Rice Today
www.irri.org
International Rice Research Institute
January-March 2010, Vol. 9, No. 1

A golden launch

IRRI celebrates 50 years of rice research

Why cold-tolerant rice is needed

The Lord of Rice

How a modern rice variety is bred

US$5.00 ISSN 1655-5422

contents

RiceToday
Vol. 9, No. 1

WILLIAM STA. CLARA

CHRIS QUINTANA

On the covers:
To kick off IRRI's 50th anniversary year, *Rice Today* readers will see one of two covers for the January-March 2010 issue. One cover features Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand, with camera in hand, as she toured the Genetic Resources Center (with Director General Robert Zeigler behind her) on 17 November 2009 at IRRI's headquarters in the Philippines to formally launch the Institute's anniversary activities.

The other cover shows the grand finale fireworks over IRRI that culminated a day-long fiesta on 13 December 2009 for more than 3,000 IRRI staff members and their families and friends. See pages 32 and 33 for details.

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

TRT, for 19 years, brought its 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.

Responsibility for this publication rests with TRT and IRRI. Designations used in this publication should not be construed as expressing TRT or IRRI policy or opinion on the legal status of any country, territory, city, or area, or its authorities, or the delimitation of its frontiers or boundaries.

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.

The Rice Trader Inc.
2707 Notre Dame Blvd., Chico, CA 95928
Web: www.thericetrader.com

International Rice Research Institute
DAPO Box 7777, Metro Manila, Philippines
Web (IRRI): www.irri.org; www.irri.org/ricetoday
Web (Library): http://ricelib.irri.cgiar.org
Web (Rice Knowledge Bank): www.knowledgebank.irri.org

Rice Today editorial
telephone: (+63-2) 580-5600 or (+63-2) 844-3351 to 53, ext 2725; fax: (+63-2) 580-5699 or (+63-2) 845-0606; email: mia.aureus@thericetrader.com, l.reyes@cgiar.org

publisher **Jeremy Zwinger**
associate publisher **Duncan Macintosh**
managing editor **V. Subramanian**
editor **Mia Aureus**
associate editor **Lanie Reyes**
contributing writers **Gene Hettel, Sophie Clayton, Sam Mohanty, Leah Baroña-Cruz, Trina Leah Mendoza**
Africa editor **Savitri Mohapatra (AfricaRice)**
copy editor **Bill Hardy**
art director **Juan Lazaro IV**
designer and production supervisor **Grant Leceta**
photo editors **Chris Quintana, William Sta. Clara**
advertising manager **Logan Wilson**
circulation **Lourdes Columbres**
Web masters **Forrest Orndorff, Darell Sison**
printer **DHL Global Mail (Singapore) Pte. Ltd.**

New horizons of rice research

Rarely do we begin a year with the promise and potential we see for 2010.

It has been decades since there has been such broad and strong interest in (and concern about) agriculture and rice production. This, combined with the extraordinary progress we are making in rice research, augers well for how we will deal with the sobering set of problems and challenges that we now face to sustainably achieve global food security and help reduce hunger and poverty in the face of a changing climate.

Although there is plenty for us to worry about, we don't have to look too far to find some good news. Whether it is the strong, visionary support for rice research by the Bill & Melinda Gates Foundation or the fresh, thoughtful support from nations such as Japan and Singapore, the news is as reassuring as it is welcome. The launch of the IRRI Fund Singapore should be a way for a whole new set of partners to invest in rice science for a better world.

All of this comes as the International Rice Research Institute (IRRI) turns 50. Although we like to maintain a culture of learning and renewal in the Institute, this important milestone gives us an unprecedented opportunity to pause and reflect on the lessons of the past, while embracing the incredible opportunities that science is set to bring us in the future.

Whether it is famine caused by droughts in Africa, the uncertainty caused by the delayed monsoon in South Asia, or the almost paradoxical devastating floods of the same monsoon season, we have the means to deal with these age-old problems. By applying our knowledge to develop technologies and policies that can neutralize these threats, we can help make calls for emergency food aid a thing of the past. The number of global hungry is now over one billion—and this is completely unacceptable. This reflects serious errors in judgment spanning decades based on the belief that all of our food security problems have been solved. But rather than rage against this depressing situation, we must continue to show that investments in research, infrastructure, and capacity building within an enlightened policy environment are far more effective than short-term, seemingly endless famine relief. Scientific solutions are a vital part of any sustainable, long-term answer to global food security, especially in the face of climate change. As we celebrate 50 years of successfully feeding almost half the world—and the extraordinary contributions of thousands of committed scientists and researchers—we can take comfort in the awareness that we have the knowledge and the tools we need to overcome the challenges we face. We just have to persevere.

2010 should be the year in which we look forward to new horizons of rice research and imagine how it can change our world for the better. I am convinced that our impact will surpass our wildest dreams, much as the achievements of those pioneers 50 years ago saw their dreams surpassed in ways they hardly thought imaginable.

Duncan Macintosh
Associate Publisher
Rice Today

Hidden Treasure

The real joy in finding treasures comes from the search. The longer you search for one, the more you treasure every piece of it, once found. I find this to be strikingly true considering the events that have happened over the last few months. The most personal and precious example for me is the beauty of a new-born baby who takes a good part of the year to grow inside a mother's womb before coming into this world. I must sentimentally admit that my wife and I have been blessed recently with a new baby daughter. In the many travels I have made, I find great joy in witnessing how much parents love their children and how they work hard to give them a bright future. I believe this shared love between parents and children is one of the many common threads that connect all of us around the world. In this regard, I must dedicate this issue of *Rice Today* to my beautiful wife, Susan, and lovely baby daughter, Dakota.

Many challenges lie ahead for our children—the future generations. These challenges may strike their most basic needs, such as food, and undermine the foundations of their existence and survival. So, we must try to anticipate the problems of tomorrow and see what we can do today to sustain feeding the world's growing population. In light of this, there is a great need for people who can help tackle present issues before they blow up into bigger problems. We need leaders who can plan ahead (decades before, if not further) for the benefit of the next generations. This was one of the topics brought up during the World Rice Conference that we, The Rice Trader, organized in October 2009 in Cebu, Philippines. The Honorable Philippine Agriculture Secretary, Arthur Yap, graced our event and in his opening speech stressed the importance of looking forward to find a solution. Further emphasizing the significance of this moment, Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand officially opened the 6th International Rice Genetics Symposium—the event that kicked off the International Rice Research Institute's (IRRI) 50th anniversary—and welcomed over 800 participants from different nations who sought ways to power the next agricultural revolution. It is striking to see these important leaders spend time away from their family and friends to work on such problems ailing the world.

Quite significantly, the private sector has similarly stepped up to help solve global concerns. The Bill & Melinda Gates Foundation is a prime example of this. One only has to look at the amount of resources they have put in, to fund seed research, health gains, education, and other forward-looking projects to see the true impact of their services. Personally, I hold great respect for their motto, "All lives have equal value." This is another piece of wisdom that reminds us that we are all connected; any event that causes instability to this harmony will affect everyone, no matter where they are in the world.

As I travel again away from my family to attend another important rice event, I am struck by the challenges we have at hand that even a president of a country or the richest people on Earth cannot solve them alone. But then again, these are global concerns and we must all do our part in finding solutions. The "size" of our contributions is not important. What matters is the effort to help. Small steps will still make a long journey, so to speak, and I believe it is an individual choice to be part of the solution. So, I may not have the same amount of influence that Secretary Yap or Mr. Gates has, but I have come to follow their examples by donating $10,000 to IRRI to promote a sustainable food supply. This amount may be just a drop in the vast ocean of needs, but one can never know the effects of even the smallest actions. I believe tiny drops such as this will serve their purpose and ripple into bigger things that would benefit the world today and tomorrow.

Jeremy Zwinger
Publisher

Entire genetic diversity of rice to be revealed and shared

The International Rice Research Institute (IRRI) invites the global rice science community to join its vision to reveal the genetic diversity of more than 109,000 different types of rice.

The vision aims to sequence the genomes, or all the genetic information, of all different types of rice in the International Rice Genebank—the world's most comprehensive collection of rice genetic diversity, including wild rice, rice's ancestors, and traditional, heirloom, and modern varieties.

"If we can sequence the genomes of all types of rice, we have truly opened the door to understanding the rich genetic diversity of rice, to help conserve that diversity better, and to use it to breed improved rice varieties," said IRRI Director General Dr. Robert Zeigler.

"All rice types need to be sequenced to capture the entire genetic diversity of rice. Rapidly progressing technologies have made this a realistic goal—achievable within a few years."

IRRI already shares seeds from the International Rice Genebank with farmers and rice breeders worldwide, and the genome information from the sequencing will also be shared.

Sequencing the genomes of the entire collection of the International Rice Genebank will provide a platform that rice breeders can use to rapidly identify the genetic source of beneficial rice traits such as pest and disease resistance or the capacity to cope with climate change.

These genes and their associated traits can then be bred into new rice varieties. IRRI will now look for partners and donors to support its vision.

Rice trade supports rice research

The Rice Trader (TRT), co-publisher of Rice Today, donated US$10,000 to the International Rice Research Institute (IRRI) for rice research at the World Rice Conference in Cebu, Philippines, in October 2009.

TRT's publisher, Mr. Jeremy Zwinger, said he was inspired to give the support by an increased focus on the importance of agriculture and a desire to fund public research aimed at increasing production and alleviating poverty. "While the rice trade has not been known for giving private dollars to fund public research, the example of the Bill & Melinda Gates Foundation is particularly inspiring," Mr. Zwinger explained. "I hope that others in the trade may also look at this example."

The new support was welcomed by Dr. Robert Zeigler, IRRI's director general. "We would certainly like to encourage support for rice research from the rice trade as this has been a very successful model in other crops like wheat," he said.

More than 300 rice trade executives and 200 officials from 33 countries attended the World Rice Conference 2009.

THE RICE TRADER

Aroma genes scattered in Asia

The version of the gene mainly responsible for the aroma in Thai Jasmine rice is found in many rice varieties around the world, not just in Thailand. To clear up confusion about the origin of the aroma gene found in Thai Jasmine rice, scientists from the International Rice Research Institute (IRRI) analyzed 318 varieties of aromatic rice from the International Rice Genebank, including 16 types of Thai Jasmine rice.

"Ninety-five percent of the aromatic rice analyzed shared the same version of the major gene for fragrance found in Thai Jasmine rice," says Dr. Melissa Fitzgerald, grain quality researcher at IRRI. "Our research also suggests that the aroma gene did not originate in Thai Jasmine rice.

"Traditional varieties of aromatic rice from 17 Asian countries—Afghanistan, Bangladesh, Bhutan, China, India, Indonesia, Iran, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, and Vietnam—have the same version of the gene that contributes to their aromatic qualities," she adds.

The aroma gene has been prized by farmers everywhere for thousands of years and it became widely adopted in different rice varieties throughout the ancient rice-growing world long before modern national boundaries were established.

Not surprisingly, for a trait valued as highly as aroma, rice breeders in many countries around the world try to develop new improved varieties of aromatic rice, such as Jazzman developed by Louisiana State University (LSU).

"Any organization, including LSU, can legally obtain seed of aromatic rice for breeding purposes from many different sources, including the International Rice Genebank," says Dr. Ruaraidh Sackville Hamilton, head of the International Rice Genebank.

"However, to obtain material from the International Rice Genebank, they must accept the terms and conditions set out for such sharing under the International Treaty on Plant Genetic Resources for Food and Agriculture," he elaborates.

This Treaty, agreed upon and adopted by most countries, promotes the responsible sharing of genetic diversity. It allows breeders access to the material they need, under carefully defined conditions that ensure they don't misappropriate the material and that the benefits arising from its use are shared fairly and equitably.

"The unique aroma of Thai Jasmine rice is a result of a combination of the presence of the version of the major gene for fragrance, other minor genes, and the climatic and soil conditions in Thailand where Thai Jasmine rice is grown," says Dr. Hamilton. "Duplicating exactly this combination of genetic characteristics and growing conditions would be difficult, assuring a place for Thailand's distinctive Jasmine rice in the market."

BRIEFLY

World to dip into rice reserves in 2010

The United Nations' Food Outlook (December 2009) forecasts that world rice production in 2009 will fall short of global rice use in 2010 by around 3 million tons, which would have to be met by world reserves. As a result, rice carryover stocks at the close of the marketing seasons ending in 2010 are expected to shrink from 124 million tons in 2009 to 121 million tons in 2010—still high compared with the 110 million tons held on average between 2002 and 2009.

