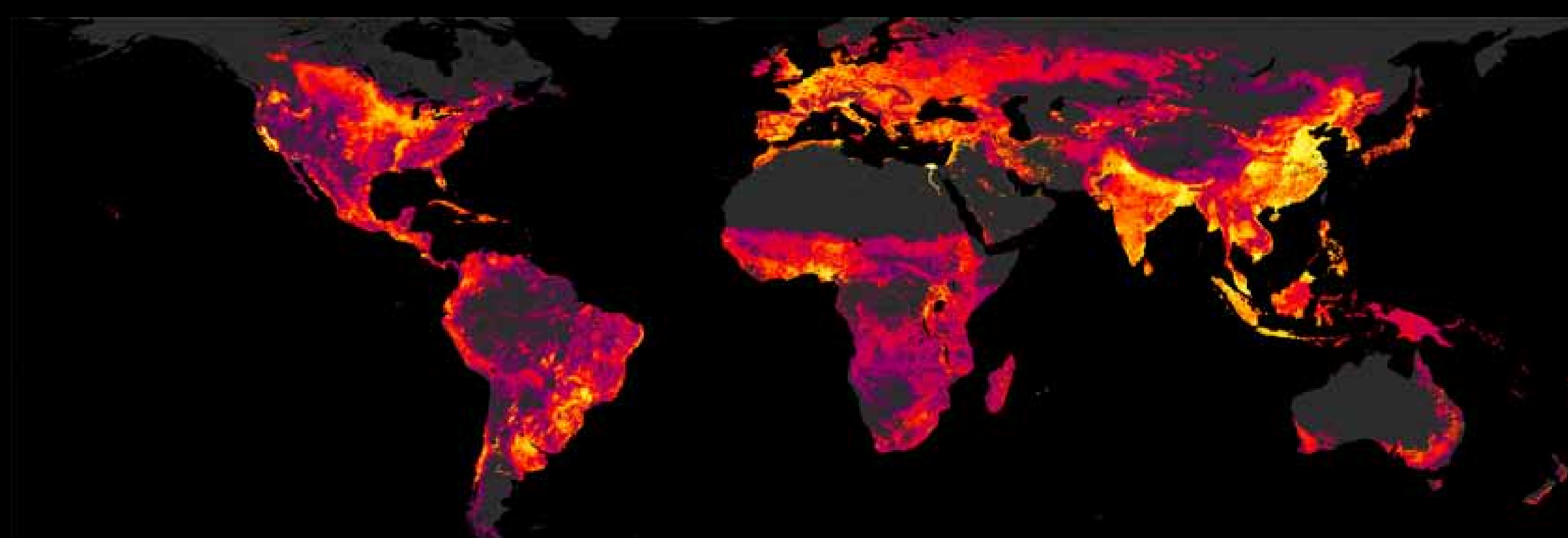
Rice agriculture has been described as the most important economic activity on Earth. Here, we map out the value of rice production (*top map*) and the total value of the world's crop production for 120 crops (*bottom left*) to visualize the economic significance of rice. The maps were created by multiplying the international commodity price (in US$)[1] for each crop against the geographic distribution of production[2] (in tons per hectare) for each crop for the year 2005.[3] In 2005, the value of the world's crop production reached $919 billion—$128 billion of which (14%) came from rice. But, as the chart on the bottom right shows, the percentage value and, hence, the importance of rice vary from region to region.



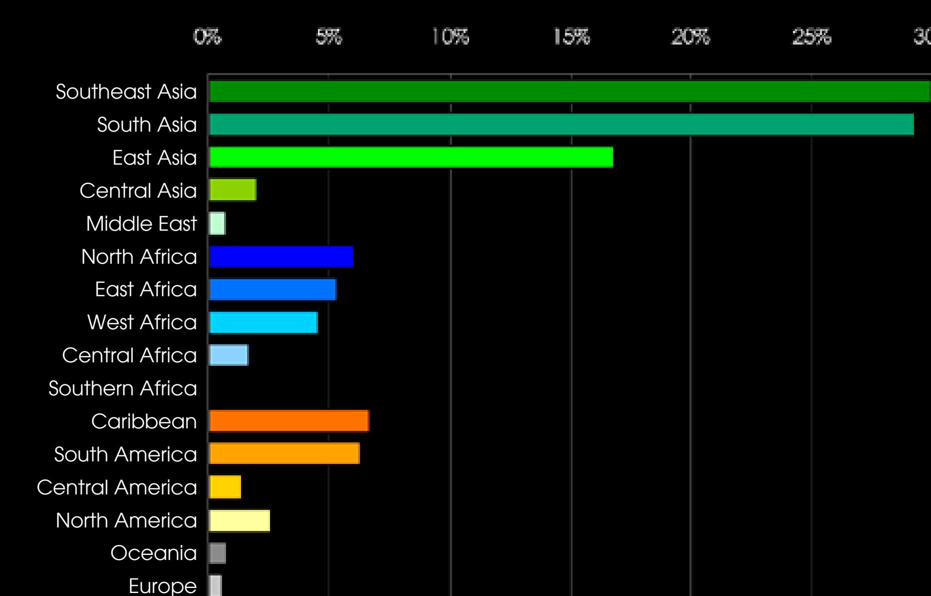
Value of rice production

Value of crop production in US$ per hectare





Total value of crop production for 120 crops



Value of rice production as a percentage of all crops

[1] International commodity prices: http://faostat.fao.org/site/339/default.aspx.

[2] Crop production maps: based on Monfreda et al. 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global Biogeochemical Cycles 22.

[3] Production figures for year: http://faostat.fao.org/site/567/default.aspx#ancor.

Extension goes MOBILE

by **Katherine Nelson**

Farmers can now use ubiquitous mobile phones to access fertilizer information whenever and wherever they need it

After labor, fertilizer is the most expensive input in rice farming. However, as crucial as fertilizer may be in improving rice production—despite the costs—the inefficient use of fertilizer can render its application futile and, worse, it can even be harmful to the environment.

On large-scale, mechanized farms in North America, Europe, Australia, and parts of South America, fertilizer can become more efficient through precision farming, which matches the application of fertilizer with location-specific needs of the crop by using such technologies as global positioning systems (GPS), variable-rate application equipment, and accurate field-mapping technologies. However, these sophisticated and expensive technologies are typically unsuitable for small-scale farmers, which include most rice farmers in Asia. So, what methods are appropriate to deliver fertilizer information to small-scale farmers in a rapid, accessible, and inexpensive way?

Roland Buresh, principal scientist at the International Rice Research Institute (IRRI), and his team have spent thousands of hours turning the idea of small-scale precision farming into a reality through the decision tool known as *Nutrient Manager for Rice (NMRice).* This computer-based software guides farmers in applying fertilizer properly and efficiently in their respective rice fields. The software, which was first made available on CD and through the Internet, was intended to assist extension workers and farmers in accessing recommendations regarding fertilizer application specific to the conditions of a rice farm. But the necessity for computers, Internet, and even electricity to run these tools limits access for many small-scale farmers in Asia.

JOSEPH SANDRO (2)

A FARMER in Laguna Province pretests the mobile phone service to receive fertilizer recommendations.

Hence, Dr. Buresh's team thought of using the mobile phone since it is affordable and widely available to farmers. *NMRice Mobile* was created to transfer the information available from the Web version to a mobile phone application that provides rapid, accessible, inexpensive, and credible field-specific fertilizer recommendations to farmers through a basic SMS (short messaging system). A farmer simply calls a toll-free number and is guided by an automated voice to answer several questions about his or her farm by pressing the corresponding button on the mobile phone. After all the questions have been answered, the farmer receives a text message, which recommends optimal timing, amount, and type of fertilizer to be applied to the farmer's rice field.

NMRice Mobile was launched in the Philippines in September 2010 to reach farmers without access to the Internet version of *NMRice*. The Philippines was an ideal pilot location for *NMRice Mobile* because the *Nutrient Manager* had already been developed and released in the country as a Web version (*NMRice Web*) and was supported by partners as an accurate recommendation.

The team achieved its objective of providing farmers with rapid, accessible, inexpensive, and credible field-specific recommendations by making the service available by mobile phone free of charge, and by accessing the previously validated *Nutrient Manager* software to make sure generated recommendations are consistent and accurate. The mobile service is available in English and in three local languages, namely, Tagalog, Ilocano, and Cebuano, so it can be better understood and used properly by farmers throughout the Philippines. The long-term vision is to create a platform that can benefit farmers through improved access to information, including finance and marketing opportunities, better management practices, location-specific information and warnings, and supplier

A FARMER in Mindanao gives feedback about *NMRice Mobile*.

contacts. The user will have the option to accept or deny receiving additional information.

An important step in developing the application is involving the social network, both national partners and farmers. The participation of national research and extension partners at an early stage is crucial to ensure consistent and accurate messages in training, promotion, and dissemination. This was accomplished through two workshops where public and private partners from the Philippines contributed to the development of *NMRice Mobile*. In addition, pretesting and farmer interviews in four provinces provided critical insight into the practical use of *NMRice Mobile*, and these interactions resulted in valuable changes to the service.

The first workshop, during the initial phase of the project, aimed to formulate the decision tool, tailor which questions to ask and how, determine which local languages should be available, and build ownership among national partners. In creating a product from multipartnership, many compromises need to be made along the way. Ideas were challenged and criticisms were accommodated. Translations, the questions asked or not asked, the length of the call, the instructions and disclaimers, the phone number, and the product name, among other topics, were discussed.

The second workshop took place during the final stages of development and helped further test the service with farmers in the field. Promotional and training materials were critiqued and translated into local languages. Field testing revealed valuable information on ways farmers answered questions. With this information, it was necessary to re-word some questions and fine-tune the program. These workshops and field tests involved public and private partners from the early stages all the way through to the final product and engaged them in the entire process of development—a collaboration essential to the success of the project.

NMRice Mobile confirms that precision agriculture can be made available to small-scale farmers by using a basic mobile phone to tap into decision-making tools that determine fertilizer needs based on variable rice field conditions. Participation from the public and private sector has contributed to the development of the service, and these partnerships will continue to guide the development and use as extension workers provide feedback from farmers for enhanced applications of *NMRice Mobile*.

For a 12:37 YouTube demonstration video on how Philippine rice farmers can use the mobile phone to get fertilizer information, go to www.youtube.com/watch?v=3GbguNguk-8.

Ms. Nelson is a graduate student at Cornell University and served as communications consultant at IRRI.

Farmers speak

A recent survey conducted among farmers highlights the benefits of the Nutrient Manager for Rice Mobile *program*

by **Kyeong Ho "Ken" Lee**

Rice farmers from the provinces of Isabela and Iloilo in the Philippines who tried *Nutrient Manager for Rice* (*NMRice*) *Mobile* for the first time praised the new phone application.

"It's so fast and easy to understand," states rice farmer Mamerto Jimenez from Isabela.

Farmers generally commended the application's ability to adjust to specific field conditions and its quick response and precise recommendations via text messages that help make farmers' use of fertilizer more cost-effective, with the added benefit of maintaining or possibly increasing yield. According to Romeo Pungan of Isabela, he does not have to guess the amount of fertilizer needed anymore. The use of a toll-free call from a mobile phone greatly increases access to *NMRice* because most farmers do not own computers, let alone have access to the Internet.

Interestingly, 14 out of the 47 farmers interviewed admitted that, even if they own a mobile phone, they do not feel comfortable using it. Hence, these farmers, with an average age of 60 years, opted not to use the application.

Considering that the younger generation is more attuned to technology these days, *NMRice Mobile* seeks to target farmers' children and spouses. All the interviewed farmers had younger family members in the household who owned and knew how to use mobile phones. In fact, most of the farmers preferred to have their children or spouse use *NMRice Mobile*, even if they were somewhat proficient with a mobile phone.

Many farmers said that their wives are more adept at using mobile phones because they are the ones who are likely to keep in touch with family members who have moved out and are living in different places. Their children, on the other hand, quickly adapt to the new technologies because of peer influence and fervent curiosity. Many farmers also described their children as far more "modern" than they are.

Although some of the farmers were hesitant to test the application, many of them requested training on mobile phones as *NMRice Mobile* reinforced the importance of keeping up with technology.

In this regard, *NMRice Mobile* should not be promoted only to farmers. Although it is vital that farmers understand the merits of the technology, it is equally important to teach farmers' spouses and children how to use *NMRice Mobile*. Many of these children attend public schools. Training workshops can be organized in cooperation with the local Department of Education and municipal agriculture offices, especially since agriculture is included in the school curriculum.

It is also crucial to recognize the essential role of extension workers in guiding farmers in the use of a phone application such as *NMRice Mobile*. With proper training, they are key to the successful transfer of skills and information to farmers.

Mr. Lee is a Robertson Scholar at the Sanford School of Public Policy at Duke University who served as an intern at IRRI.

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WILLIAM STA. CLARA

Hybridizing the world

by **Adam Barclay**

As China pushes on with its successful hybrid rice program, more and more countries around the world are taking a leaf out of the hybrid book

It is fair to say that, without a successful hybrid rice program, China would have struggled to achieve its phenomenal growth that has made it the second-largest economy in the world, let alone successfully feed more than 1.3 billion people. Hybrid rice varieties have allowed the world's most populous country to attain rice yields of above 6 tons per hectare—one of the highest averages in Asia.

China's interest in hybrid rice emerged from a famine in the 1960s at a time when failure to boost agricultural production substantially would have led to mass starvation. This investment has also seen the country lead the world in hybrid rice research and development.

The hybrid advantage

Hybrid varieties gain their yield advantage—a successful hybrid must yield at least 15% above a farmer's best available nonhybrid—through the phenomenon of heterosis, otherwise known as hybrid vigor. In conventional rice plants, each flower contains both male and female organs, allowing the plant to self-pollinate in order to reproduce (inbreeding). Hybrid rice seeds, on the other hand, come from two genetically distinct parents.

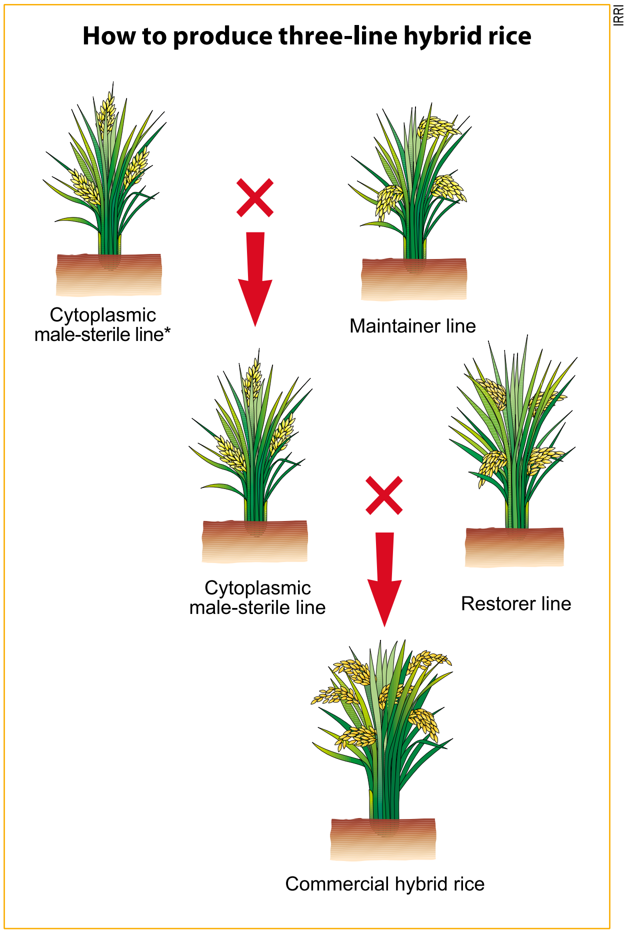
One of the reasons why creating viable hybrid varieties was so difficult was that, as it turned out, three breeding lines were required. These are known as the male-sterile line, the maintainer line, and the restorer line (for more information on this, see illustration on page 33, and *A hybrid history* on pages 22-25 of *Rice Today,* Vol. 6, No. 4).

The male-sterile plant does not produce pollen itself, but accepts pollen from other plants. When a maintainer line is crossed with a male-sterile line, the plants obtained (the F_1 generation) are also male-sterile; therefore, maintainer lines allow a continuous supply of male-sterile seeds. The restorer line, which restores fertility in the F_1 generation when crossed with a male-sterile line, is used to pollinate the male-sterile parent and thus produce hybrid rice seeds that can be grown by farmers.

China's edge

Hybrid varieties' yield advantage does not come for free, however, as farmers need to buy new hybrid seeds every season. Seed of inbred varieties is almost genetically identical to that of its parents and can thus be saved by farmers to be planted the following year. The outcrossed seeds of hybrid varieties are genetically diverse—meaning a crop planted to such seeds will display a mish-mash of varying traits and offer low yields of poor-quality grain.

Currently, Chinese farmers plant hybrid rice on around 17 million hectares annually—more than half of China's total rice area of around 29 million hectares. The country has commercialized hybrid versions of both of the main subspecies of cultivated rice, japonica (sticky rice grown in China's northern region) and indica (less sticky rice grown in the southern and central areas). Although most (85%) of China's indica rice is already hybrid, hybrid japonica varieties account for only around 3% of total japonica area.



*A cytoplasmic male-sterile line is the type of rice line required for the production of three-line hybrid rice varieties.

Chinese researchers are also developing two-line hybrids and so-called super hybrids. These are produced from parent lines that are genetically more distinct than regular hybrids and thus exhibit a greater degree of heterosis and, consequently, even higher yields (25–40% above those of inbreds). These varieties currently account for around one-fifth of China's total hybrid rice area. With much of the current research focusing on the development of super hybrids, this figure is growing slowly, but steadily.

Hybrids outside China

Realizing hybrid rice's potential, the International Rice Research Institute (IRRI) restarted its own hybrid rice research program in 1979 under the leadership of plant breeder Sant Virmani (now retired), who was convinced that the technology had great potential for rice farmers outside of China (see his anecdote about when IRRI began to take hybrid rice seriously on page 41).

Today, IRRI hybrid rice breeder Fangming Xie (in photo on page 32) is leading a suite of hybrid rice research projects. One of these aims to increase the yield of not only hybrid rice varieties themselves but also the varieties' parents, which are used to produce the hybrid seeds grown by farmers. This is important because it will help reduce the price of hybrid seeds, which inhibits adoption by farmers. Other projects include the development of hybrids with improved resistance to diseases such as bacterial leaf blight (the number-one disease of hybrid rice) and the analysis of the mechanism of heterosis. By better understanding heterosis, Dr. Xie and his colleagues hope to increase tropical hybrid yields up to 20% above those of the best inbred varieties grown by farmers.

Outside China, the area planted to hybrid rice continues to increase. The crop is being adopted most rapidly in the United States, India, and Vietnam, but Indian, Bangladeshi, Filipino, Indonesian, and Brazilian farmers are also gaining enthusiasm for hybrids (see timeline on page 34). The 2008 food crisis, which saw rice export prices more than triple in just a few months, sparked further interest in countries such as India and Bangladesh, where concerns about food security prompted urgent plans for increasing overall food production.

Recognizing the potential of hybrid rice to increase productivity, the government of India has supported hybrid rice research and development for the past two decades. During that time, 43 hybrid varieties have been released to farmers, with contributions from both the public sector (28 varieties) and private sector (15 varieties). The government has also identified hybrid rice as one of the components of its National Food Security Mission, which aims to produce an additional 10 million tons of rice by 2011-12.

In 2008, hybrid varieties were planted on 1.4 million hectares in India, with more than 80% of that area in the eastern states of Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, and Orissa. A survey conducted in Chhattisgarh and Uttar Pradesh in 2008 in farmers' fields revealed that hybrid rice varieties are indeed superior to inbred rice varieties in yield and profitability. The yield advantage in Chhattisgarh was found to be 36%, whereas, in Uttar Pradesh, it was 24%, generating an additional net profit of 13% and 34%, respectively. The extra rice resulting from the yield advantage of hybrids over inbreds is estimated to have contributed an additional 1.5 to 2.5 million tons of production in India.