International rice trade in calendar year 2010, at 31.2 million tons, points to a 2.7% or 800,000-ton increase from the 2009 estimate, which is higher than the forecast last June. The revision reflects larger import requirements by countries that faced important crop losses in recent months. If confirmed, trade in 2010 would be the second largest after 2007.

Total rice use, including food, feed, and other uses, will likely reach some 454 million tons in 2010—8 million tons more than consumed in 2009. Virtually all of the increase is expected in food consumption that is forecast to absorb 389 million tons in 2010, compared with 383 million tons in 2009. The increase, however, would be barely sufficient to meet the needs of the world's growing population and would keep average per capita intake unchanged at around 57.3 kg per year.

Source: www.fao.org

GM rice in China

According to Reuters, China has approved its first strain of genetically modified (GM) rice for commercial production.

According to two members of the Chinese Ministry of Agriculture's Biosafety Committee, this group already issued biosafety certificates to pest-resistant Bt rice and large-scale production would start in 2 to 3 years. However, the government has not officially announced any decision yet.

Currently, no varieties of GM rice are grown commercially in the world, although several have been approved for commercialization. Many organizations, including the International Rice Research Institute (IRRI), are using GM rice as a research tool and a process to develop potential GM rice varieties.

According to IRRI, the responsible and ethical research and development of GM rice presents a unique opportunity that should be explored to help meet rice production challenges. IRRI has not developed any GM rice varieties yet, but it is researching GM rice with better tolerance of drought, heat, and salinity; geater photosynthetic capacity; and improved nutritional value.

Source: www.reuters.com

BPH outbreak in Thailand

Brown planthopper (BPH), one of the most devastating rice pests, is on the rise in Thailand.

"This is the worst outbreak of BPH I have seen in my career since 1977," said Dr. Manit Luecha, director of Chainat Rice Seed Center. "Most of the paddy fields—probably more than 1 million hectares—will suffer rice yield losses of more than 30%."

Damage has spread from the north, especially in Pissanulok and Phichit, to the Central Plain—the rice bowl of Thailand. Damage is already serious and new outbreaks are being reported every day.

"We predicted that 2009 would be a bad year for BPH outbreaks," said Dr. K.L. Heong, BPH researcher at the International Rice Research Institute. "High rice prices in 2008 motivated farmers to grow rice continuously, fertilize their rice more in an effort to boost yields, and attempt to protect their investment by spraying more pesticides to keep leaf-eating insects at bay.

"Unfortunately, pesticides that destroy leaf-eating insects also kill many natural predators of BPH," he added. "Without predators, BPH multiply rapidly and outbreaks occur."

Dr. Heong's solution to solve the problem now is to stop spraying pesticides. "Eliminating pesticides helps restore balance to the natural ecosystem and increases the diversity and quantity of BPH predators in rice fields," he explained. "It is also unwise to indiscriminately spray to directly control BPH, as we are seeing a higher degree of immunity within BPH to pesticides intended to control them, especially in China and Vietnam, and increasingly in Thailand."

MANIT LUECHA

Making concrete from rice

Rice hulls, the part of the rice removed prior to consumption, have a possible new purpose in life—to help make concrete.

Texan chemist Rajan Vempati led a group that developed a new process to make rice hulls into ash. The idea is to replace some of the Portland cement, which is the material that holds the sand and crushed stones together in concrete.

The process involves heating the hulls to 800 °C, after which carbon is driven out, and fine particles of almost pure silica remain.

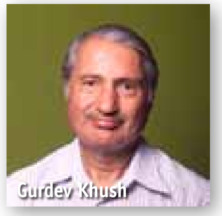
The National Ready Mixed Concrete Association points out that using ash in cement is not a new idea. The ancient Romans discovered that volcanic ash made better cement.

But modern inventors say rice hull ash works better than other materials. They developed the process with money from the National Science Foundation. They have not yet brought it to the market.

Source: www.voanews.com

Awards and recognition

The Academy of Science of Malaysia honored two IRRI scientists—**Gurdev Khush** and **K.L. Heong**. Dr.

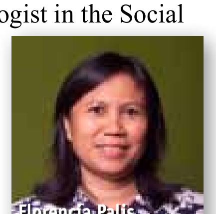

Gurdev Khush


K.L. Heong

Khush, who retired from the International Rice Research Institute (IRRI) in 2000, was given the Mahathir Science Award for his pioneering work in developing rice varieties that have greatly helped alleviate world hunger, while Dr. Heong was given the title Fellow of the Academy of Science for his contribution to rice insect ecology, innovative integrated pest management approaches, and farmer education through media.

Dr. Khush was also among the recipients of the 2009 Award of Distinction from the College of Agricultural and Environmental Sciences of the University of California-Davis.

Two IRRI scientists were cited as distinguished alumna by the University of the Philippines Los Baños. **Monina Escalada**, former international research fellow at IRRI, was recognized by the College of Development Communication Alumni Association for "spreading the art, science, and practice of development communication in Southeast Asia through her participatory research and extension projects." **Florencia Palis**, agricultural anthropologist in the Social Sciences Division (SSD), on the other hand, was cited by the College of Arts and Sciences for her work in extension.


Florencia Palis

Darshan Brar, head of the Plant Breeding, Genetics, and Biotechnology Division (PBGB), received the Yunnan Friendship Award from the Yunnan Government, Republic of China. This award recognizes the contribution of foreign experts in the development of Yunnan Province, where Dr. Brar has been working for more than 10 years with scientists of the Yunnan Academy of Agricultural Sciences to improve rice through wide hybridization.


Darshan Brar

The International Plant Nutrition Institute (IPNI) named **J.K. Ladha** as winner of the 2009 IPNI Science Award. Dr. Ladha is a senior soil scientist, coordinator of the Rice-Wheat Consortium in Asia, and representative of IRRI in India.

A logo designed by Achilleus "Les" Coronel, professional service staff in Communication and Publications Services (CPS), was chosen by UNESCO as the logo for World Day for Audiovisual Heritage. The design represents cellulose film stock that forms an adorned box symbolizing collected media in their traditional state.

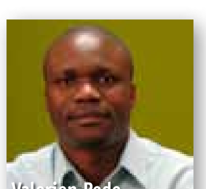
Keeping up with IRRI staff

Effective 1 January 2010, **Roland Buresh, J.K. Ladha, Hei Leung, David Mackill**, and **To Phuc Tuong** reached the pinnacle of IRRI research achievement, leadership, and prestige as they were promoted to principal scientists.

S.M.A. Jabbar joined the Crop and Environmental Sciences Division (CESD) as visiting research fellow under the Japan International Research Center for Agricultural Sciences to investigate the impacts of continuous rice cultivation under alternate wetting and drying irrigation management.

New scientists who have joined IRRI are **Amit Mishra** and **Deeksha Krishna** for soil and plant analysis at the IRRI-India Office under the Rice-Wheat Consortium; **Andrew Nelson** as geographic information systems specialist; **Chengzhi Liang** as crop information systems specialist; and **Valerien Pede** as economist.


Andrew Nelson


Valerien Pede

Three members of the IRRI Board of Trustees concluded their terms: **Ruth Oniang'o** of Kenya, **Ronald Phillip**s of the United States, and **Baowen Zhang** of China.

In CESD, **Sarah Beebout** replaced **Tanguy Lafarge** as deputy division head starting in January 2010.


Sarah Beebout

In a reorganization of management effective at the end of 2009, IRRI formed its Office of External Relations (OER), which will incorporate public relations and non-host-country external relations and subsume into it the offices and mandates of the Office of the Director for Program Planning and Communications, International Programs Management Office, and the Development Office. To provide leadership within the OER are **Corinta Guerta**, head of OER and donor relations and projects coordinator; **Sophie Clayton**, public relations manager; **Julian Lapitan**, national programs relations manager; and **Duncan Macintosh**, development director.


Corinta Guerta

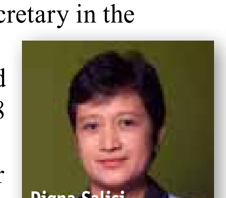
Staff who left

IRRI bid farewell to **Hari Gurung**, international research fellow in SSD, and **Jong-Cheol Ko**, visiting research fellow in PBGB.

Obituaries

Susan Hargrove, wife of Thomas Hargrove (IRRI editor and later head of CPS, 1973-91), passed away on 27 October at the Hargrove home in Galveston, Texas. Susan had lung cancer, but may have died of complications from radiation and chemotherapy treatments.

Digna Salisi, secretary in the T.T. Chang Genetic Resources Center and IRRI employee for 18 years, passed away on 10 December after battling with cancer.


Digna Salisi

TRAINING COURSES AT IRRI

Basic Experimental Design and Data Analysis Using CropStat

IRRI Training Center, Los Baños, Philippines
22-26 February 2010

This course is designed to acquaint researchers with the principles of experimental design, basic experimental designs used in rice research, analysis of variance and regression, and correlation analysis. It also introduces CropStat, a microcomputer-based statistical package that facilitates the analysis of experimental data.

Molecular Breeding Course

IRRI Training Center, Los Baños, Philippines
22 February-5 March 2010

This course aims to provide hands-on training to enhance rice scientists' capability to apply molecular technologies in ongoing rice breeding programs, which seek to develop high-yielding varieties that are resistant to various biotic and abiotic stresses, and that will produce rice with improved grain and nutritional qualities.

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

NEW BOOK http://books.irri.org

Popong eats brown rice

Written by Chat Garrido-Ocampo
Illustrated by Grace C. Dy
Published by Department of Agriculture-Bureau of Agricultural Research, Philippines

As a solution to junk-food culture, Chat Garrido-Ocampo's 24-page fully illustrated children's book, *Popong eats brown rice*, encourages and educates children to eat the nutritious but unfamiliar staple—brown rice. This is a sequel to her other book, *Popong eats rice*, which highlights the value of simply eating rice.

Popong eats brown rice has the elements of adventure, science, fiction, and fantasy. It is science-based and it familiarizes children with concepts such as husk, rice bran, vitamins B1, B3, and B6, manganese, phosphorus, fiber, and fatty acids in a simple, clear, and effective way, allowing children to expand their science vocabulary and also become more aware of the value of rice.

The book is instructive but the style of writing makes it a fun, light-hearted, and a quick read. The brightly colored illustrations similarly help in conveying the theme and tone of the story, not to mention capturing readers' attention, quite effectively.

What is also interesting about this book, apart from "rice," is how it celebrates the special bond between mothers and children and between grandparents and grandchildren. It highlights the importance of universal values such as love, care, compassion, and understanding that are especially shared among family members. This science-based book has an original plot and believable characters that are well crafted and engaging. It is an excellent read-aloud choice—the best way to introduce the benefits of eating brown rice and the wonderful world of rice science to preschool, kindergarten, and primary school.

With its main message of eating nutritious food, the book could be used as an advocacy material for helping to overcome the worldwide problem of malnutrition, as it has the ability to, perhaps, change people's perception and appreciation of brown rice. Simply put, the book is an enjoyable gift of valuable information on brown rice for young and old alike.

Contact Don Lejano at dlejano@bar.gov.ph for information on obtaining hard copies of the book. A digital version will be available soon at http://books.irri.org.

Dear Gene,

Back in September, you were most kind in helping me get a digital version of a Mayon Volcano photograph from *Rice Today* that showed the damages caused by the lahar during Reming's passing in late 2006. I made good use of the photo in a recent presentation on lahar damage around Mayon and recovery from 2006 to January 2009 at a conference here in Canada this September.

I was particularly pleased to see some of the items in your Oct-Dec 2009 edition of *Rice Today*. I intend to use the information on the rat-eating pitcher plant from Palawan and the two rainfall maps on South Asia (2007 and 2008) in my biogeography and tropical environment courses. Some years ago, I published a photo of a Canadian pitcher plant in an encyclopedia, but it was nothing like Palawan's monster!

To show my appreciation, I have attached a photo of my wife, Nila, and me taken this August 2009 at our cottage in the boreal forest near Lake Winnipeg. Nila originally hailed from Cadiz City, Negros Occidental. We met in Winnipeg and were married over 36 years ago. Our "cottage" is not exactly a "rice-growing country," but you can see a banana tree behind me and, perhaps, make out a papaya tree to the right of my wife! Like us, they spend the long cold winters indoors!