According to B.C. Viraktamath, project director of the Directorate of Rice Research in Hyderabad, the adoption of hybrid rice in India was slow over the first 10 years. However, since 2004, it has become increasingly popular and profitable for farmers. Constraints to expansion include undesired grain quality in some regions (for example,

A timeline of hybrid rice

1926
First paper on the application of heterosis to rice production

1964
Led by "father of hybrid rice" Longping Yuan, China begins hybrid rice research

1970
Male-sterile rice plants found on Hainan Island

1972
IRRI begins hybrid rice program; discovery of IRRI restorer lines

1973
Three-line hybrid rice system completed; skepticism from some scientists forces IRRI to terminate hybrid rice program

1976
Hybrid rice commercia-lized in China

1979
IRRI restarts hybrid rice program

1980s and 1990s
Rapid, widespread adoption of hybrid rice by Chinese farmers

1994
Hybrid rice developed at IRRI released for commercial production

1995
Two-line hybrids commercia-lized in China

2004
Prof. Yuan receives World Food Prize

2008
Hybrid Rice Development Consortium founded by IRRI; area covered by hybrid rice reaches 20 million hectares globally

2010 →
Hybrid rice area continues to increase outside of China

some hybrid varieties exhibit a stickiness and aroma that are unpopular in southern India) and a lack of hybrids bred for particular environments, including shallow lowlands, coastal areas, *boro* (dry-season) rice, and problem soils. Further, in some areas, existing hybrids are expected to not be economically attractive without an even greater yield advantage than the current 15–20%.

Despite these challenges, hybrid rice is steadily gaining popularity, especially in the country's eastern states, which have the greatest potential for its production.

"The government has created a task force for the promotion of hybrid rice, which plans to bring more area under hybrid varieties in the coming years," says Dr. Viraktamath. "We expect that by 2015 hybrids may be cultivated in India over an area of 4 to 5 million hectares."

With the policy support of the Indian government, a range of hybrid varieties is under development to meet the country's wider requirements and, he says, "With a strong private seed sector, seed production targets could be met without many problems."

According to IRRI Deputy Director General for Research Achim Dobermann, India's private sector does have the strength required to keep the hybrid ball rolling.

"The private sector is a real driving force in India," says Dr. Dobermann. "More than 100 companies sell hybrid rice seed already and many have their own breeding programs."

India's priorities for promoting hybrid rice include expanding the range of varieties suitable for various rice-growing regions and environments; developing new male-sterile lines, improvement of parental lines, and increasing the level of heterosis; identifying additional sites for seed production and increasing seed yields; conducting a large number of demonstrations across several states to increase awareness among farmers; training and capacity building; and fostering effective public-private partnerships for hybrid seed production and promotion.

According to Dr. Xie, hybrid rice outside China will continue to grow in the coming years, but not as quickly as it did in China during the 1980s and 1990s.

"The Chinese government was the main force behind hybrid rice expansion in China during those decades," explains Dr. Xie, "but, in other countries, the private sector will play the main role in commercialization. That will take time because it's closely linked to such factors as production cost, commercialization mechanisms, and marketing."

Linking the private and public sector

The requirement for farmers to buy new seeds each season means that the private sector—which produces 99%


ARIEL JAVELLANA
HYBRID RICE allowed China to attain one of the highest averages of rice yields in Asia.

Hybrid rice area in major hybrid rice countries (000 ha) (2009)			
Country	**Total rice**	**Hybrid rice**	**%**
Bangladesh	11,741	800	6.8
India	44,000	1,400	3.2
Indonesia	12,309	62	0.5
Philippines	4,460	191	4.3
Vietnam	7,414	700	9.4
USA	1,204	175	14.5
Others		100	
Subtotal		**3,428**	
China	29,493	17,000	57.6

of commercial hybrid rice seed—plays a very large role in marketing and seed distribution. The obvious trade-off for this extra expense is improved yield. But, there is another major benefit, too.

"By purchasing high-quality seeds of recently released varieties, farmers avoid yield losses that are often caused by poor seeds," explains Dr. Dobermann. "Seed produced by farmers themselves often suffers from poor germination, seed-borne diseases, or contamination with weed seeds. Yield losses from such problems are often as high as 10%."

Public organizations such as IRRI focus on research and breeding, rather than seed production and marketing. To strengthen the collaboration between the public and private sectors and to enhance the dissemination of hybrid rice technology, IRRI established the Hybrid Rice Development Consortium (HRDC) in 2008 (See *Learning lessons from the HRDC* on page 46 of *Rice Today,* Vol. 9, No. 2). The HRDC has a membership of around 50 public and private organizations.

One of the HRDC's initiatives is a regional hybrid testing network that facilitates the assessment of HRDC members' hybrid rice in a range of environments in different locations. Breeders from member organizations are involved in the selection of IRRI-developed breeding lines, which can then be integrated into the members' own breeding programs.

By increasing and focusing the flow of hybrid rice research outputs, the HRDC aims to ultimately improve rice farmers' access to and use of improved products (such as high-yielding hybrid seeds resistant to pests and diseases, and tolerant of environmental stresses).

The father of hybrid rice


WORLD FOOD PRIZE FOUNDATION

Longping Yuan is known as the father of hybrid rice. Born in Peking in 1930, he graduated from China's Southwest Agricultural College in 1953 before teaching crop genetics and breeding at Ahjiang Agricultural School, where, in 1964, he began his research on hybrid rice. His decision to dedicate his career to this pursuit was inspired by a series of poor harvests that created serious food shortages in China in the 1960s.

In 1971, he moved to the Hunan Academy of Agricultural Sciences, where he made his seminal discovery of the genetic basis of heterosis in rice. Heterosis had been achieved in cross-pollinating crops such as maize, but research into the phenomenon in rice had been more or less abandoned by the early 1960s, with plant scientists believing that heterosis was not possible for self-pollinating crops.

Through Prof. Yuan's work, China's first commercial hybrid variety was released in the mid-1970s. Yielding up to 20% higher than available inbreds, hybrid varieties largely contributed to increased food production in China. The extra rice produced by hybrids, which are now grown on more than half of China's rice area, is estimated to feed 70 million additional people annually.

Prof. Yuan currently directs China's National Hybrid Rice Research and Development Center, where he continues his work. In recent years, this institution focused on "super hybrids," which produce yields of 10 tons per hectare and more.

In 2004, Prof. Yuan received the World Food Prize for his career's work. Other honors and awards include China's State Supreme Science and Technology Award, the 2001 Magsaysay Award, the United Nations Food and Agriculture Organization Medal of Honor for Food Security, and the 2004 Wolf Prize in Agriculture.

Prof. Yuan's influence extends beyond rice—with agricultural researchers successfully using his methods to develop hybrid versions of other crops, such as rapeseed—and even beyond China, with many rice-producing countries around the world steadily increasing their hybrid rice production.

Combining the comparative advantages of the public sector (research and development, product assessment, technology dissemination, and capacity building) and the private sector (large-scale commercial production, seed processing, and marketing) benefits both parties and is crucial for the ongoing growth of the hybrid rice industry.

Although there remains room for improvement of hybrid varieties—including more consistent heterosis, better grain quality, greater disease and insect resistance, and expanded seed production—Dr. Dobermann says that the technology is progressing rapidly in both the private and public sectors because of increasing investment in research and development.

"Governments should support this process through policies that encourage the establishment of a sustainable, vibrant seed industry in their country," he says. "Such an industry, composed of small and large seed companies, will ultimately offer farmers more choice and greater potential to improve both their production and their livelihood."

Mr. Barclay is a freelance writer based in Australia.

2010 IRRI Outstanding Alumni

Compiled by **Imelda Molina** and **Sophie Clayton**

As part of the International Rice Research Institute's (IRRI) 50th anniversary this year, IRRI established the 2010 Outstanding IRRI Alumni awards to acknowledge the contributions of alumni who conducted research at IRRI as part of their graduate degree program. The 2010 awardees were selected on the basis of their significant contributions across rice research, extension, policy, and research management to advance IRRI's mission to reduce poverty and hunger, improve the health and welfare of rice farmers and consumers, and ensure the environmental sustainability of rice production.

IRRI would like to congratulate the 2010 awardees:

- Rice Research: Dr. Jose E. Hernandez
- Rice Policy: Dr. Jikun Huang
- Rice Technology Development and Extension: Dr. Phan Hieu Hien
- Rice Research Management: Dr. Tin Htut

The awards will be presented at IRRI's gala dinner—the final event to celebrate IRRI's 50th anniversary—at the third International Rice Congress 2010 (IRC2010) on 10 November in Hanoi, Vietnam.

Rice Research: Dr. Jose E. Hernandez

Professor and director
Crop Science Cluster, College of Agriculture
University of the Philippines Los Baños (UPLB)

Dr. Jose Hernandez has been actively involved in the Rice Varietal Improvement Program of UPLB since 1986. Under his excellent leadership, the program developed ten rice varieties (seven for irrigated lowland and three for rainfed lowland) that were released by the Philippine Seed Board (now the National Seed Industry Council). In 2009, UPLB, in collaboration with the Philippine Rice Research Institute (PhilRice), released the first two-line hybrids (Mestiso 19 and 20) in the Philippines.

He has authored and co-authored 22 refereed journal articles and a book chapter. He has presented and co-presented more than 50 scientific articles at local and international conferences, workshops, scientific meetings, and conventions.

He is also an excellent administrator—he was a two-term chair of the former Department of Agronomy (1998-2006) and is on his second term as the first director of the Crop Science Cluster (2006-12)—both at UPLB.

Dr. Hernandez worked at IRRI while completing his MS degree at UPLB between 1978 and 1980 and as a postdoctoral fellow between 1992 and 1994.

Rice Policy: Dr. Jikun Huang

Founder and director
Center for Chinese Agricultural Policy (CCAP)
Chinese Academy of Sciences (CAS)

Dr. Jikun Huang is one of the most well-known agricultural economists in the world. He has published more than 150 articles in domestic journals, nearly 120 articles in refereed international journals (including three papers in *Science* and *Nature*), and 14 books. Topics have included the rice economy, agricultural research and development, rural development and poverty alleviation, and demand, supply, and trade of rice and other agricultural commodities. His publications have been widely cited in international journals.

His work also influenced China's agricultural policy and development—including China's rice policy. He has prepared numerous policy reports for the State Council of China that have been used in decision-making processes concerning agricultural development and improving the livelihood of rice farmers and rural people in China.

He was a PhD scholar in the Agricultural Economics Department at IRRI from 1987 to 1990 while studying at UPLB.

Rice Technology Development and Extension:
Dr. Phan Hieu Hien
Affiliate (retired)
Center for Agricultural Energy and Machinery
Nong Lam University (NLU), Vietnam

Dr. Phan Hieu Hien pioneered the spread of grain drying technology, such as the flat-bed dryer, across Asia and Africa. Around 6,500 units, which can dry 4–15 tons per batch, are now being used in the Mekong Delta, and they can dry 30% of the 7 million tons of the region's wet-season rice harvest. The dryers were patterned after the different versions released by NLU, which, in turn, were modeled after dryers developed at UPLB and IRRI.

Moreover, he helped introduce IRRI's axial-flow thresher and rice reaper to Vietnam in 1974 and 1984, respectively. The designs were modified locally and, by 2009, about 50,000 threshers and 3,500 reapers were in use. Laser-controlled land leveling, which was transferred by IRRI to NLU in 2004, is also beginning to spread in Vietnam, with nearly 200 hectares leveled.

With IRRI, he helped transfer flat-bed drying technologies from Vietnam to Lao PDR, Myanmar, and Cambodia. In August 2009, 48 dryers had been installed in Myanmar, 7 in Cambodia, and more than 14 in Lao PDR. Dr. Hien and his team worked with Briggs & Stratton (an engine manufacturer) and PhilRice to develop and adapt a mini-combine harvester for Vietnam and, with the support of IRRI, transferred it to Lao PDR and Cambodia (see *Machines of Progress* on pages 38-41 of *Rice Today*, Vol. 9, No. 3).

Last year, he worked with Kilombero Plantations Ltd. in Tanzania to source suitable dryers and established the drying facilities for a large farm of 5,000 hectares of rainfed rice. He also trained local staff in the operation and maintenance of dryers.

He completed his PhD in energy engineering from 1989 to 1993 at IRRI while studying at the University of the Philippines, Diliman.

Rice Research Management: Dr. Tin Htut
Deputy director and head breeder
Rice Research Division
Department of Agricultural Research (DAR), Ministry of Agriculture and Irrigation, Myanmar

Dr. Tin Htut began collaborating with IRRI in 2000 to breed rice resistant to bacterial blight disease. By 2002, he became the lead scientist for the Plant Genetic Resources Division at DAR, where he served as genebank manager and helped draft the Myanmar action plan for plant genetic resources. In 2003, he became a national consultant for the Myanmar Rice Trade Liberalization project under the United Nations Food and Agriculture Organization (FAO) and was invited as a research fellow to IRRI to assist in genetic analysis for iron-dense grain. By 2004, he became the assistant director and head of the Plant Genetic Resources Division at DAR and initiated rice prebreeding activities and developed screening methods for nitrogen-use efficiency in rice.

He has coordinated with multilateral, bilateral, and international organizations, and participated in policy forums. As national consultant for Myanmar's National Medium-term Priority Framework project, he collaborated with FAO, and has participated in global forums on food security, prepared speeches, and supported Myanmar's minister for agriculture and irrigation. In April 2010, he rejoined the DAR as senior rice breeder.

He completed his BS degree in agriculture at Yezin Agricultural University, Myanmar, in 1980, and his MS in plant breeding from North Carolina State University in 1991 through the USAID scholarship program. From 1996 to 2000, he worked at IRRI as a scholar to complete his PhD in plant breeding from UPLB.

Ms. Molina is an associate scientist in IRRI's Social Sciences Division.

3rd INTERNATIONAL RICE CONGRESS 2010 Hanoi, Vietnam

COUNTRY HIGHLIGHT:

IRRI IN VIETNAM

Compiled by **Ma. Lizbeth Baroña**

Rice and Vietnam

Just south of Vietnam's largest city, Ho Chi Minh City, the great Mekong River meets the South China Sea, forming a delta so rich it has become Vietnam's "rice bowl." It includes 12 rice-growing provinces that produce about half of the country's rice.

After the Pacific War that resulted in famine in 1945, and the Vietnam War that saw its last gunfire in 1975, Vietnam sought to rebuild itself—and rice production has been a part of this. In 1968, the International Rice Research Institute (IRRI) released rice variety IR8 (dubbed "miracle rice") to the northern and southern rice-growing regions of Vietnam, but this was not enough for the nation to become self-sufficient in rice.

Things changed, however, when, in 1986, Vietnam adopted the "Doi Moi" policy that sought to reform the economic system into a market-driven economy. The Vietnamese government effectively told its rice farmers to "grow and sell" their rice. This decision allowed Vietnamese rice growers to start adopting the improved varieties and management techniques of the Green Revolution that had vastly improved rice production in other nations about 20 years earlier.

Soon after, Vietnam finally became rice self-sufficient and went on to increase its rice production year after year, over a period of more than 20 years. This sustained growth allowed the country to export rice to Asia, Africa, the Middle East, the Americas, and Europe. In 2008, according to the Food and Agriculture Organization of the United Nations, Vietnam produced almost 39 million tons of rice on 7.4 million hectares, making it the fifth-largest rice producer and the second-largest rice exporter in the world.

IRRI and Vietnam

Since 1963, IRRI and Vietnam have been partners in a wide range of collaboration in the exchange of rice breeding materials, rice varietal improvement, resource management, and capacity building.

In 1978, 3 years after Vietnam and IRRI formally established ties, IRRI Director General Nyle Brady signed a memorandum of agreement with Vietnam, which laid the foundation for decades of collaboration. This partnership was strengthened with the establishment of the IRRI-Vietnam office in 1992, as well as visits of Vietnamese government officials to IRRI, including President Le Duc Anh's trip in 1995.

As farmers in the Mekong River and Red River deltas enjoy the potential of high-yielding varieties, which were made available to them through these joint projects, Vietnam further expanded its scope of collaboration with IRRI to include rice production in upland ecosystems, protecting the environment, and improving grain quality.

IRRI's partnerships and work with Vietnam were recognized in 1994 with the First Class Friendship Order that the Vietnamese government awarded IRRI.

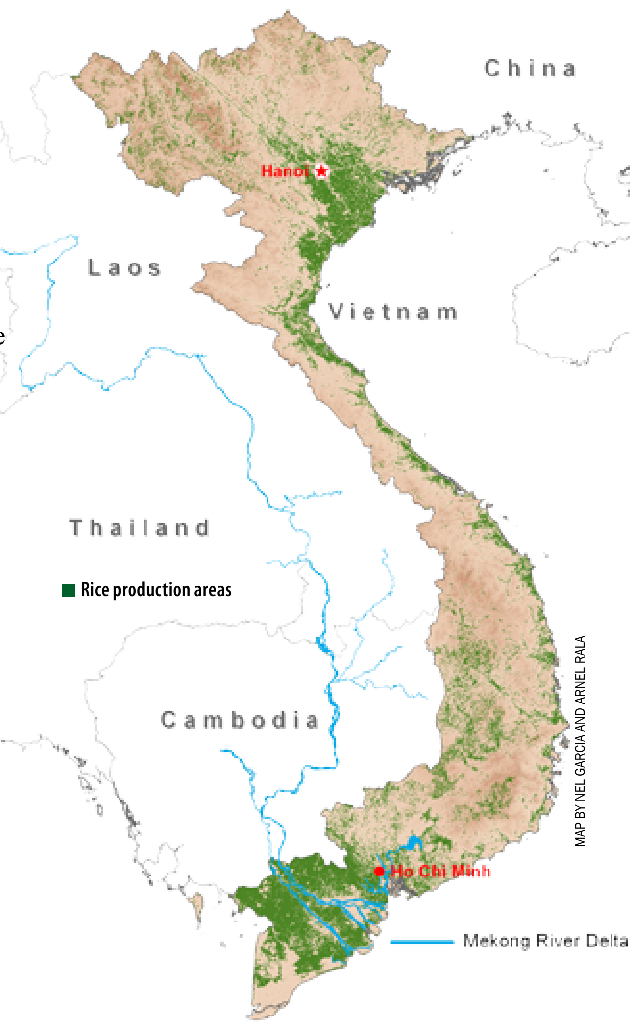
Notably, IRRI's collaboration with Vietnam includes more than a dozen projects and the training of hundreds of Vietnamese scientists. The cooperation continues today, as Vietnam's Ministry of Agriculture and Rural Development gears up to host IRRI's 3rd International Rice Congress that will be held in Hanoi on 8-12 November 2010.

New rice varieties, conservation, and exchange

The exchange of rice breeding materials between Vietnam and IRRI has been the highlight of the long years of working together. Since the introduction of the first semidwarf rice variety—IR8—in 1968, a total of 89 breeding lines have been released in the country. It is estimated that 70% of the rice area is grown with IRRI varieties.

Vietnam's participation in IRRI's rice conservation program has resulted in Vietnam contributing 2,326 types of rice to IRRI's International Rice Genebank. IRRI has dispatched 2,116 accessions to Vietnam. Two Vietnamese varieties, Tetep and Moc Tuyen, have been valuable to IRRI and its partners' hybridization work.

Recently, IRRI helped Vietnam use marker-assisted breeding to develop varieties with enhanced tolerance of salinity and submergence.



MAP BY NEL GARCIA AND ARNEL RALA

Vietnam: fast facts	
Country area (ha)	33 million[1]
Agricultural area (ha)	10 million[2]
Population	88 million[3]

[1]FAOSTAT 2007
[2]FAOSTAT 2007
[3]FAOSTAT 2009

"The Vietnam-IRRI collaboration has continued to grow on the principle of true partnership and it has brought many benefits to Vietnamese farmers and rice consumers. Significantly, it has contributed to Vietnam's turnaround from a rice-importing country (prior to 1985) to the world's second-largest rice exporter."

Robert Zeigler, IRRI director general

A model of sustainable lowland rice production

With its local partners, IRRI is working to develop An Giang Province in Vietnam's lowlands as a model province for sustainable rice production by adopting the standards of good agricultural practices (GAP).

GAP are introduced to farmers through the Mot Phai, Nam Giam or One Must Do, Five Reductions program. This provides recommendations related to reducing postharvest losses and water use, as well as the timely use of fertilizers. The one "must do" in this program is the use of certified seeds. This program builds upon the success of the Three Reductions, Three Gains (Ba Giam, Ba Tang or 3G3T), an IRRI-led project that motivated rice farmers in the Mekong Delta to modify three resource management practices—seed, fertilizer, and insecticide use.