Salamat,

Geoffrey Scott
254 Kirkbridge Drive
Winnipeg, R3T 4Z4
Canada, (204) 269-5156,
and
Department of Geography,
University of Winnipeg,
515 Portage Ave.
Winnipeg, R3B 2E9
(204) 786-9297

RiceToday around the world

1. **SHARED KNOWLEDGE.** IRRI's Ramon Oliveros shares *Rice Today* with Filipino students at Chonbuk National University, Korea.
2. **WHERE THE wind blows.** *Rice Today* finds itself in the Netherlands with IRRI staff members (*left* to *right*) Clarissa Pimentel, Corina Habito, and Warren Constantino.
3. **RICE BOND.** *Rice Today* captures the hearts of Dr. Halil Sürek (*left*) and Mustafa Öden (*right*), Turkey's "father and grandfather of rice."
4. *RICE TODAY* in London. The Marchong family (*left* to *right*: Paul, Alexander, and Sandra) happily takes the magazine to the Picadilly Circus.

1

2

3

4

How a modern rice variety is bred

by **Darshan Brar** and **Parminder Virk**

IRRI scientists explain how plant breeding, aided by new technologies, has helped improve rice varieties around the world

New rice varieties have revolutionized rice production around the world. Despite devastating stresses attributed to climate change, farmers now have more reasons to hope and expect rice to cope and provide enough yield. Submergence-tolerant rice, for example, can survive floods. Drought-tolerant rice can withstand heat and lack of water. Plant breeders took many years to develop these varieties. Many more are in the pipeline and they will soon power the next agricultural revolution. Meanwhile, allow us to briefly take you through the process that gave birth to these improved varieties.

Challenges to rice production

Farmers were the earliest rice breeders. In pursuit of higher yields and better grain quality, they selected superior plants over average ones. Because of this, they were responsible for rice improvement until 1900. During that year, scientists rediscovered Mendel's law of inheritance, which laid the foundation of breeding. Soon thereafter, systematic breeding began and progressed.

Now, plant breeding is the art and science of changing and improving the hereditary traits of crop plants, such as high yield; multiple resistances to major diseases, insects, and other environmental stresses; and better grain and nutritional quality, to meet human needs. Over the past four decades, annual world rice production has increased from 252 to more than 600 million tons. This is mainly because of the development and adoption of new high-yielding, fertilizer-responsive, semidwarf varieties accompanied by appropriate production technologies. However, by 2025, we will require 25% more rice to meet the growing need of the human population.

Rice production, though, is continually threatened by a series of biotic stresses (blast, bacterial blight, tungro, brown planthopper, sheath blight) and abiotic stresses (drought, submergence, salinity, heat, cold, soil toxicities, etc.). So, the major challenge is to overcome these stresses and produce more rice with less land, less water, fewer chemicals, and less labor in the context of global climate change. This is where breeding new and adaptive varieties comes in.

Breeding a new variety involves different steps as shown in the Figure. However, these should be seen as broad guidelines involved in the development of varieties through conventional and marker-assisted breeding. This scheme could be modified in several ways depending upon the target traits, breeding methodologies, and rice production systems, which vary from one to three cropping seasons in a year.

Major steps in breeding a rice variety

The following steps are involved in breeding a rice variety:

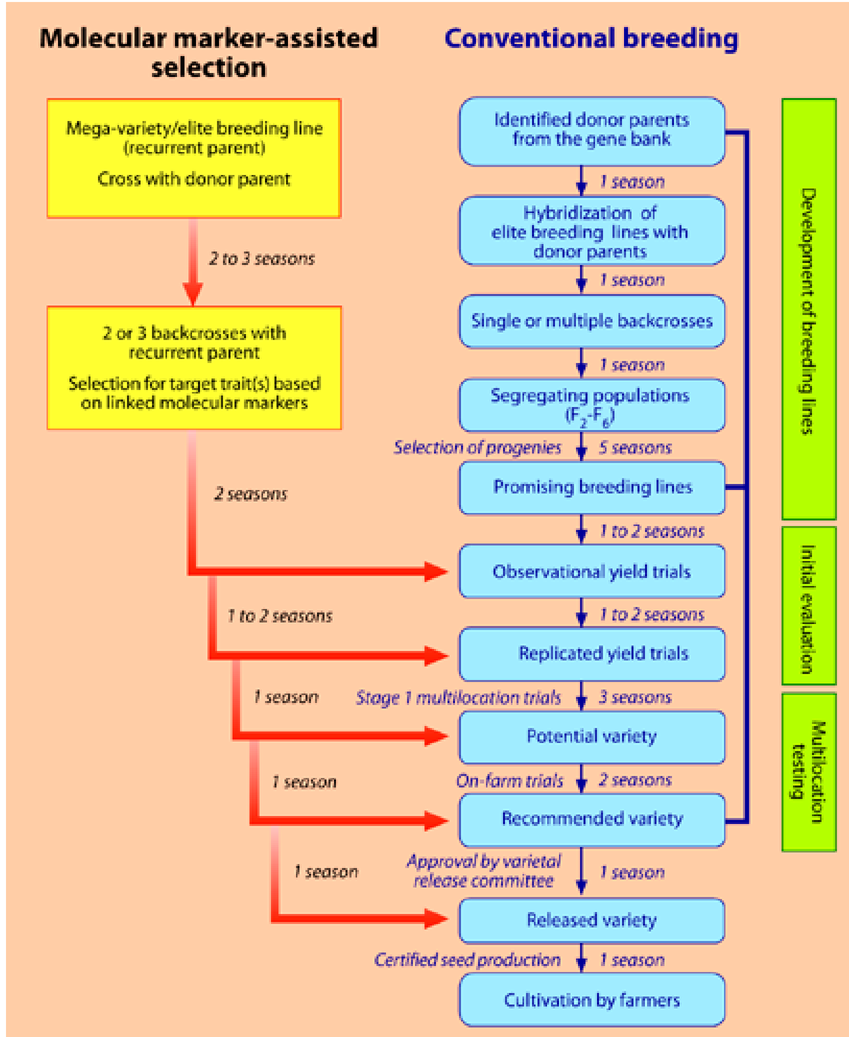
1. Identify genetic donors for target traits.
2. Develop segregating populations and select plants or lines possessing desirable traits.
3. Evaluate elite breeding lines in replicated yield trials and multilocation testing.
4. Conduct on-farm evaluation and testing in national trials.
5. Nominate varieties for prerelease.

6. Release the new variety through a country's variety release committee (VRC).
7. Lastly, distribute the variety for commercial cultivation.

After making an initial cross, it usually takes 8–10 years (or 16–18 seasons) to develop a new rice variety using traditional techniques. However, recent advances in molecular marker technology and genomics have offered opportunities to accelerate rice breeding and the release of varieties to farmers.

Molecular techniques can be integrated into traditional backcrossing methods to allow plant breeders to quickly and precisely transfer a particular trait that is lacking in a popular variety, without significantly altering its salient characteristics—thus speeding up the creation of the improved version of the variety. Molecular markers serve as tags to select the target traits in the laboratory, thus avoiding the cumbersome process of growing many progenies in the field. It is worth noting that this is a conservative breeding strategy involving the improvement of already existing varieties that lack a few traits desired by farmers.

Breeders were able to save time both in the development of an improved variety (3 to 4 seasons) and in the evaluation and release processes of such a variety (another 3 to 4 seasons) through marker-assisted selection (MAS). In some countries, such as India and the Philippines, MAS products have already been fast-tracked by the VRCs. It is hoped that the VRCs of other countries will adopt similar steps in the near future to accelerate the release of such breeding products.



Transgenic breeding is another way of developing new rice varieties, especially when genetic variability for target traits is either limited (e.g., sheath blight, stem borer) or altogether lacking (e.g., pro-vitamin A/Golden Rice) in the germplasm. Transgenes for useful traits can be transferred into desirable genetic backgrounds using MAS. In certain cases, transgenes for a specific trait can also be stacked together for added advantage. However, the development and release process of transgenic products is variable and depends on the biosafety guidelines and regulatory processes of each country. So far, no transgenic rice has been released for commercial cultivation by farmers.

In many countries, variety release is restricted by seed laws or regulations. But some countries do not have any specific regulations governing variety release. The decision to market a variety is then left to breeders' discretion and initiative. Variety release systems vary in different countries according to the regulatory framework. National seed boards established VRCs to review and evaluate the new varieties bred by both the public and private sector. However, varieties can be recommended by either the VRC or a duly designated multisectoral and multidisciplinary reviewing body. This group reviews the varieties based on agreed-upon norms and standards and they make their recommendations based on the results of multilocation performance tests and registration data submitted by breeders.


DR. BRAR, IRRI plant breeder, together with his research team, examines breeding lines in the field.

Dr. Brar is a plant breeder and head of IRRI's Plant Breeding, Genetics, and Biotechnology Division (PBGB) and Dr. Virk is also a plant breeder in PBGB.

Jasmine meets Jazzman

The Louisiana State University Agricultural Center jazzes up the market with a new breed of aromatic rice

by **Xueyan Sha** and **Steve D. Linscombe**

XUEYAN SHA

Often hailed as the "queen" of rice, Thailand's Jasmine variety has reigned over many consumers' palates because of its rich aroma, texture, and taste. In 2009, however, word spread that Jasmine had found its rival. The United States had come up with its own fragrant variety called Jazzman.

U.S. demand for Jasmine-type aromatic varieties accounts for about 80 percent of the country's total rice imports. Inasmuch as American farmers would like to take advantage of this increasing demand by growing these fragrant varieties, only Jasmine 85 is currently available in the U.S. Initially released in Texas in 1989, it is an improved indica variety developed by the International Rice Research Institute. Unlike its relative varieties, however, Jasmine 85 is inferior in quality and, as such, not widely grown in the U.S. Challenged to satiate the American demand for fragrant rice, the Louisiana State University Agricultural Center in 1992 started working on an improved Jasmine-type variety that would have better milling quality and higher yield capacity on top of having special characteristics similar to those of Jasmine rice. After 12 painstaking years of crossing elite U.S. long-grain genotypes and Jasmine-type germplasm, plant breeders finally came up with Jazzman—a product of the cross between 96a-8, an unreleased Chinese aromatic rice line, and Ahrent, a variety from Arkansas.

Following the news of Jazzman's release in the market, Thailand conducted tests to compare Jasmine and Jazzman. The results showed that Jasmine's quality still reigns superior. Nonetheless, Jazzman's higher yield capacity could prove to be a critical characteristic. Unlike Jasmine, which can yield 2.5 metric tons per hectare, Jazzman can produce 7.9 metric tons in the same area. Moreover, it is a moderately early-maturing and short-statured variety with excellent seedling vigor. On average, it can reach heading from emergence in 86 days. Standing at an average height of 100 centimeters, a Jazzman rice plant does not easily bend or break. It is also resistant to sheath blight and blast—an important trait farmers look for.

Now, considering the growing demand for such fragrant rice varieties, an improved and better yielding Jazzman could soon sing its way into the hearts of more consumers and find its own niche in the U.S. market. More American farmers are expected to grow this new variety for good returns and more consumers can also be expected to turn to it as an affordable alternative to Jasmine rice.

Dr. Sha is a rice breeder and associate professor at the Louisiana State University Agricultural Center, while Dr. Linscombe is a senior rice breeder and director of the center.

No-cook rice

by **Lanie C. Reyes** and **Mia Aureus**

Indian scientists have developed high-yielding soft rice that requires no cooking

To some, this new rice variety could be a time-saver. But to most people struggling to make ends meet, "no-cook" rice is a life-saver.

In early September 2009, the world got wind of the news that Indian scientists had developed a new rice variety that does not require fire to cook. It simply needs to be soaked in water and "voilà!" the rice is ready to be eaten. Now, in countries where a majority of the population suffers from poverty and malnutrition, no-cook rice would help poor families ease hunger pains, especially those who live in rural places where sources for fuel are relatively scant.

Commonly known in India as Aghonibora, no-cook rice was bred by Titabar Rice Research Station of Assam Agricultural University and worked on by the Central Rice Research Institute (CRRI). According to Dr. Tapan K. Adhya, CRRI director, the Institute started working on this rice in 2007. He said they got the idea from soft rice called "komal sawl," which has been known for quite some time in Assam, the northeast province of India, where the climate is temperate. This variety has not been grown outside the northeastern region. Recognizing its potential and benefits for rice consumers, CRRI improved the variety, which can grow in the hot and humid climate of Orissa—a state on the east coast of India.