Radio soap operas using entertainment-education

Vietnam and IRRI pioneered the use of entertainment-education using radio soap operas to teach farmers to decrease their seed and fertilizer use by about 10% and their insecticide applications by 50%. These radio soap operas reached an estimated 2 million rice farmers across Vietnam. Recognized as an innovative and pioneering effort, the project won several international awards: the World Bank Development Marketplace Award (2005); the COM+ Communications Award for Communicating Science for the People, and the Planet Award (2007); and the Global Development Award for best research paper from the Kuwait Development Fund (2009).

Better pest management

In 2008, the Asian Development Bank and IRRI began the Rice Planthopper Project to develop sustainable means to reduce crop vulnerability to losses from pest outbreaks. This was after Vietnamese rice exports took a serious hit in the 2006 planthopper outbreak. The project is developing resistant varieties and new field evaluation methods, strategies for the management of viral diseases carried by planthoppers, and biodiversity-based pest control. It also seeks to understand farmers' decision-making processes, develop communication strategies, and initiate policy dialogues to upscale ecological practices while enhancing the capacity of national systems in research, communications, and extension.

Water management in the coastal zone

Bac Lieu, one of the coastal provinces of the Mekong Delta, hosts a range of livelihoods for its population that significantly relies on its water resources. Water from the Mekong River is delivered through extensive networks of canals, while the saline source is managed by a series of sluice gates—infrastructure built by the government to control saline intrusion into the area. Conflicting demand for water quality (rice farmers need fresh water, while shrimp farmers need brackish water) and appropriate water management created social conflicts and pushed farmers to unsustainably use these resources.

In a series of projects funded by the United Kingdom's Department for International Development, the Challenge Program on Water and Food explained these issues hand-in-hand with the Bac Lieu People's Committee. The project used a hydraulic and water quality model, the improved Vietnam River System and Plain (VRSAP) model that helped improve sluice-gate operations, and worked with the Bac Lieu People's Committee to revise the province's land-use plans. The project also developed and evaluated a successful participatory extension approach that helped farmers and aquaculturists select appropriate technologies.

An independent impact assessment showed that the project resulted in more sustainable farming practices, a reduced number of conflicts over water resources, use of the VRSAP for the whole of Ca Mau Peninsula (to which Bac Lieu belongs), use of on-farm technologies in neighboring provinces, and the emergence of agribusiness in the area.

Landscape management for rice in the uplands

Vietnam's Northern Mountainous Region (NMR) forms the largest upland environment in Vietnam. Rice is grown in this region on sloping land, irrigated terraces, and flat intermountain basins and narrow river valleys where water sources provide for irrigated agriculture. These various parts where rice is grown constitute the rice landscape in these uplands.

An IRRI-led rice landscape management project is collaborating with national organizations in validating technologies and suitable rice varieties for the sloping uplands, and improving the upland rice-based cropping system. In the region's lowland paddies, hybrid and high-yielding inbred rice varieties for the spring season and inbred short-duration summer paddy varieties have been identified.

Likewise, cold-tolerant spring rice varieties for middle-hill paddies, high-yielding middle-range summer paddy rice varieties, and inbred summer-season rice varieties for upland paddies were identified. Seeds of these improved varieties are being multiplied and widely distributed to farmers in the NMR by national programs.

"Vietnam and IRRI have been collaborating for more than 4 decades. It started with the introduction of the first high-yielding semidwarf variety from IRRI, IR8, which triggered a rice revolution in Vietnam. This partnership will continue with new dimensions for the future of rice in Vietnam under changing environments."

Bui Ba Bong, Vietnam's Ministry of Agriculture and Rural Development deputy minister

G. HETTEL/J. IBABAO (12)

It's like playing roulette—and you get paid for it!

A pioneer interview potpourri of opinions, ideas, and anecdotes

My contribution to IRRI's 50th anniversary celebration has been an extraordinary experience as I have logged more than 100 hours in 54 videotaped interviews, to date, with IRRI's pioneers. These exceptional personalities have ranged from researchers who first roamed the rice plots with IRRI's first director general, Robert F. Chandler, Jr., to others recently retired, to researchers' spouses and children, to our research partners, and to our clients themselves, the farmers. *Rice Today* has published 10 of these illuminating dialogues in the magazine (and in their entirety on the Web with video) plus one installment that provided a cross-section of opinions regarding IRRI's greatest upcoming challenges.

The final chapter in this 12-part series features a selection of opinions, ideas, and anecdotes, which cover relevant commentary on current events, children growing up at IRRI and views on their fathers, and even a discrepancy or two.

Although this is the last regular installment in this series, I reserve the right to occasionally publish more in the future as I sift through the tapes and transcripts and, yes, continue to conduct more interviews because I know I've left out many key figures whose stories and matchless memories deserve to be preserved as part of the Institute's rich history and legacy. Maybe there is a book and/or video documentary in all of this—something to consider for my own retirement—some day!

Hubert Zandstra (IRRI agronomist, 1975-80; IRRI deputy director general for research, 1989-91) on the excitement of conducting research: There's nothing more exciting than being a scientist and researcher. It's like playing roulette—and you get paid for it! You know, it's incredible that you go out there, you place your bet, you put your plots in, and then you find out it works—damn it! It is so exciting!

The excitement of conducting research is not talked about enough. Scientists are perceived as being pretty dull, but, you know, it is really a very, very exciting existence. So that's a highlight. And, as I mentioned, the other highlight is that the best job in the [CGIAR] system, in my opinion, is that of director of research. It's tough to handle on the people side, interacting and dealing a lot with an incredible amount of interpersonal problems among scientists and between them and giving direction to the scientists, and so on. This can be a very tough fight, but I think it is an extremely rewarding position.

Gelia Castillo (Philippine National Scientist and long-time IRRI consultant) on her interest in rice: I was really interested in rice before IRRI was created. I don't know why—perhaps it's because it's something that we eat every day. We can't do without it and it's something that you find among both rich and poor and you can't ignore it. It's always there; no matter what happens, it's always there. If it's not there, you better find it, you know. More than that, in agriculture, rice could be grown, in the early 1960s, in 6 months. Of course, now, I think it's about 120 days. So, it's about 4 months or less and you can easily see the product within that period. But, most of all, it is a product of science that has reached the farthest corner of this country. There are not many products of science that have touched the common man as much as rice—maybe vaccines, too. So, this is terribly important to me.

Peggy Hill (daughter of IRRI co-founder Forrest "Frosty" Hill, Ford Foundation vice president of overseas development, who served for 14 years as chair of IRRI's Board of Trustees) on her father: I think back to my Dad's last years—he died October 20, 1988, just shy of his 88th birthday—he continued to be very much interested in what was going on at the [CGIAR] centers. Now, I hear a lot of discussion going on about the future challenges at the centers.

My father had three things that he saw as long-term concerns. The first was, where would they get the right kind of directors general and who were they? Initially, of course, the first several [at IRRI, for example] were Americans; most of them have been at least western

trained. In some of his conversations with the staff—Asian, American, and every other nationality, there was a feeling that at least the next director general—at the time he was still part of the selection process—probably should be another westerner. But he envisioned the need for the right kind of men—or women—to head up a growing number of institutes and he was concerned about where they were going to come from. The second thing he was concerned about was political pressure. He saw a couple of institutes being created in areas and in subject matter where he felt the return on the investment would be very low and the focus minimal because a particular geographic region had to have one. The third concern was keeping the kind of focus there was with fewer centers and directors general out in the field. As you grow bigger and become spread out more thinly, you become more bureaucratic. He had a lifetime horror of bureaucracy and what it could do to stop progress.

Sant Virmani (IRRI hybrid rice breeder, 1979-2005) on getting IRRI to commit to hybrid rice research: In 1980-82 when the hybrid rice program at IRRI was at the exploratory stage, I recall that, during the April Board of Trustees meeting, the chairman of the board normally came on the Friday before and spent the weekend. I remember Dr. Clarence C. Gray III was the chairman in 1981, and, on a Saturday morning, he took a ride around the IRRI farm to see what was going on. In those days, many scientists worked in the field even on Saturdays. I was trying to convince myself and also find the experimental evidence whether or not hybrid rice would be a practical option for tropical rice farmers. I was looking at my trials around 11 o'clock in the morning. Seeing me in the field, he [Dr. Gray] stopped. He knew Director General Nyle Brady and IRRI were exploring hybrid rice and everybody was asking IRRI about it.

I showed him the experimental hybrids in the trials that compared them to such high-yielding varieties as IR36 and IR42. He saw that there was really something to it. Then, he had lunch with Nyle Brady, mentioning what he saw in the field and that the hybrid program looked promising. After the board meeting was over, Nyle organized a meeting the following week with the scientists and we went back out to those experimental plots. I think that was the turning point when management and the board of trustees realized that this was something serious and that we should make a commitment to hybrid rice work at IRRI.

Ron Cantrell (IRRI director general, 1998-2004) on public-/private-sector cooperation and hybrid rice: One of the things that intrigues me about hybrid rice is that it is a way for the private sector to get involved in rice. There are a lot of issues surrounding hybrid rice (see *Hybridizing the world* on page 32). There are problems that you have in rice that you don't have in sorghum, maize, and other hybrid products in terms of heterosis and production systems. But I think it would be great if rice hybrids were successful because this is clearly something that would draw in private-sector support. Then, all of a sudden, we would start having product research being done by the private sector on rice germplasm.

Merle Shepard (IRRI entomologist, 1984-88; currently professor emeritus and executive director of the Archbold Tropical Research and Education Consortium, Clemson University) on Carolina Gold: When I left IRRI in 1988, I went back home to Charleston, South Carolina, where rice first came into the United States. The major rice variety grown there on huge plantations and making huge fortunes along coastal areas of [pre-U.S. Civil War] South Carolina was called Carolina Gold (see *Carolina Gold and Carolina White rice: a genetic odyssey* on page 20). So, realizing the importance of rice in the region and the many threads associated with history, slavery, and so forth, I got interested in Carolina Gold and we started a Carolina Gold Rice Foundation. I'm the vice president and chairman of the Board of the Foundation. In August 2005, we held a major symposium [Carolina Gold Rice Symposium in Charleston], which included presentations by many people in the rice world. In addition to scientific presentations on rice, it included information on rice architecture, rice culture, rice history, and so forth. That is one of the spinoffs when you work in a culture where rice is so important.

Heidi Barker, daughter of Randy Barker (IRRI agricultural economist and head, Agricultural Economics Department, 1966-78; acting head, IRRI Social Sciences Division, 2007-08), on being a kid at IRRI: IRRI was a magical place. I think your perspective of IRRI as a child depends on what age you were because when you were 5, 6, and 7, it was so huge and you just ran free and wild out of the house; who's out playing; who's coming out to play; going to each other's houses and all that. As you got a little older, you know, 10, 11, and 12, there were incredible games at night. We all got out at night, you know, 7 o'clock after dinner, to play soccer at the tennis court or volleyball or kick the can. There was great camaraderie between the kids.

School friends from Manila asked about my dad. He was gone for many months out of the year and we couldn't tell exactly where he was at any given time, but we got a postcard once in a while. Friends expressed real concern that they thought he was really part of the CIA and we were in some sort of witness protection program. We had no idea what he did. We really didn't.

Sons of T.T. Chang, IRRI's first geneticist, 1962-91, reflect on who their father was and what he was doing: **Dean Chang:** In retrospect, we should have realized what was going on at IRRI because an entire cast of scientific all-stars were visitors. Some of the best agricultural research scientists were making pilgrimages to IRRI to view and review the work here. We always had a chance to meet them because these scientists would come to our home and sit with my father on the porch and sometimes we would be sitting right next to him when he was having a scientific discussion with, say, a Norman Borlaug, Sir Otto Frankel, Sir Ralph Riley, or other luminaries. I should have realized why these famous scientists were coming to visit IRRI all the time.

Jeff Chang: As I grow older, I find myself getting more philosophical. I've really started to appreciate what my father and all the other fathers accomplished at IRRI. I've gotten a more world view of things and have found out what the ramifications are for the world's population. Growing up, we probably didn't get a full feel for how important the work was because a lot of the scientists went about their work very quietly and very modestly. I got a sense of the importance of their work more through my classmates and their parents who worked at the Asian Development Bank or the World Health Organization. When they found out that our parents were working at IRRI, they would say, "Oh, we would like to come for a visit and talk to your parents." So, for me, it was more of an external stimulus.

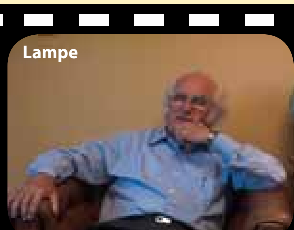
Ed Price (IRRI economist, 1975-85; currently associate vice chancellor, Texas A&M University) on farming systems technology: There are a couple of things that were very striking in the early days. One of them was that, we discovered—and were able eventually to persuade our colleagues throughout the Institute—that not always did rice technology considered alone turn out to be the best approach. We were able to show that many times IRRI technology, as developed on the farm, might not be successful on farms because of the many other conditions that impinge on rice farming. For example, the real value of an early rice variety, such as 1529, which is an early-maturing rice variety that was followed later by IR36, was not that it was higher yielding globally, which it was, but the fact that it matured early. So, there was a sacrifice of yield for timeliness. And that made rice fit much better into an entire farming system and enabled other crops to be grown in other seasons.

Colleagues sometimes see things differently: Ronnie Coffman, IRRI plant breeder (1971-81), stated in a sidebar to the Kwanchai Gomez pioneer interview [see *Figures, fake guns, and fund-raising* on pages 16-19 of *Rice Today*, Vol. 7, No. 4]: If I had to identify the person most responsible for the development of IR36 [at one time the most widely planted crop variety of any species in the world], it would probably be Kwanchai Gomez. She designed the sensitive, quadruple lattice yield trials that caused us to notice it. IR36 was an open plant type, not very attractive to the eye. Prior to the establishment of those yield trials, we would have almost certainly thrown it away. Prior to 1971, the IRRI breeding program did not replicate its yield trials, much to the chagrin of Kwanchai.

In his unpublished pioneer interview, **Gurdev Khush, IRRI rice breeder and principal scientist, 1967-2001,** stated: I have a very high regard for Kwanchai Gomez as a statistician and a scientist, but frankly there is absolutely no use of that design in selecting IR36. I knew what plant type I was looking for. I knew the height. I knew the plant architecture and growth duration. So, it was just my visual observation, the keen eye for what I was looking for. The statistical design of Kwanchai played absolutely no part in the development of IR36. **Note:** In a follow-up later that was not a part of Dr. Khush's pioneer interview, he added: Dr. Coffman's statement [Prior to 1971, the IRRI breeding program did not replicate its yield trials] is absolutely incorrect. I can show the yield trial books with proper cover so indicated and the replicated yield data in the books much before Ronnie joined IRRI.

Klaus Lampe (IRRI director general, 1988-95) on advice from his spouse, who emulated Eleanor Roosevelt: During one of the most critical days at IRRI in my time (actually during a board meeting), Annemarie sent me a little note. She was not aware that the board meeting was still going on. So, that note was brought into the meeting. It quoted Eleanor Roosevelt, who once also advised her husband [U.S. President Franklin Roosevelt] in a written note: "Do what you think is right. Do it against all odds because you will be blamed anyway and you will be right as long as you feel good in your heart."

That was helpful in that moment, I can tell you. And it was about half a year ago when I was reading in a book about the ideas of Lao Tzu. As you know, he lived 2,500 years ago. I don't know if Mrs. Roosevelt ever read Lao Tzu, but he said, at that time already, almost the same thing: "Decide carefully what you do, do it, and leave the place. That is the best avenue towards inner peace." And, when I read it, I said, "Yes, you and Eleanor are right, and I have found the avenue towards inner peace and I am almost there."



Read expanded excerpts of those presented here plus those from additional pioneer interviews that are being included over time—all with hotlinks and video clips—on the *Rice Today* Web site at **irri.org/publications/today/potpourri.asp.**

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Clearfield technology clears out red rice

by **Steve Linscombe**

The adoption of Clearfield technology brings positive changes to the U.S. rice industry

Rice production is an important part of the agricultural industry in the southern United States, especially in the major producing states of Arkansas, Louisiana, Mississippi, Missouri, and Texas. The mechanized production of rice began in the 1880s in southwest Louisiana, when farmers started to use some of the new agricultural implements invented during this period. From the earliest beginning of this industry, production was plagued by a weedy relative of commercial rice called red rice, which came in with the first seed used by the fledgling industry.

Most red rice biotypes are characterized by a red pericarp or outer covering. Thus, if the grain is harvested, and makes it through the milling process, it reduces the quality of milled white rice. However, much of the red rice produced in a commercial rice field will never make it through the combine harvester because red rice tends to shatter as it matures. Also, its seed can be dormant for a longer time. Because of its shattering and dormancy traits, once a field is infested with red rice, the seed will remain viable and problematic for many years. Since commercial rice and red rice are so closely related, it has been difficult to develop a conventional herbicide that can control red rice without significantly damaging the commercial rice crop. However, work initiated by Dr. Tim Croughan and his associates in the 1980s at the Rice Research Station in Crowley, Louisiana, USA, eventually led to the development of Clearfield®[1] rice production technology, which can control red rice in commercial rice production.

Developing Clearfield rice

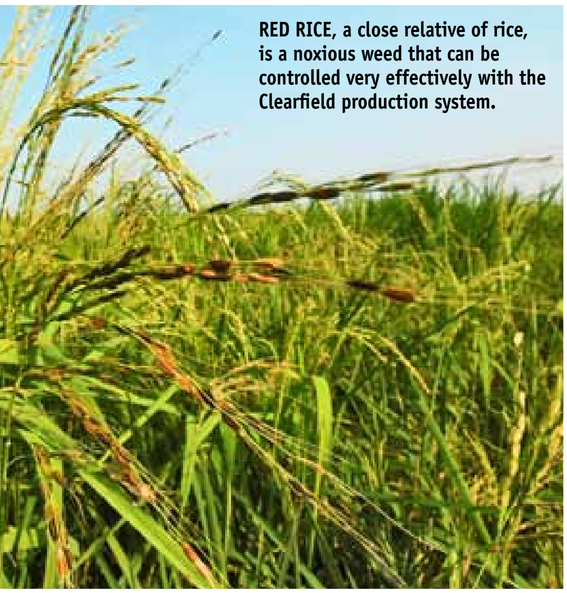
As it was not feasible to develop a rice herbicide to control red rice without harming the commercial rice, the idea was to develop a new type of rice plant that would be genetically resistant to a herbicide that would control red rice. This was accomplished by a process known as induced mutation breeding, in which many seeds are subjected to an agent that causes a high level of mutations or changes to the genetic makeup of the seed. The agent used was a chemical called ethyl methane sulfonate (EMS). After treatment with EMS, the seeds were planted, and the resulting plants were sprayed with imazethapyr, a herbicide known to control red rice (as well as conventional rice) effectively. After several years of repeating this process with billions of rice seeds, success was finally achieved when a lone plant survived the imazethapyr treatment. This single plant, along with several more resistant plants, which were developed in the same way a few years later, led to the birth of the successful Clearfield rice technology. We finally had rice that could be safely sprayed with a chemical that would kill red rice. Then, through conventional rice breeding, new varieties were developed that have high yields and superior traits and at the same time are resistant to imazethapyr and to a related chemical called imazamox, which is also used with the technology. Thus, we could now effectively control red rice while growing high-yielding, high-quality rice varieties.

The technology was first used on a limited area in 2002. This area has steadily grown through the years, and, in 2010, Clearfield rice is being grown on more than 60% of the rice area in the southern United States. This includes varieties developed by both the Louisiana State University Agricultural Center and the University of Arkansas breeding programs, as well as hybrids developed by RiceTec, a private rice breeding company. Moreover, the breeding programs of Mississippi State University and Southeast Missouri State University are actively working to develop new Clearfield lines.

Controlling red rice

The Clearfield technology has dramatically improved rice producers' ability to control red rice. Imazethapyr and imazamox excellently control many other problematic weeds in rice production. Also, the Clearfield technology has changed the production systems used in rice farming. Before Clearfield rice, the only approach to minimize red rice on severely infested fields was by combining water-seeding and water management

[1] Clearfield rice is a technology owned by BASF.