Since field trials of Aghonibora were already positive, Dr. Adhya said that it could be grown in other areas that have similar weather conditions, including Southeast Asian countries. "For the moment, we plan to grow the variety in similar agroclimatic areas of Andhra Pradesh, West Bengal, and Bihar states of the country," he added.

Aghonibora is already a released variety. However, its seeds are still insufficient for it to be distributed to farmers. Dr. Adhya and his team hope to make the variety available in 2010 when they will have ample seeds for farmers to use. Developed with the lower income group in mind, Dr. Adhya believes that this variety will not cost more than ordinary rice. First, planting Aghonibora will not require any special treatment or inputs; second, with its improved yielding capacity of 4.5 tons per hectare (on average based on experimental conditions), enough stocks will be available for consumers.

CRRI is now also testing other promising "komal sawl" varieties and hopes to develop other cereal products that will benefit more consumers.

Winning the upland poverty war

Upland rice finds a niche in the mountain prosperity of Chiang Mai, Thailand

Story by **Bob Hill**
Photos by **Dante Palmes**

For much of the past three decades, the remote uplands of Southeast Asia and Indochina have been home to large but isolated human populations living in poverty; their struggle for sustenance draining the life from vast areas of mountain forests.

Hence, improving life for isolated mountain communities, numbering as many as 20 million people, has become a priority for scientists and policymakers alike, concerned on the one hand to make upland cropping systems more productive and on the other to halt further destruction of forests by farmers anxious to find new and more fertile fields.

At last, the seemingly impenetrable cycle of poverty in the uplands is being broken, and misery is retreating in the face of new hope. However, the transformation has been sporadic. In China's southwestern Yunnan Province, vast numbers of mountain farmers have emerged from long poverty through the government's introduction of new higher-yielding varieties of upland rice (see *A mountainous success*, on pages 33-35 of *Rice Today* Vol. 5, No. 1). In northern Thailand, huge tracts of mountainsides have become richly productive vegetable gardens in response to the development of road access to markets.

In both cases, the turning point came when food security was assured. Relieved from the crushing struggle to feed their families, farmers could think, instead, of boosting their cash incomes.

Tyrannical terrain

The staple food in the mountain communities is upland rice or rice that grows on dry land, like wheat or maize. Traditionally, it is grown on sloping fields carved out of mountain forests. But, even at best, in the first planting season on a newly cleared field, traditional varieties of upland rice barely yield enough grain to feed a family. As soil nutrients are exhausted in successive cropping seasons, rice yields dwindle and weeds and pests multiply. Eventually, the field is abandoned and the farmer "shifts his cultivation" to another area, intending to return to the original field when its fertility is restored by a period of fallow.

When populations were smaller and the cropping pressure on fields was significantly less, abandoned fields could remain fallow for long enough to regain their fertility. But, as populations grew and governments forbade further forest encroachment, the pressure on farmers' fields to continue producing food became intolerable. Exhausted fields lost the ability to either produce crops or recover after a fallow period.

Adding to their predicament, upland farmers are risk averse; they either cannot afford or are unwilling to invest in technologies that may help them. All around, the tyranny of their mountainous isolation bears down on them—from long, cold winters and hot, wet summers to sloping fields, which, if given a choice, no farmers in their right mind would opt to cultivate.

Improvement has been slow and difficult. But, increasingly, upland communities have started to overcome the problems.

Rice landscapes

At the heart of the issue are rice and food security. The International Rice Research Institute (IRRI) has long been involved in the uplands, coordinating regional scientific efforts and helping to apply the successes of one community to those in neighboring countries. It manages a broadly based project called Rice Landscape Management for Raising Water Productivity, Conserving Resources, and Improving Livelihoods in Upper Catchments of the Mekong and Red River Basins. Supported by the Challenge Program on Water and Food (CPWF), the project has collaborators across Southeast Asia and Indochina and from as far away as France and the United States. It covers northern Thailand and Laos in the Mekong Basin and northern Vietnam in the Red River Basin, matching a parallel project supported by the International Fund for Agricultural Development (IFAD) covering India and Nepal.

With a focus on managing rice landscapes, the research effort is not restricted to rice fields alone, but to rice landscapes as a whole, and ranges from introducing new higher-yielding rice varieties to improving the way farmers use their land and water resources. By intensifying food production in favorable pockets of the uplands, people hope that pressure on less favorable, more fragile areas will decrease.

Producing more rice on less land and with less labor is seen as the key to breaking the poverty cycle, says Sushil Pandey, senior agricultural economist and leader of IRRI's research program "Rice Policy Support and Impact Assessment." Dr. Pandey also leads the rice landscape management project.

Importantly, the project's aim is to help poor upland farmers to develop livelihood options, to break the cycle of constraint that holds them in poverty. It is widely acknowledged that these options will only beckon when poor farmers achieve a secure food supply, so they can begin to think about how to increase and diversify their income—possibly by growing cash crops or raising livestock.

Link with the past

One of the best examples is the success story of northern Thailand, where the poverty and food insecurity of two decades ago have been defeated by the construction of roads, access to markets, and long official and scientific effort. Large numbers of upland farmers have become commercial vegetable gardeners, covering entire mountainsides with colorful mosaics of cash crops. In stark contrast to the lives of their fathers and grandfathers, individual farmers have become wealthy.

In the mountains between the township of Mae Chaem, southwest of Chiang Mai in northern Thailand, and the border with Myanmar, the landscape of the Mae Suk watershed is breathtaking. The mountainsides climb in a checkerboard of colors from narrow valleys to forested ridges reaching more than 1,000 meters above sea level. A patchwork of green, yellow, brown, orange, and russet is painted across slopes that would daunt a nimble goat.

Yet, in the midst of this abundance is an enduring link with the past. Upland rice still has its place among the cabbages, shallots, tomatoes, maize, and soybeans. Moreover, the farmers have maintained paddies for lowland rice in the valley bottoms, committing their meager water resources to an age-old practice that logic suggested they would abandon upon achieving sufficient food security.

"This is not something I expected to observe here," says Dr. Pandey. "Farmers either grow upland rice [as a subsistence crop] and a very small area of cash crops or forego rice altogether and grow commercial crops only." In other words, if cash income from growing vegetables is dependable, why not abandon rice growing altogether, commit their entire land and water resources to growing vegetables, and simply buy rice from the market?

The Karen[1] farmers of Mae Suk, perhaps, demonstrate how difficult it is for upland communities to accept that their food supply is secure.

In one area, a group of Karen farmers cultivates a large area of upland rice, despite their simultaneous cultivation of cash crops. One of the farmers explained that the rice crop was purely to feed farmers' families.

Growing commercial crops alone involves a substantial financial risk, because market prices fluctuate, and the mix of vegetables and rice mitigates that risk, this farmer indicated. Growing commercial vegetable crops also requires finance, and the Karen farmers have limited access to capital. They also lack water for irrigation, eliminating the option of dry-season crops.

The leading vegetable gardeners in the Mae Suk watershed are of Hmong[2] ethnic background. Much to the surprise of researchers, the urge to grow their own rice continues even among the Hmong farmers, even though their steep mountainsides are closely packed with vegetable crops and their land is seldom, if ever, left fallow.

[1] Karen, also known in Thailand as the Kariang or Yang, is one of the ethnic groups in Thailand and Myanmar.

[2] Hmong is an Asian ethnic group in the mountainous regions of Vietnam, Laos, Thailand, and Myanmar.

SENG YANG, a Hmong farmer, earns well from cash crops but reserves patches of his field to grow better-quality upland rice.

Seng Yang, a Hmong farmer, claims to own about 16 hectares of soaring hillsides. Aged 45, he is head of an extended family of 17, including his own eight children and the families of three of his older children. He grows shallots, cabbages, maize, and rice.

"I earn well from shallots," he says. "I can harvest 100,000 kilograms of shallots from one crop, and sell them at 10 baht (US$0.30) per kilogram."

Flourishing upland farms

In many respects, this moderately crowded but remote community of upland farmers stands at the leading edge of upland agricultural development. The productivity of the towering mountainsides is prodigious. Throughout each day, legions of laboring pickup trucks—each carrying about one and a half tons of freshly packed vegetables—head off up the sealed road that first introduced the farmers to the bonanza of city markets.

The farmers admit that to deliver vegetables in the prime condition sought by the market often requires "a lot" of fertilizer and pesticide. Beside the sealed road and snaking their way across most of the landscape are endless threads of bright blue PVC pipe, taking water from weirs built across mountain streams and delivering it over astonishing distances to the vegetable fields. If one farmer builds a new weir, then his competitor will take his pipes one step upstream to ensure his water supply is not diminished, and so on. Small cooperatives buy water from the owners of the weirs. It is stored in farm ponds and diverted to different fields in a strictly controlled sharing system.

The competition for limited water is obvious. Flooding and heavy runoff are, in most cases, out of the question. Much of the irrigation is done with sprinklers, so the farmers are quick to dispute any suggestion that their heavy use of fertilizer and pesticides may become a downstream problem. They say they use water sparingly and the chemicals stay where they are applied.

But, because—in a sense—the farmers of the Mae Suk watershed lead the upland development field, their successes and failures, and excesses and constraints, serve as a rich learning ground about the kinds of systems that might evolve elsewhere in the highlands of Southeast Asia and Indochina, together with the trade-offs involved, and the conflicts.

"I live for eating rice, so I grow rice," Seng Yang explains, voicing a common standpoint in the uplands of northern Thailand. "I know it's easier to buy rice, but it's not good quality. It's better to grow it myself."

His latest crop was lowland jasmine rice, grown in small terraces covering about one-sixth of a hectare. He also grows upland rice on a mountainside block. It yields only about half the grain he gets from his lowland fields, mainly, he says, because of competition from weeds.

Seng Yang says he will offer some of his rice to his ancestors as soon as the grain is bagged and stored. He still wants to grow rice for this reason although he could earn more income by growing vegetables. He says that to grow the same area with vegetables, he would earn three times the value of the rice crop.

"But it's not good to buy rice for my ancestors," he says. "Offering them rice I have grown myself shows the proper respect."

Balancing act

Not far from Seng Yang, another Hmong farmer, Daecha Kulsawatmongkol, 32, sets aside a sizable plot for upland rice every season in his tightly packed checkerboard of mountainside vegetables.

He grows rice to feed his family of 15 people, because "rice is expensive now." What's more, he says, it is difficult to buy good-quality rice—the kind of rice he likes to eat. As it is, his half-hectare field of upland rice, although it will yield nearly 1.5 tons of paddy, will fall well short of feeding his family and he will have to buy about 1.2 tons of "rough rice" to supplement his harvest.

The area Daecha sets aside for upland rice every year is a balancing act between his family's desire for a good-quality staple and the need for income from cash crops.

A TRUCKLOAD of cabbages destined for the market.

He claims to maintain high productivity by ceaselessly rotating his crops around his 9.6 hectares of sloping land. He uses fertilizer for upland rice only if it is planted on the same field for two consecutive seasons.

Daecha also laments the limitations on his vegetable production because of a shortage of water. He has a farm pond, but still runs short in the dry season. Nevertheless, even if he had less land, he would still grow upland rice because it supplies food during the "hungry months" of September and October, when lowland rice has not been harvested and rice prices in the market are relatively high.

In his community, comprising about 18 Karen and Hmong families, five or six have opted not to grow rice, and concentrate solely on cash crops.

"They find it easier to concentrate on vegetables and buy their rice, but in recent years the price of vegetables has gone down and the price of rice has gone up," he said.

Love for rice

If the upland farmers of the Mae Suk watershed provide a "window into the future" for mountain communities elsewhere in the region, then one of its most surprising aspects has been the tenacious desire of farmers to continue growing upland rice, despite being well ahead—relative to other upland communities—in the escape from poverty. Among researchers on the rice landscapes project, it is additionally fascinating for its demonstration that there is still room in the uplands of northern Thailand for their project to reinforce the process of income generation, by further improving local rice technologies.

In the uplands of Laos and Vietnam, the IRRI-led project is seeking to improve farming technologies ranging from rice varieties to better management, with the latter focusing mainly on water productivity. The improved varieties—better suited to upland conditions as well as to lowland areas in valley bottoms and on terraces and lower slopes—are being validated in farmers' fields. Improved technologies for irrigation of rice, such as alternate wetting and drying, seek to use sometimes meager water resources more effectively. By producing more rice from less water on less land and with less labor, farmers will be able to turn these resources to producing cash crops or other income-generating activities.