RED RICE, a close relative of rice, is a noxious weed that can be controlled very effectively with the Clearfield production system.

BRUCE SCHULTZ (2)

practices that prevented red rice seed from germinating. Water in soil keeps oxygen away from the seed and prevents germination. A typical system involved flooding a rice field in the early spring and then working the field in the water to destroy any red rice seedlings present. After this operation, pregerminated seeds were scattered over the field. Shortly after seeding, the field was drained briefly to help seeds establish their root system. The trick was to leave the field drained only long enough for the root to anchor, but not too long for the soil to crack and for oxygen to find its way to the red rice seed below the soil surface. This system suppressed only red rice, and its success depended on weather conditions as well as pumping capabilities that would allow a field to be quickly re-flooded. Another major problem with this system was, when fields were drained after seeding, the water left in the field contained a high sediment load from the water tillage operation. This led to soil erosion as well as water quality problems in receiving streams.

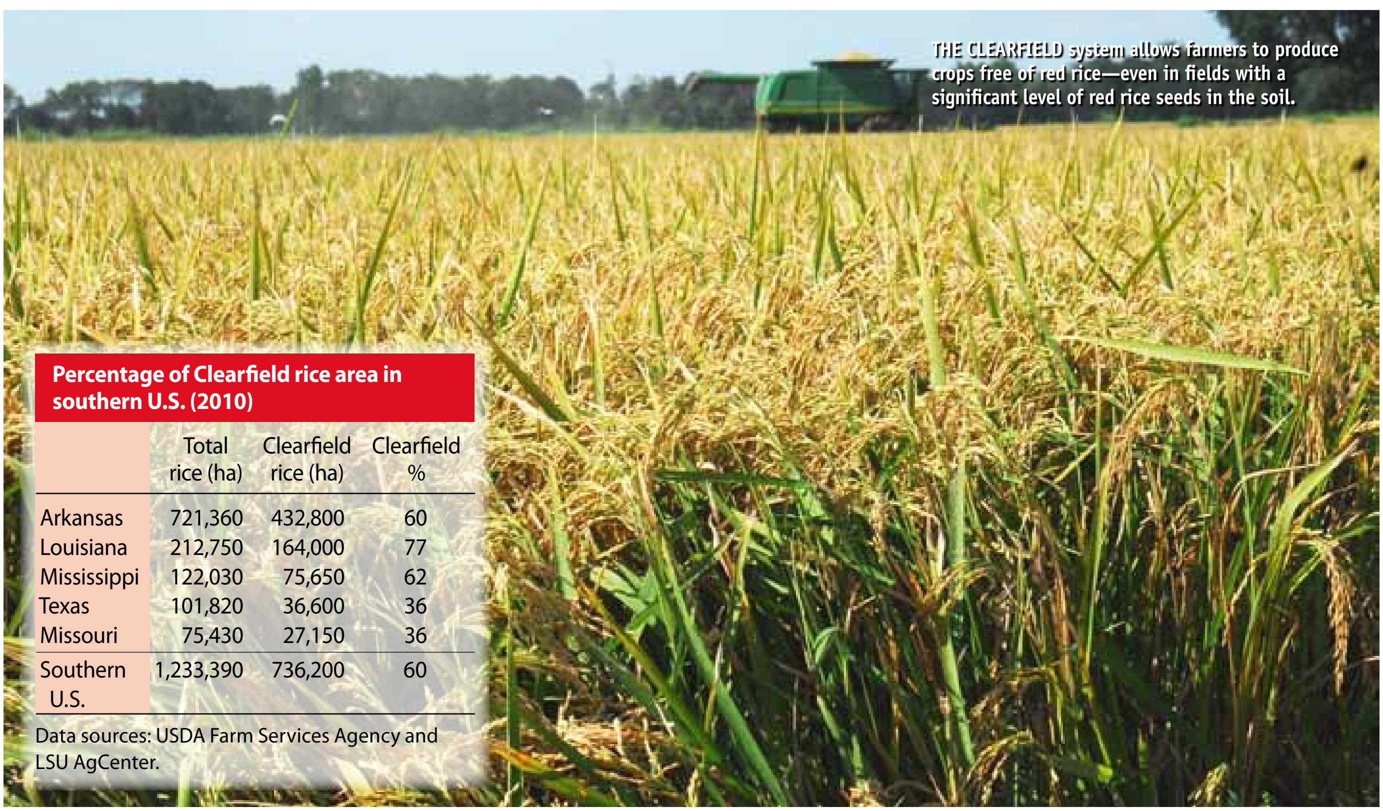
The advent of the Clearfield technology meant that these fields would no longer have to be worked in the water and could now be dry-seeded—in many cases, using no-till or minimum-till techniques. So, in addition to improving weed control, Clearfield technology has greatly reduced soil erosion and improved water quality and overall environmental stewardship.

An inherent setback

It is important to note, however, that the Clearfield technology is not without its shortcomings. Because rice and red rice are so closely related, pollen can flow between the two types of rice. Thus, Clearfield rice can pollinate red rice and vice versa. Either way can lead to red rice plant types with resistance to the herbicides used with the technology. Stewardship programs have been designed to minimize this problem that is inherent with the technology. Another problem is the contamination of adjacent fields of conventional (non-Clearfield) rice with herbicides used in Clearfield rice, which can cause severe injury. These are very real issues, and every effort must be made to minimize their occurrence.

Despite the problems, this technology has been rapidly adopted across the southern United States and has led to high-yielding, higher-quality rice being produced using more environmentally sound production practices. The reduction of red rice has also greatly benefited the milling industry as well as consumers and other end users. Clearfield rice is also being grown today in a number of other rice-producing countries.

Dr. Linscombe is a senior rice breeder and director of the Louisiana State University Agricultural Center.



THE CLEARFIELD system allows farmers to produce crops free of red rice—even in fields with a significant level of red rice seeds in the soil.

Percentage of Clearfield rice area in southern U.S. (2010)

	Total rice (ha)	Clearfield rice (ha)	Clearfield %
Arkansas	721,360	432,800	60
Louisiana	212,750	164,000	77
Mississippi	122,030	75,650	62
Texas	101,820	36,600	36
Missouri	75,430	27,150	36
Southern U.S.	1,233,390	736,200	60

Data sources: USDA Farm Services Agency and LSU AgCenter.

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Global wheat markets in turmoil: What does this mean for rice?

by **Samarendu Mohanty, Josephine Narciso, Harold Glenn Valera, Imelda Molina,** and **Mary Joanne Matriz**

The global food situation is making headlines again. However, unlike in 2008, wheat is now the focus of attention because of weather-related production losses in the major exporting countries. The Russian wheat crop has been severely damaged by drought and wildfires and production is estimated to fall by more than 30%. Two of its wheat-exporting neighbors, Ukraine and Kazakhstan, are also reeling under severe drought and are expected to harvest 20–30% less. On top of that, Canada has been hit hard by excessive rain in the major wheat-growing regions of Saskatchewan, Manitoba, and Alberta. According to the September 2010 World Agricultural Supply and Demand Estimates (WASDE) published by the United States Department of Agriculture, 2010-11 global wheat production is expected to be 37 million tons lower than the previous year's production of 680 million tons.

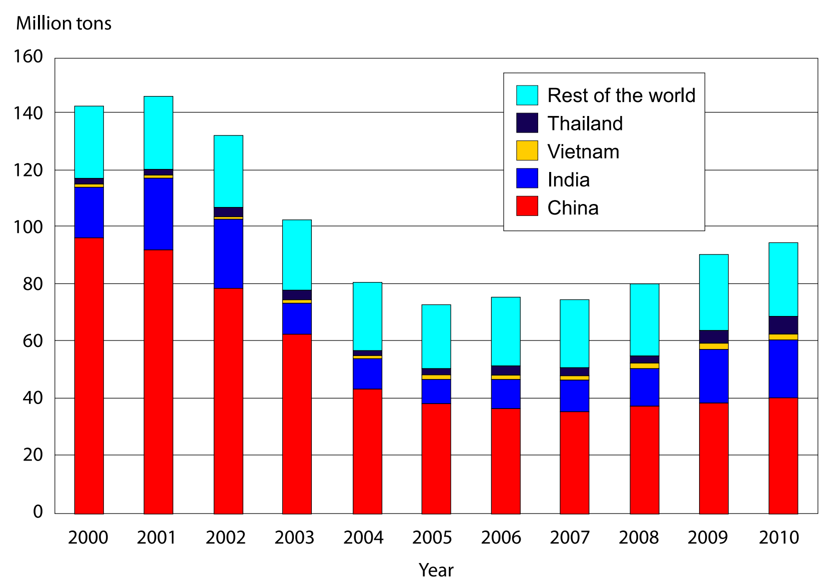
Rising uncertainties in production have kept wheat prices on the move since the beginning of July 2010. But, prices shot up to a two-year high in the first week of August when Russia announced its temporary ban on wheat exports until the end of this year. The effects of higher wheat prices are beginning to be felt on the streets of poor food-importing countries. For example, riots broke out in Mozambique as its people protested against the rising prices of bread and other food items. The recent announcement of the extension of the Russian export ban until next year's harvest further complicates an already fragile global food situation.

This rapidly evolving wheat situation brings back the memory of 2008 and raises some important questions: How will this affect the rice market and what can be done to minimize the recurrence of price crises in the future?

How will wheat prices affect the rice market?

There is no simple answer to this question, but at least one can say that the rice situation is different now than in 2007-08. This is particularly true for the global rice inventory, which is nearly 25% higher now. The most recent estimate from the USDA put 2010 global rice stocks at 95 million tons compared with 75 million tons during the 2008 rice price crisis (see Figure). However, many believe that current large grain stocks may not mean much because the majority of this inventory is sitting in India and China, which are unlikely to release rice to the international market during any crisis situation.