Other technologies include purer seed stocks of better traditional rice varieties and improved techniques for maintaining fertility or restoring plant nutrients to exhausted soils.

However, no matter how prosperous they may become, the Thailand experience suggests that upland farmers will most likely continue to grow upland rice, and there will probably always be room—if not demand—for improved technologies in their rice landscapes.

One of the project's principal collaborators in Thailand is Chiang Mai University. Its professor of agricultural economics, Benchaphun Ekasingh, has studied her country's upland farming systems for many years.

"They have come a long way," she said. "Because of market access, we have a very productive upland farming system in Thailand. We thought that upland rice was going away, that the farmers would abandon it in favor of cash crops; but the farmers have decided there is a niche for it. It is their choice not to abandon it."

Dr. Benchaphun said she saw a very productive future for Thailand's upland farmers. "But I think their farming systems will have to be more conservation-oriented—in particular soil and water conservation. This will come about because outsiders will demand it."

Bob Hill is a Thailand-based writer specializing in science and technology. Dante Palmes is a Philippines-based freelance photographer.

Grappling with cold

by **Lanie C. Reyes**

IRRI, in collaboration with the Republic of Korea, is developing new rice varieties that will soon warm up to cold temperatures

Recent headlines read: *Cold spell compounds woes of Palestinian farmers*; *Cold spell hits farmers in Nueva Vizcaya, Philippines*; and *Longest-ever cold spell hits northern Vietnam.*

Behind these headlines are agricultural crops placed in jeopardy, especially rice, which is originally a plant that has no built-in mechanism against cold.

Because of centuries of genetic selection, some rice varieties can already be grown in areas where the temperature is low. Of the two major groups of rice, japonica varieties can thrive better in temperate regions than indica varieties, which are more common in hot and humid areas. Hence, japonica rice is widely grown in temperate and subtemperate countries, the Southern Cone of South America, the Mediterranean climate zone, and high-altitude areas in the tropics.

A COLD-tolerant line (*indicated by red arrows*) performs well in an experimental field at Chuncheon, South Korea.

JUNG-PIL SUH (2)

About 20 percent of the rice areas worldwide are planted with temperate rice, which comes from countries as diverse as Australia, Turkey, Japan, China, Republic of Korea (South Korea), Democratic People's Republic of Korea (North Korea), Uzbekistan, India, Kazakhstan, Bangladesh, Tanzania, Madagascar, and the United States.

And, the demand for cultivating temperate japonica rice may increase because of some erratic changes in climate in some parts of the world. To cite an example of an extreme weather change, in December 2009, Orissa State in India, known for its hot and humid climate, was gripped by a cold wave that dipped as low as 8 °C. This drop in temperature set a new record in the state within a period of 50 years.

Cold damage

Although japonica rice varieties in Japan and Korea produce higher yields, when cold temperature blows its chilly air and remains during the critical stage of the crop's development, it is like a silent curse with its destructive spells, and it determines rice's fate: a less productive season.

In South Korea, for example, marked drops in temperature in 1971, 1980, and 2003 damaged 17%, 80%, and 20% of its total rice area, respectively. In 1980, yield loss in milled rice hit 3.9 tons per hectare. In China alone, the recorded yield loss per year because of cold is 3–5 million tons. More recently, in Vietnam, the 30-day cold spell that hit in February 2008 reportedly destroyed more than 53,000 hectares of rice.

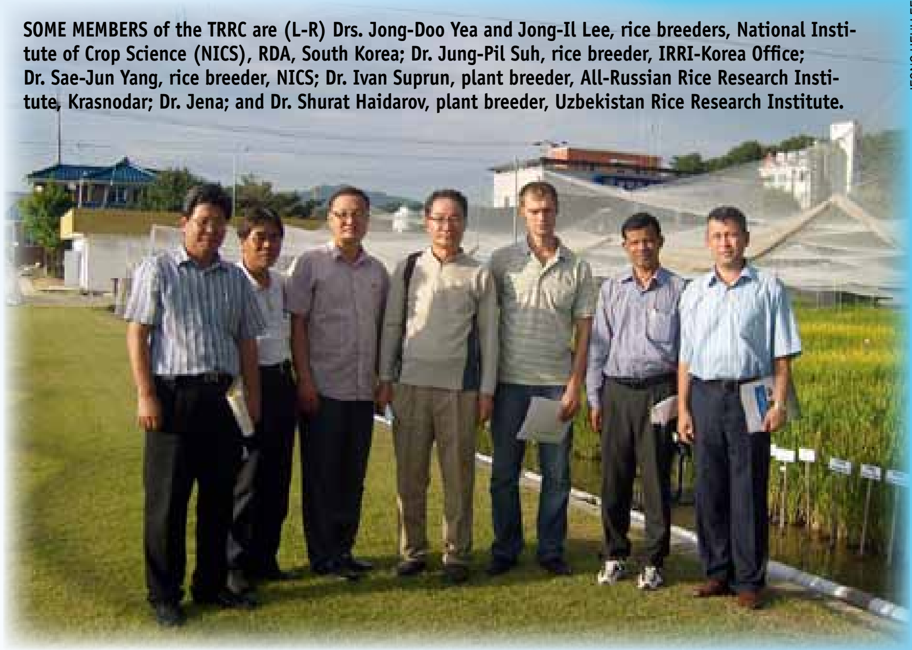
Needless to say, cold temperature is one of the major environmental stresses in rice production.

DR. JIN-CHUL Shin, head, Chuncheon Substation, RDA, shows a cold-tolerant breeding line developed through IRRI-Korea collaboration.

No pollen, no grain

According to Kshirod Kumar Jena, plant breeder and International Rice Research Institute (IRRI) country representative for Korea based in Suwon, cold temperature can damage rice in its germination stage, seedling stage, and/or reproductive stage. However, a drop in temperature during rice's early vegetative stage until its grain-filling stage causes the most severe damage. Dr. Jena explained that cold stress hinders rice plants from forming fertile pollen that is crucial for fertilization. Consequently, they fail to produce grains, which leads to a decrease in yield or, worse, no yield at all.

Moreover, Dr. Jena mentioned that low temperature impairs seed germination, reduces seedling vigor, weakens rice's photosynthetic ability by inducing leaf discoloration, reduces plant height, produces degenerated spikes, delays days to heading, reduces spikelet fertility, promotes irregular grain filling and maturity, and leads to poor grain quality.



SOME MEMBERS of the TRRC are (L-R) Drs. Jong-Doo Yea and Jong-Il Lee, rice breeders, National Institute of Crop Science (NICS), RDA, South Korea; Dr. Jung-Pil Suh, rice breeder, IRRI-Korea Office; Dr. Sae-Jun Yang, rice breeder, NICS; Dr. Ivan Suprun, plant breeder, All-Russian Rice Research Institute, Krasnodar; Dr. Jena; and Dr. Shurat Haidarov, plant breeder, Uzbekistan Rice Research Institute.

JEONG-HEUI LEE

It's in the genes

Rice breeders see no other way to reduce cold-related losses in rice production than genetically improving cold-sensitive cultivars using modern breeding techniques. The sequencing of the rice genome and the development of marker-assisted selection (MAS) have fast-tracked their research efforts.

"Cold tolerance is a complex trait; it is controlled by many different genes," Dr. Jena said. "But now, it has become easy to identify the correct DNA markers linked to the quantitative trait loci (QTLs) conferring cold tolerance." By developing desirable mapping populations and accurate phenotyping for cold-tolerance and -sensitive traits, and conducting QTL analysis, Dr. Jena and his team were able to identify three QTLs or genomic regions from chromosomes 3, 7, and 9—QTLs that have a direct link to cold tolerance at the reproductive stage. Through this, they identified markers that linked the QTLs to seed fertility.

IRRI started collaboration with South Korea's Rural Development Administration (RDA) using the International Rice Cold Tolerance Nursery (IRCTN) in 1978. However, recently, in collaboration with RDA's National Institute of Crop Science, a new source was discovered, a cold-tolerant breeding line—IR66160-121-4-4-2—that inherited cold-tolerance genes from Indonesia's tropical japonica cultivar Jimbrug and northern China's temperate japonica cultivar Shen-Nung89-366.

DR. K.K. Jena, plant breeder and IRRI country representative for Korea, explains how cold-tolerant lines are developed.

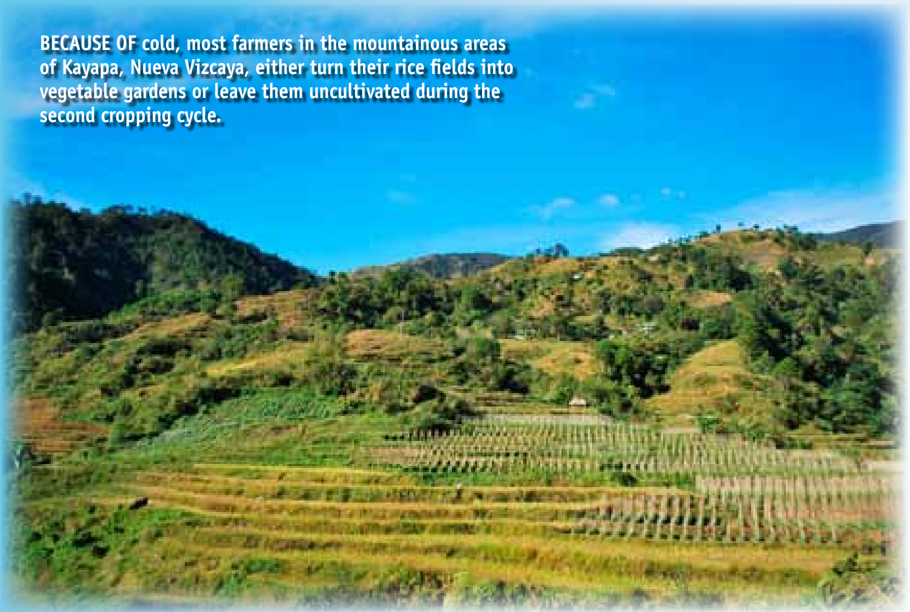
CHRIS QUINTANA

Using this line, Dr. Jena and his team from RDA, namely, Jung-Pil Suh, Ji-Ung Jeung, Jung-Il Lee, Jong-Doo Yea, Jeong-Hee Lee, Yeon-Gyu Kim, and Jin-Chul Shin, produced recombinant inbred lines (RILs) by crossing cold-tolerant and cold-sensitive cultivars. They then evaluated these RIL progenies under two conditions: one, by subjecting them to cold-water stress at 18–19 °C in the field; two, by exposing them to cool air temperature in the greenhouse at 18 °C. After the experiment, they selected some promising cold-tolerant lines that also have desirable seed fertility and early maturity traits.

Concerted efforts

To further strengthen international efforts to develop cold-tolerant varieties, IRRI established the Temperate Rice Research Consortium (TRRC) in 2007. Its country members are Australia, Bhutan, Chile, China, Egypt, Japan, Kazakhstan, Nepal, the Philippines, Russia, South Korea, Spain, Tanzania, Uruguay, Uzbekistan, and the U.S. Dr. Seong-Hee Lee, Korean member of the IRRI Board of Trustees, was instrumental in the formation of this Consortium, bringing along with him the full financial support of the RDA. A steering committee and four working groups were formed. Each working group focused on one of the four major constraints identified for temperate rice: (1) yield potential and grain quality, (2) blast resistance, (3) cold tolerance, and (4) nitrogen and water use efficiency.

The third group, in particular, aimed to evaluate a selected number of cold-tolerant germplasm accessions provided by working group partners at seedling and reproductive stages



BECAUSE OF cold, most farmers in the mountainous areas of Kayapa, Nueva Vizcaya, either turn their rice fields into vegetable gardens or leave them uncultivated during the second cropping cycle.

MOISES JOHN C. REYES

and identify promising cultivars or breeding lines at key sites; combine cold-tolerant genotypes with cold-sensitive cultivars and develop suitable cold-tolerant germplasm adapted to different countries; use potential DNA markers linked to cold-tolerance traits for marker-assisted breeding; develop a common set of cold-tolerant lines for use in breeding in collaboration with working group partners; and provide training opportunities to young researchers by monitoring key sites and visiting advanced cold-tolerance breeding laboratories.

According to Ms. Thelma Padolina, plant breeder at the Philippine Rice Research Institute (PhilRice), one of the benefits of being a member of the working group is that breeding materials can now be thoroughly screened [as PhilRice does not have a screening facility]. Before, they just relied on observing plants' physical reactions, which are mostly erratic. Another benefit is that they will be able to infuse genetic diversity by making other sources of germplasm from other countries available for breeding. "The varieties that we were able to develop still lack the necessary traits," she said. "They are specific to a season and to the developmental stage of the plant and lack biotic and abiotic stress tolerance."

Collaboration with Bangladesh

Farmers in flood-prone areas of Bangladesh cannot usually plant rice during the rainy season. And, after the rainy season, during November to December, when the water subsides, the soil is more fertile because of the nutrients brought in by the flood. But, there is another problem—cold.

To solve this problem, Dr. Jena has started collaborating with the Bangladesh Rice Research Institute to develop cold-tolerant varieties for boro or winter-season cultivation. Several cold-tolerant lines have already been produced from a cross between BR29, a popular cold-sensitive variety in Bangladesh, and Jinbu, a cold-tolerant variety from Korea. These generated cold-tolerant lines will be useful for rice breeders in their selection for varieties suitable to their specific locations.

Bangladesh is only one of the countries that the TRRC is extending its hand to. More countries benefit from the sharing of this cold-tolerant germplasm. And, all these efforts boil down to improving the quality of life for farmers in cold-prone areas, just like those in cold-affected areas in Kayapa, Nueva Vizcaya, Philippines (see *Cold reality* below).

Cold-tolerant rice is indeed a necessary product for cold-prone areas. Thus, it goes without saying that IRRI's and its partners' concerted efforts through an effective channel, the TRRC, in combating the devastating effects of cold should clearly increase the productivity of about one-fifth of the rice-growing areas in the world.

Cold reality

by **Lanie C. Reyes**

Filipino farmers in the cool northern regions hope to plant cold-tolerant rice soon for better harvests

Most rice farmers in Kayapa, Nueva Vizcaya, Philippines, grapple with the cold every year. During the summer, maximum temperature peaks at 25.3 °C in May. But, in January, during the cold season, it can drop to 14 °C. To understand better and get a sense of how farmers in high-altitude areas are affected by cold and how they cope with it, let's look into their stories.

Alternative crop

Herminia Himson

MOISES JOHN C. REYES

Herminia Himson, 50, has been a farmer for more than 20 years. From mid-February to July, she grows rice for her family's consumption in the quarter of a hectare she owns in an upland area. However, when the second cropping cycle starts, her farm turns into a vegetable garden. She explains that, since the temperature becomes too cold for her commonly planted rice variety, planting rice during the second season is not an option. When asked what she thinks about cold-tolerant rice varieties, she beams and says, "That would be the best! The rice that we plant during the first cropping is not enough for my family." For Mrs. Himson, not having meat or vegetables does not matter much as long as there is enough rice for her family to eat.

"Rice is still the more preferred crop to plant," she adds. "The price of vegetables, such as tomatoes, can fluctuate from three pesos (US$0.064, or less than a cent) to 30 pesos ($0.64)." She recalls a season when her tomatoes rotted in the plots because the cost of harvesting them was even higher than the market price. Given a choice, Mrs. Himson says she would still prefer rice to vegetables because the rice price does not fluctuate as wildly as those of vegetables. Also, being able to plant rice for a second cropping would secure her family's need for rice. It could also mean having surplus stocks, which they could sell in the market for extra income.

Taking some chances

Not far from Mrs. Himson is another farm, owned by Mr. Wilson Bandro. Wearing a cowboy hat, and maybe a cowboy's tough heart, too, Mr. Bandro, 50, dares to experiment planting rice on his half-a-hectare land during the second cropping cycle. His patches of rice, growing on terraced land, have varied shades of green because each patch is planted with three different kinds of traditional rice varieties, which are locally known as C1, Galo, and Bongkitan. Mr. Bandro is unsure which of these varieties will cope well with the weather, but he hopes that the prevailing low temperature will not be too cold so his rice can survive.

A RICE field turns into a vegetable garden during the second cropping cycle in Kayapa, Nueva Vizcaya, Philippines.

LANIE C. REYES

Like Mrs. Himson, Mr. Bandro also chooses to grow rice over vegetables because the latter are costly. He says vegetables need more capital for inputs such as fertilizer and pesticides, and also more labor. He simply cannot afford these additional expenses. He adds that vegetable gardening is fine if the price is good. If not, then that is another story.

As he shifts his gaze to his patches of rice, which he planted in August, he wistfully says, "Hopefully, I can harvest from these soon." He cannot, however, help feeling uncertain about his crops. Although the panicles have rice in them, the grains, when pressed, are not yet hard enough. He simply has to wait until harvest time arrives.

Not tending the farm

On the fields of a nearby farm, small pale pink and purple flower heads arise from the branches of *Mimosa pudica* (sensitive plant) and among other weeds that are creeping, trailing, and standing tall. In between these weeds is a second growth of rice, which grew during the first cropping season—untended and abandoned.

This farm belongs to Jacob Camson, 57. He decided not to plant rice for the second cropping season because he thought that the cold breeze wafting on the highlands might be too cold for rice. He recalled that the last time he planted rice during the second crop cycle—which was years ago—he harvested nothing. Now, he left his farm to overgrown weeds. He says he could have planted vegetables there but finds it too costly.

ROQUE MARTIN, a farmer-cooperator, finds hope in cold-tolerant lines.

WILLIAM STA. CLARA

Farmer-cooperators

Three farmer-cooperators, on the other hand, are looking forward to planting a variety that is suited to their climate as they participate in the National Cooperative Testing for cool elevated area being implemented in collaboration with PhilRice, by Nueva Vizcaya State University (NVSU) through Elbert Sana, NVSU professor, and his team, who brought the breeding lines for evaluation in one of the elevated areas in Kayapa.

According to Roque Martin, a farmer-cooperator, one of his reasons in participating in the field testing is that, if a cold-tolerant line can succeed in their area, he will be the one to benefit first. Then, he can multiply the seeds for his needs.

If other low-temperature areas such as Kayapa were planted with cold-tolerant rice, logically, rice production could be doubled. Farmers could thus help enhance food security in the community and also alleviate poverty.

William Sta Clara

Cold spells often sweep across the mountainous province of Nueva Vizcaya, Philippines, between November and February, when temperatures can drop to 14 °C. This affects rice production in both the uplands and lower-lying areas.

Weathering the cold

Africa develops rice that can thrive in the region's cooler zones

by **Negussie Zenna, Ashura Luzi-Kihupi, Baboucarr Manneh, Rabeson Raymond, Elie Rene Gasore,** and **Karim Traore**

TANZANIAN FARMERS bend their backs transplanting rice beneath snow-capped Mt. Kilimanjaro, the highest peak on the African continent

KILIMANJARO AGRICULTURAL TRAINING CENTRE

In sub-Saharan Africa, rice is one of the most significant crops—as both a food and cash crop. This is evident from the recent civil unrest that broke out in many African countries because of rice shortages. As the African population is expected to hit one billion soon, the region is worried that its rice production will fall short of the growing demand. Africa's terrain poses many challenges to farmers, thereby limiting the continent's full potential to grow rice and attain food self-sufficiency.

The most striking geological feature in Africa is undoubtedly the East African rift system. The main section of the valley starts from the Red Sea, crosses through Ethiopia, Kenya, Tanzania, and Malawi, and plunges into the lower Zambezi River valley in Mozambique. The rift has formed Africa's mountainous regions, including Mount Kilimanjaro in Tanzania, which soars 5,796 meters above sea level. It is permanently capped with snow even though it is near the equator. This unique topography gives sub-Saharan Africa the most diverse and complex agroecological zones for rice production of any region in the world.

If cold-tolerant varieties of rice can be improved for farmers to maximize planting and boost rice production in the highlands of East Africa and the cold-prone areas of the Sahel region, Africa will be well on its way toward alleviating poverty and ensuring food security for its many people.

Low temperature retards the rice plant's growth. This is a common problem among farmers who sow rice during cool seasons, and among those who grow rice at high altitudes and in areas that have a cold irrigation-water supply. Damage depends on the prevalent air or water temperature, cropping pattern, growth stages of the crop, and variety. Damage can be observed at any growth stage, and it often leads to crop failure. Cold conditions inhibit the seed's metabolic process; hence, seed germination fails. Other outcomes are slow seedling growth, stunting, discoloration, panicle degeneration, sterility, and irregular maturity. Given such wide-ranging effects of low temperature on rice and the serious impact on productivity, several African rice-growing countries have invested their resources in developing cold-tolerant rice varieties. Among these countries are Ethiopia, Madagascar, Tanzania, Rwanda, Mali, and Senegal.

Ethiopia

Although rice production was just recently introduced in this country, paddy area has already surpassed 150,000 hectares—and this has been achieved in mid- and low-altitude areas only. The vast highland plateaus located at about 2,000 meters above sea level, in spite of their high potential for rice production, could not be used because of the unavailability of cold-tolerant varieties. A few varieties are grown in the mid-highlands (as high as 1,800 meters) such as X-jigna and WAB 189. Recently, through support from the Sasakawa Africa Association, germplasm collections from the International Network for Genetic Evaluation of Rice (INGER) at the International Rice Research Institute (IRRI) and other sources were introduced to adapt or develop cold-tolerant varieties suitable for higher altitudes.

Madagascar

Rice is the staple food in the densely populated high plateau of Madagascar. Farmers traditionally grow irrigated rice or rainfed lowland rice in inland valleys and on hillsides. Magnificent rice terraces can be seen at 1,900 meters. Mean temperatures at 1,500 meters vary from 17 °C in October, the rice-sowing period, to 20 °C during the reproductive stage. Minimum temperatures can fall below 10 °C during early vegetative stage and are below 14 °C during reproductive stage and grain filling. Low-temperature damage is worse with a temperature drop during the seedling or reproductive stage.

Madagascar's cold-tolerant rice breeding program started with a vast collection of irrigated rice germplasm taken from local and international sources. Those belonging to the *Latsika* family had the best performance in sterility rate, grain yield, and tolerance of sheath blight. The *Latsika* family belongs to the temperate japonica group. Varieties of this family are traditionally cultivated in lowland ecosystems with altitudes above 1,800 meters. Although the released varieties have shown tolerance of cold, the extended growth period, from October to April/May (because of the cold temperature), made double cropping difficult. Hence, increasing productivity has been rendered impossible.

Tanzania

Tanzania is the second-largest rice producer in East Africa. Quite accustomed to eating rice, Tanzanians have developed a unique taste for this staple cereal. Most prefer aromatic rice that becomes long and fluffy when cooked. Varieties that have these qualities often have low yield and thus command higher prices among producers. One possible way to increase the productivity of these preferred varieties is through double cropping. However, this could not be realized in the southern highlands region because farmers use the cold water from the mountains for irrigation during the cool season.

Rwanda

Rwanda has extensive irrigation schemes for rice cultivation in the highlands. Rice production can be carried out in areas such as Ruhengeri, which is at about 2,000 meters. During the cold season, the temperature in this area can go as low as 10 °C. A few cold-tolerant japonica varieties have been grown in the country since the 1970s, such as Zong eng, Yunyine, and Yun keng. However, since consumers prefer long-grain indica rice, farmers grow japonica types only during the cold season for their own consumption. Thus, breeding cold-tolerant indica rice is the major objective in the country.

The Sahel region (Mali and Senegal)

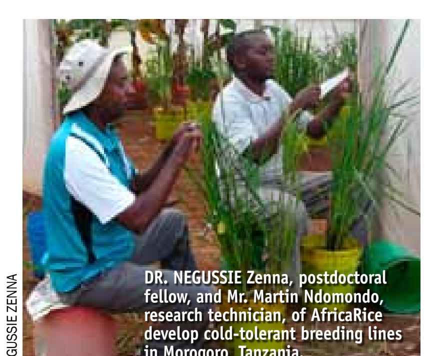
Rice consumption is very high in West Africa. For instance, Mali and Senegal consume 60 and 70 kilograms per capita per annum, respectively. Total crop failure because of low temperatures in the Sahel region has been a major problem. Planting rice seeds between mid-September and mid-November was associated with near-total spikelet sterility in Sahel countries. Higher variation in the crop cycle was observed in the coastal west and extreme north of the Sahel due to cold stress. Short-duration varieties were introduced earlier; however, they were mostly japonica types (I Kong Pao from Taiwan, Tatsumi Mochi from Japan, and AIWU and China-998 from China). None of these varieties are now widely grown because consumers prefer the slender indica types. Finding varieties that can thrive during the cold dry season has therefore become crucial in order to increase rice productivity in the Sahel region.