Apart from higher stocks, 2010 global rice production was progressing well until some weather-related damage strongly affected production in recent weeks. The recent floods in Pakistan have put a big question mark on the size of its rice crop. Both Punjab and Sindh provinces, which account for more than 90% of Pakistan's total rice production, were severely affected by this flooding. Apart from damaging standing crops, the floods have almost certainly damaged irrigation infrastructure and farmers' grains stored for their consumption and seed supply. These damages will likely affect the next season's wheat and short-duration rice crop. The September USDA report estimates a 22% drop in Pakistan's rice production this year (5.3 million tons vis-à-vis 6.8 million tons last year). Such a massive expected decline in production can result in lower export prospects from Pakistan—and exports could decline by as much as the drop in production. Drought and floods have also affected the rice crop in China, with estimates ranging from 5% to 10% lower production this year. Rising uncertainties in rice supply are now reflected in the global market, with Thai rice prices rising nearly 10% in August. For example, the Thai price for 5% broken rice was quoted at $476 per metric ton on 1 September 2010 compared with $434 per metric ton on 4 August 2010.[1] The estimate USDA released this September showed lower 2010-11 global rice production. It declined to 455 million tons from 460 million tons projected in August, although this is still 15 million



Global rice inventory.
Data source: Production, Supply, and Distribution, USDA (accessed on 11 September 2010).

[1] According to the Thai Rice Exporters Association.

tons higher than last year. More than two-thirds of the projected increase is expected to come from India, which is recovering from last year's severe drought that affected more than 5 million hectares of rice. Overall, the global rice supply is tightening but it is not as bad as what is happening in the major wheat-growing regions in the world. Given these supply uncertainties, prices are likely to be more volatile in the coming months, but nothing points to a repeat of the 2008 price crisis.

However, all these arguments will be for naught if the wheat supply continues to deteriorate and panic in the wheat market spills over to the rice market, causing prices to move upward. This is exactly what happened in late 2007 when rising wheat prices caused panic among rice-exporting countries, which resulted in an astronomical increase in rice prices that had not been witnessed in 30 years. Moreover, there is still the risk of weather uncertainty, as bad weather can damage the rice crop on the ground.

How can we minimize the recurrence of price crises in the future?

To answer this question, one needs to look deep into the changing conduct of the global rice market. Since the 2008 crisis, many countries where rice is a staple food have moved away from food security to food self-sufficiency through a host of policy measures, including control on the flow of rice in and out of the country. These trade measures (see Table) are intended to expand domestic production and, more importantly, keep it for domestic consumption.

This raises another important question as to whether or not these recent policy shifts are detrimental to global food security in the long run. The answer is a resounding "yes," and this is particularly true for rice, which is already a thin market to begin with. The whole idea behind this thinking is to protect poor domestic consumers from global uncertainties. So far, the evidence shows that these policies have been counterproductive and countries have not been able to insulate themselves from global happenings through trade restrictions. For example, India raised its minimum procurement price for rice by 40% after the 2008 crisis and refused to lift its ban on nonbasmati rice exports to keep rice affordable for local consumers.

Rice trade policies in the major rice-growing countries.

Country	Policy
Bangladesh	• Continues to have a ban on rice exports, which was imposed after the 2008 crisis. The policy was relaxed in September 2009, when the government decided to permit the export of up to 10,000 tons of aromatic rice until December. • The government also controls rice imports.
Cambodia	• Removed the requirement for rice export licenses and is now implementing an open agricultural policy to boost rice exports to a million tons by 2015.
China	• Uses a tariff rate quota (TRQ) for rice imports, with 50% traded by state-owned companies. Rice exports are also controlled by a quota.
India	• Has a minimum export price for basmati rice and a ban on nonbasmati rice exports. However, government-to-government exports of nonbasmati rice are allowed from time to time. • The government also controls imports through an import licensing system.
Indonesia	• Has an import ban on rice for the third consecutive year, as national stocks were sufficient to handle domestic requirements. The government allows imports only of specific rice for healthy diets and for restaurants that demand rice that cannot be produced domestically. • The government limited exports of rice to maintain domestic supply, allowing the state agency to export only when domestic stockpiles were above a threshold of 3 million tons and domestic prices were below their target price.
Japan	• Restricts imports to 770,000 tons a year as part of its World Trade Organization (WTO) minimum market access (MMA) agreement. The tariff rate for MMA rice imports is 5%.
Malaysia	• Rice may be imported only by the state agency, Padiberas National Berhad (BERNAS).
Myanmar	• The government issues export permits to private traders and levies a 20% export tax.
Philippines	• Has a quantitative restriction on imports for 350,000 tons of rice at 40% tariff. In addition, the Philippine government recently agreed to provide special access for 367,000 tons of Thai rice annually and, in return, the Philippines will be allowed to keep its 40% tariff until 2014 instead of lowering it to 35% as mandated by the ASEAN Trade in Goods Agreement.
South Korea	• Restricts imports to 327,311 tons of rice as part of its WTO MMA agreement. Import volumes will continue to grow according to a predefined MMA schedule until 2014 or until Korea announces early tariffication. The tariff rate for minimum-access rice imports is zero.
Taiwan	• Restricts imports to 144,720 tons (brown rice basis) as part of its WTO MMA agreement.
Vietnam	• The Vietnam Food Association sets a floor price for exports of 25% broken rice, while the minimum export price of 5% and 10% broken rice is set by businesses.

The end results have been exactly the opposite, with domestic rice prices rising by more than 50% in the past 2 years. At the same time, government warehouses have been overflowing with grains because of diversion from the market through higher procurement prices. Similar stories can be told about Thailand, where government rice stocks are estimated to surpass 5 million tons—the highest in decades.

If countries persist with these policies of rice self-sufficiency, the global rice market will eventually become smaller than it is today. This means that farmers in surplus rice-producing countries such as Thailand, Vietnam, and the United States will have to reduce their production and move area out of rice into other productive uses in response to lower global demand. The real problem comes when there is a supply or demand shock and the market cannot absorb this shock. This will significantly change prices to accommodate any changes in traded quantities. With extreme weather conditions expected to occur more frequently in the future—courtesy of climate change—it is reasonable to expect the market to flare up more often.

Ideally, one would like to see a free flow of rice across countries or regions. However, this does not imply that countries need to give up their production and depend on foreign rice. On the contrary, countries should focus on infrastructure and technology development to expand rice production sustainably. They should recognize the effects of their actions at the global level, particularly with respect to trade restrictions. The free flow of rice across borders will not only lower the price of rice but will also provide a necessary cushion for the market against any supply or demand shock.

Ms. Narciso is an assistant scientist, Ms. Molina is an associate scientist, while Mr. Valera and Ms. Matriz are professional service staff members in IRRI's Social Sciences Division.

Agricultural biodiversity: the lasting legacy of early farmers

By: Ruaraidh Sackville Hamilton

Agriculture is often accused of reducing biodiversity. Diverse natural ecosystems are replaced with comparatively uniform farming systems. About 10,000 to 15,000 years ago, the wild ancestors of cultivated crops were put through a genetic bottleneck, as the first farmers found and selected those few forms that were suitable for cultivation.

Yet, Charles Darwin marveled at the enormous diversity of domesticated species. This was one of the observations that led him to formulate his theory of evolution. N.I. Vavilov, a prominent Russian botanist and geneticist and widely regarded as the father of crop diversity conservation, elaborated the concept with his analysis of crop diversity, concluding that every crop has a region of exceptionally high diversity associated with its early agricultural history.

Why this apparent conflict? If early farmers reduced crop diversity by putting species through a genetic bottleneck, why is so much genetic diversity associated with early agriculture? The answer lies in the "punctuated evolution" theory of Stephen J. Gould, an American paleontologist, evolutionary biologist, and historian of science. Evolution does not just proceed gradually, as many people assume. Rather, there are long periods of stasis, interspersed with short periods of rapid change. These rapid changes occur in response to new challenges. They represent adaptation to something new: a changed environment, a new opportunity.

This situation is what the invention of farming created. Most fundamentally, early farmers changed the very rules of evolution. When they started to keep seed for planting instead of just eating, suddenly, evolution was no longer driven by natural selection. It was driven by human selection—a completely different driver—altering the course of evolution. In addition, the early farmers changed the environment of selection by introducing cultivation and weeding, so the direction of selection shifted to favor forms that grew relatively better in improved soils with reduced competition. Then, farmers' crops provided veritable banquets for pests, diseases, and weeds, facilitating their rapid development and evolution—again, changing the direction of selection and the ideal characteristics of the crop. That is not all. Farmers shared and moved seeds from place to place much more than what occurs naturally. They gave each other a greater range of choices, making each farmer better able to select a variety specifically suited to the local climate, soils, weeds, and eating preferences of the community. Finally, as seeds were moved from place to place, the introduced varieties hybridized with the wild and locally cultivated forms. This generated more novel diversity, offering more opportunities for farmers to choose the best varieties for themselves.

The result was a huge evolutionary radiation—the creation of new biodiversity guided by early farmers. The method of creation of this diversity is significant. The agricultural biodiversity that we see now is the result of adaptation to the myriad of real diverse challenges faced by farmers as rice evolved and spread across the world. No farmer wants seeds that fall off the plant before being harvested, so crop domestication has indeed created a genetic bottleneck, removing such unwanted variants. Where we see diversity is in traits that have proved themselves valuable for farmers, at least at some time in some place, with a particular combination of consumer preferences and resistance to biotic and abiotic stresses.

This is good news as we face the threats of climate change. Clearly, we must adapt, developing new varieties and farming systems better suited to future climates. Yet, this is not new. Farmers in the past have also had to respond to climate change. They have succeeded, but, in the process, they left behind a full range of genes that they needed. Much of this diversity is now safely conserved in the genebank at the International Rice Research Institute and almost certainly contains exactly what we need to adapt to the changes today and in the future. However, the task to discover which, among the millions of possible variants in the collection, are the genes we need to adapt may be rather daunting

Nonetheless, it is essential for us to not forget our responsibility to pass on this legacy to future generations. They will face their own challenges, different from ours. As R.A. Fisher's[1] fundamental theorem of natural selection (1930) stated, "The rate of increase in fitness of any organism at anytime is equal to its genetic variance in fitness at that time." This means that the rate at which a population can adapt is proportional to the genetic variation for adaptedness—the more variation we keep, the more rapidly we can respond to challenges. We must securely conserve the full range of rice diversity so that our children's children will be able to develop their own solutions to their own problems.

Dr. Sackville Hamilton is the head of IRRI's T.T. Chang Genetic Resources Center.

[1] Sir Ronald Aylmer Fisher was an English statistician, evolutionary biologist, and geneticist.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