Currently, IRRI and the Africa Rice Center (AfricaRice) have joined efforts to develop improved cold-tolerant rice varieties under the Stress-Tolerant Rice for Poor Farmers in Africa and South Asia (STRASA)-Cold project. This collaboration involves six countries in Africa: Mali and Senegal in the west and Madagascar, Tanzania, Rwanda, and Ethiopia in the east. On-site activities are carried out in AfricaRice substations—in Senegal for West Africa and in Tanzania for East Africa.

Moreover, under the STRASA-Cold project, varieties adapted to low-temperature conditions are assembled from INGER, along with prebreeding materials from the International Cold-Tolerant Nursery and Temperate Rice Research Consortium. The germplasm is evaluated under actual field conditions, in collaboration with national agricultural research and extension systems. The field screening activity has a participatory varietal selection component, in which farmers get involved in the varietal selection process; and a seed production component, in which farmers are given access to quality seed. Plant breeders use conventional and molecular breeding approaches to transfer the cold-tolerance trait to local mega-varieties.

Over the past years, different researchers have identified several genetic markers linked with genes that possess cold-tolerance traits. Hence, marker-assisted breeding has become an important component of the breeding program. This approach can facilitate the rapid generation of improved cold-tolerant varieties with acceptable grain quality for Africa. These varieties, aside from increasing productivity and ensuring food security, would also help alleviate poverty in the region, as they meet the needs of resource-poor farmers.

Dr. Zenna is a postdoctoral fellow and Dr. Kihupi is a regional liaison scientist at AfricaRice, Dar es Salaam, Tanzania. Dr. Manneh is a molecular biologist and coordinator of the Abiotic Stresses Project and Dr. Traore is a rice breeder at AfricaRice, Saint Louis, Senegal. Dr. Raymond is a scientist and head of the rice program at the National Centre for Applied Research on Rural Development (FOFIFA), Madagascar. Mr. Gasore is the director of the Rice Research Programme at ISAR (Institut des Sciences Agronomiques du Rwanda).



DR. NEGUSSIE Zenna, postdoctoral fellow, and Mr. Martin Ndomondo, research technician, of AfricaRice develop cold-tolerant breeding lines in Morogoro, Tanzania.

NEGUSSIE ZENNA

AfricaRice scientists and national partners visit a cold-tolerant rice line in Fanaye, Saint Louis, Senegal.

KARIM TRAORE

Rice in the highlands

by **Andy Nelson, Arnel Rala, Cornelia Garcia,** and **Sonia Asilo**

The temperate regions of the world lie between the Arctic Circle and Tropic of Cancer, and the Antarctic Circle and Tropic of Capricorn. Diverse climates are found within these regions depending on latitude, prevailing winds, mountain ranges, and oceanic influences. Map 1 superimposes areas where rice is cultivated,[1,2] and then a simplified version of the classic Köppen-Geiger climate map[3] shows the tropical, arid, temperate, and polar regions. The areas of rice cultivation are clearly split between the tropical and temperate areas of the world, although some cultivation is also seen in semiarid zones.

Drops in temperature during the key stages of rice's growth can damage production output. For example, during the seedling stage, temperatures below 10–15 °C inhibit the establishment of seedlings and cause seedlings to rot; during the reproductive stage, temperatures below 18–19 °C can cause sterility. Because of this, cold-tolerant varieties are keenly sought after in temperate areas to boost yields and, in some cases, to allow farmers in the region to grow a second crop.

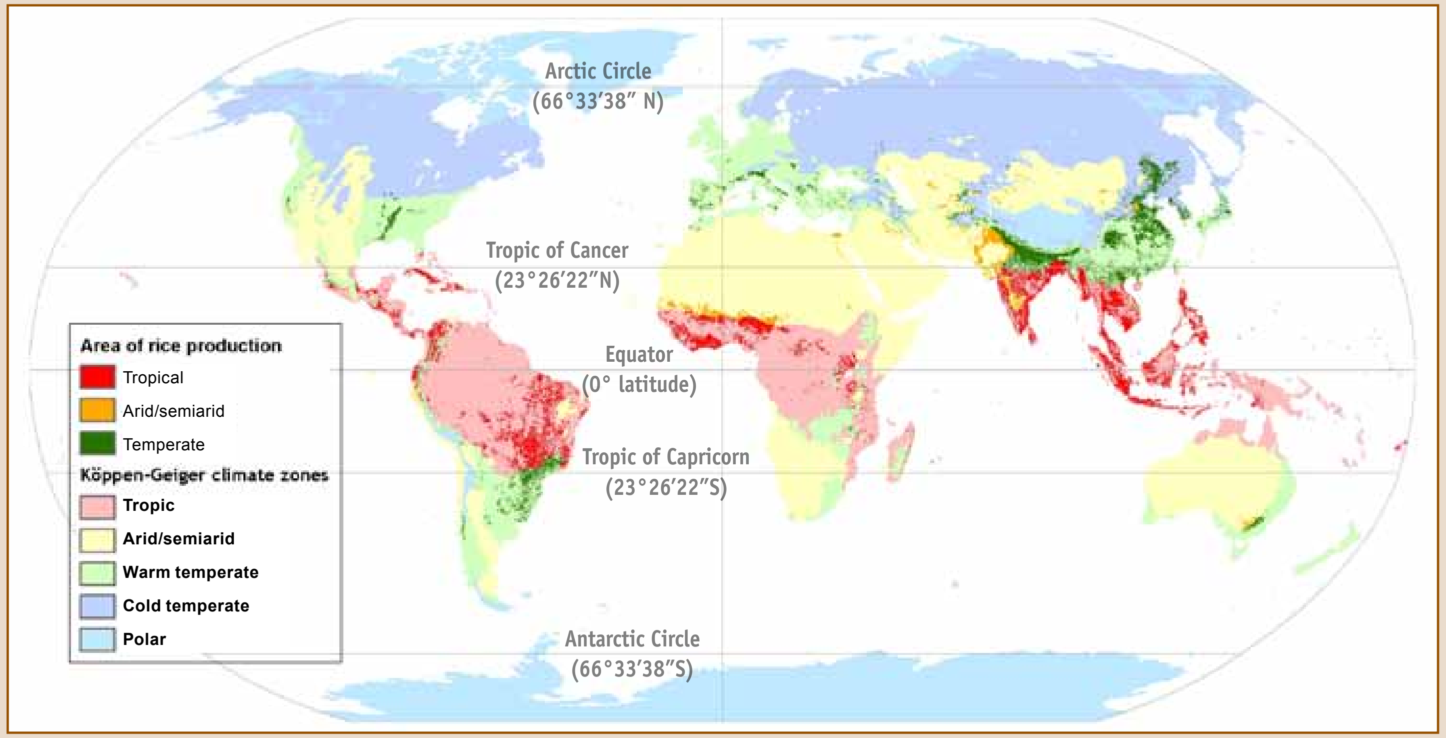
Note, however, that cold-tolerant varieties are required not only in areas of high latitude. The subtropics and tropical areas have zones of high altitude where rice cultivation also needs to endure cold temperatures. Map 2 highlights areas within the tropics that are above 1,500 meters.[4]

Ethiopia is one of the countries in the tropics that has large areas of agricultural land at high altitudes. Rice was introduced only recently in Ethiopia—during the 1970s—yet demand has already soared to the extent that rice is now a "National Food Security Crop" (see *Moving up in Ethiopia* on pages 24-25 of *Rice Today* Vol. 7, No. 4). The highland plateau has high potential for rice production but its temperate climate means that cold-tolerant varieties are required before this area can be considered for widespread rice cultivation (see *Weathering the cold* on pages 26-27 of this issue).

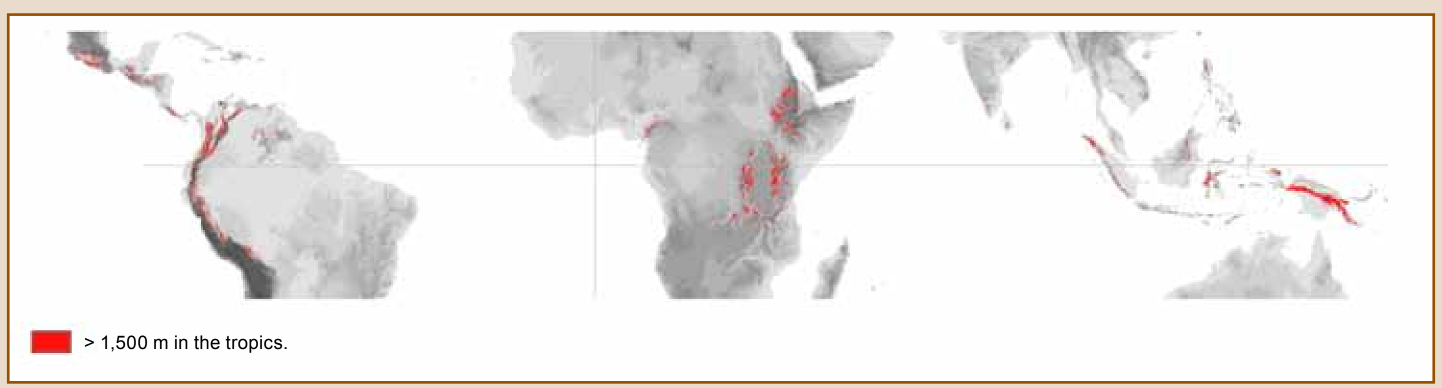
The Ethiopian Highlands range from 1,500 to 4,550 meters, but a big percentage of the plateau is below 2,500 meters. The Highlands are the largest contiguous expanse of high-altitude land in Africa. Temperatures at 1,500 meters during the rice planting months from March to June can go as low as 12 °C, as the climate chart at right for Gado demonstrates.[5]

Map 3 is a perspective view of Ethiopia based on elevation data. We used data from the Shuttle Radar Topography Mission to create this visualization of Ethiopia's dramatic terrain. We used a vertical exaggeration of the terrain and highlighted the agricultural areas in between, which are more than 1,500 meters above sea level, to reveal the extensive highland temperate region that includes areas suitable for cold-tolerant rice.

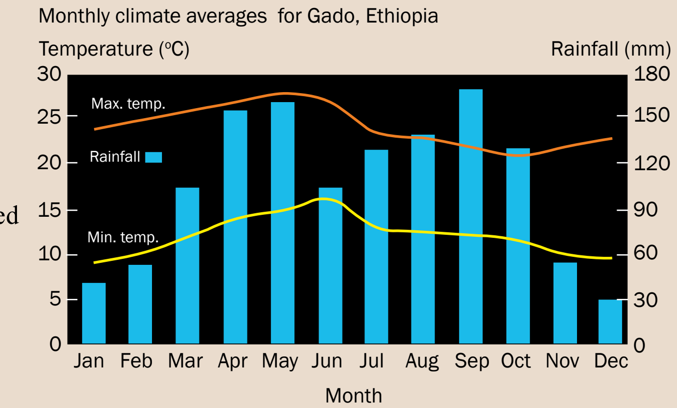
Just how much of this area could be suitable and available for rice cultivation remains to be seen. The relatively flat expanses within the Ethiopian Highlands, the plentiful rainfall, and existing agricultural land, however, suggest that cold-tolerant rice would be beneficial in increasing Ethiopia's rice production and improving food security.



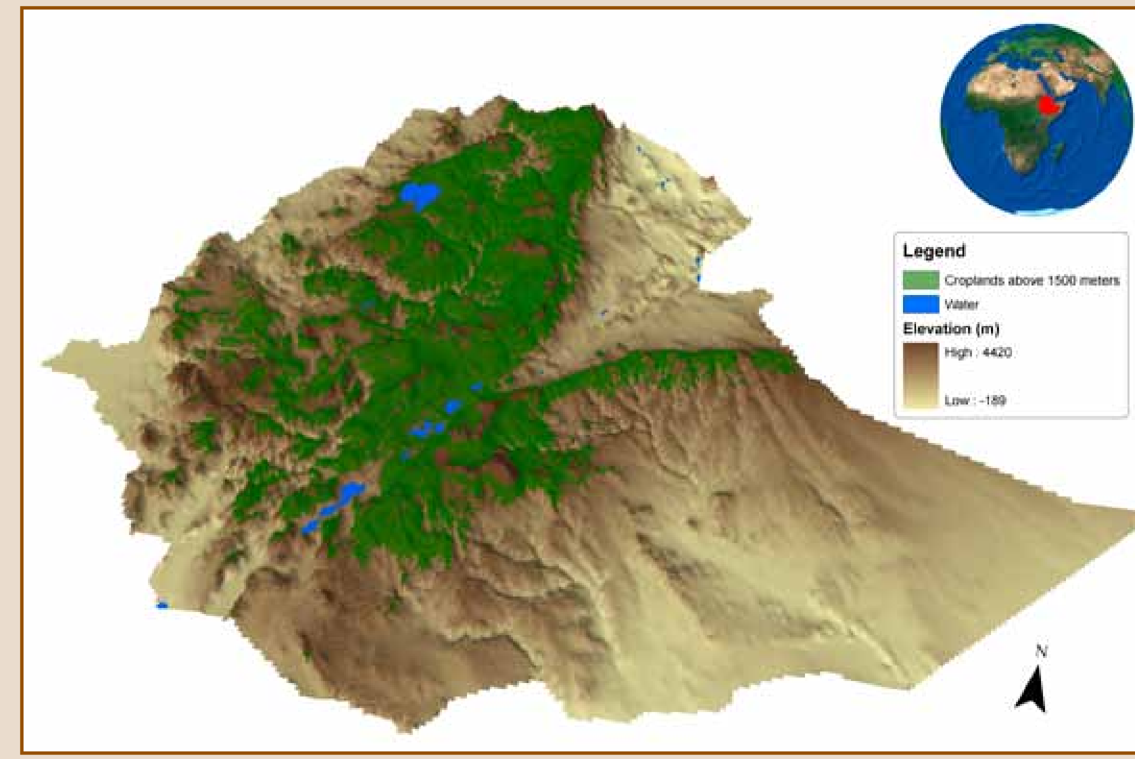
Map 1. Rice-growing areas in the tropical and temperate zones.



Map 2. High-altitude areas in the tropics.



Monthly temperature and rainfall averages for Gado, Ethiopia.



Map 3. Perspective view of Ethiopia, using elevation and highlighting agricultural areas in the highlands.

Dr. Nelson is a geographer, Mr. Rala is an associate scientist, Ms. Garcia is an associate graphic designer, and Ms. Asilo is a senior specialist in remote sensing in IRRI's Social Sciences Division.

[1] Areas of rice cultivation came from a global data set of monthly irrigated and rainfed crop areas around year 2000 (MIRCA2000), www.geo.uni-frankfurt.de/ipg/ag/dl/forschung/MIRCA/index.html.
[2] Global data set of land cover for year 2000 (GLC2000), http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php.
[3] World map of the Köppen-Geiger climate classification (http://koeppen-geiger.vu-wien.ac.at/).
[4] Source: NASA Shuttle Radar Topography Mission (SRTM) processed by the CGIAR Consortium for Spatial Information (http://srtm.csi.cgiar.org/).

[5] Data on average monthly temperatures and monthly rainfall from Worldclim (www.worldclim.org/).

Grain POWER

by **Mia Aureus** and **Lanie C. Reyes**

During RG6, geneticists from around the world find ways to power the next agricultural revolution

"The next agricultural revolution will be driven by advances in plant genetics."

This was the reverberating message that International Rice Research Institute (IRRI) Director General Dr. Robert Zeigler impressed upon more than 800 participants at the 6th International Rice Genetics Symposium on 16 November 2009 in Manila, Philippines. Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand officially opened this three-day event. In her presentation, she noted that a concerted effort such as the symposium is necessary because it brings people together to solve problems and learn from the progress of others.

She mentioned that the success of the Rice Genome Project in 2005 marked a milestone in the new era of rice genetics. It became the firm foundation for international research cooperation among rice-loving nations. Since then, the successful sharing of rice genome studies and genomics data has snowballed into advanced technological research on rice genetics worldwide. Her Royal Highness noted that rice genetics is an essential part of finding solutions to the problems of the rice industry. She added that "we must take care of rice genetic diversity around the world to secure the existence of rice on Earth."

Recent events concerning global food security have highlighted rice's essential role in feeding the world's poor and hungry population. According to Dr. Zeigler, the plight of more than 1 billion people stricken with poverty—70% live in Asia and more than 75% live in rural areas—is the driving force behind IRRI's research. Hence, the world needs to find ways to increase rice yield and improve the sustainability of rice production, as this could help alleviate poverty in many nations.

WILLIAM STA. CLARA

HRH PRINCESS Maha Chakri Sirindhorn officially opens the 6th International Rice Genetics Symposium, as well as the start of IRRI's 50th anniversary celebrations.

IIR SPECIAL EVENTS GROUP (2)

DR. ROBERT Zeigler welcomed delegates from around the world to bear witness to another "history in the making," as scientists find new ways to spark the next agricultural revolution.

More than 800 delegates registered for the event.

The road toward global food security, however, promises to be steep and treacherous. Dr. Zeigler cited some 21st-century constraints that the world needs to deal with: less land, less water, land degradation, climate change that results in extreme weather patterns, an increase in fuel and fertilizer prices, and persistent poverty and malnutrition. On top of that is the growing population that further puts pressure on supply.

To counter these problems, rice scientists at the symposium were called upon to put genetics to work. Over the years, IRRI has partnered and collaborated with various scientists to develop rice varieties that are resistant to biotic and abiotic stresses. With its pest management strategies, the Institute continues to work on varieties that are resistant to bacterial blight, blast, sheath blight, brown planthoppers, and tungro viruses. In response to climate change, varieties that are tolerant of flood, submergence, droughts, and salt water, among others, have been developed.

WILLIAM STA. CLARA (2)

DR. DAVID Mackill, IRRI plant breeder, headed the organizing committee that made the event possible.

Moreover, to overcome of malnutrition in poor countries, biofortified rice varieties are also in the works, such as ones with high zinc and iron.

The next agricultural revolution

In trying to keep up with the changing times, rice genetics has proven to be an essential tool for boosting and sustaining rice production. Yet, much about rice still has to be explored to take full advantage of its potential to feed the world. Dr. David Mackill, IRRI plant breeder and head of the symposium's organizing committee, admitted that more genetic information would allow breeders to develop more rice varieties that can withstand drought and floods, that are more resistant to pests, and that can provide higher yields in spite of the limited land and water availability.

In this regard, Dr. Zeigler said, "We cannot overestimate the central role of IRRI's germplasm in the coming generation." IRRI's gene bank now has around 110,000 accessions. The challenge is how to tap into this rich reserve of information and take advantage of its power to bring forth new and better varieties of rice. He quickly noted, though, that rice genetic diversity is not boundless. Some important traits do not exist in the known germplasm.

Enormous challenges lie ahead. And, the world today cannot afford to be complacent. The rice crisis of 2008 continues to serve as a reminder of how, after the Green Revolution in the 1960s, people thought that everything was solved. The lack of investments in agriculture led to an unstable food supply that later on triggered global food insecurity and panic.

Now, as the world moves forward into more uncertain times, Dr. Zeigler said that it is crucial to redouble our efforts. More investments must be made in agriculture again—investments that will sustain future developments. After all, he noted, the agricultural revolution is not a one-shot miracle. It takes many years of hard work.

LOCAL AND international delegates share their knowledge concerning rice genetics to help increase rice production in the future.

IIR SPECIAL EVENTS GROUP

PARTICIPANTS MAKE a quick review of past issues of *Rice Today*.

IRRI@50

1960-2010

50 years of rice science for a better world—and it's just the start!

Compiled by: **Sophie Clayton**

The International Rice Research Institute (IRRI) has embarked on its 50th anniversary celebrations, to draw the world's attention to rice and opportunities to achieve global food security through rice research.

"The plight of over 1 billion people stricken with poverty, 70% of whom live in Asia and depend on rice as their staple food, is the driving force for our research," said IRRI's director general, Dr. Robert Zeigler.

"We must find solutions to help increase rice yields and improve the sustainability of rice production because as rice yields increase, the incidence of poverty decreases," he added.

In 50 years, IRRI's high-yielding rice varieties and other technologies, plus extensive training, have contributed to the doubling of average world rice yields. This has averted famine and prevented millions of hectares of natural ecosystems from being converted to farmland.

"We were honored to have Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand launch our 50th anniversary celebrations," said Dr. Zeigler. "IRRI's achievements would have never been possible without our many partners, including our host nation, the Philippines, and donors from all over the world, and we look forward to celebrating with them."

IRRI officially launched its 50th anniversary in November 2009 in Los Baños, Laguna, Philippines. One of the events that started off its series of activities was the 6th International Rice Genetics Symposium that was simultaneously held in Manila on 16-18 November. During the same month, IRRI also inaugurated its fund-raising campaign in Singapore, where the new IRRI Fund office is located. In December 2009, IRRI headquarters organized a gathering in Manila to thank all its donors and arranged a fiesta in Los Baños to thank all its staff. More activities are planned throughout 2010, culminating with the 3rd International Rice Congress in Hanoi, Vietnam, scheduled on 8-12 November 2010.

ISAGANI SERRANO (3)

IRRI HELD a Fiesta in Los Baños, Laguna, Philippines, to thank all of its staff for their continued contribution and commitment to help IRRI achieve its mission to reduce poverty and improve the environmental sustainability of rice production (13 December 2009).

IRRI HAS launched a 5-year campaign targeting Asian philanthropists to raise US$300 million to support rice research to address food security (25 November 2009).

WOW STUDIO PTE. LTD.

CHRIS QUINTANA

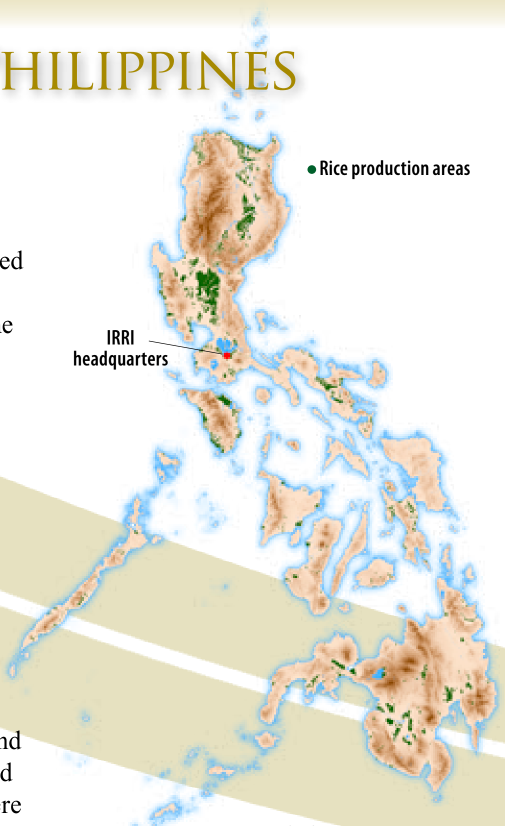
FIFTY YEARS since the signing of the agreement to establish IRRI was celebrated in Manila to thank IRRI's partners for their support (10 December 2009).

COUNTRY HIGHLIGHT:

IRRI in the Philippines

In the 1950s, Los Baños, Laguna, Philippines, was selected as the most advantageous location for an agricultural research program to expand food production in Asia. It was recognized as an emerging hub of agricultural science and economics and the Philippine government proved to be supportive of research, teaching, and extension programs to improve farm management. Subsequently, the International Rice Research Institute (IRRI) headquarters was established here in 1960.

IRRI's headquarters now has modern laboratories and glasshouses, a 252-hectare experimental farm, the Riceworld museum, library, training center, and the International Rice Genebank. Around 1,000 staff are employed at IRRI and, between 1960 and 2008, 1,880 Filipino master's degree and Ph.D. students, trainees, and interns were trained at IRRI.



MAP BY NEL GARCIA AND ARNEL RALA

IRRI has close relationships with the Philippine Rice Research Institute (PhilRice) and the University of the Philippines Los Baños (UPLB). Importantly, many of its field trials and much of its research are done in conjunction with Filipino farmers, who generously share their land and expertise.

Many IRRI innovations are tested first in the Philippines, through PhilRice, such as aerobic rice, submergence-tolerant rice, and alternate wetting and drying techniques. PhilRice is a prominent partner in technology delivery and it is often the first recipient of IRRI research.

Helping Philippine rice production with IRRI science

Most of the Institute's research is relevant to Filipino farmers. Some highlights follow:

New rice varieties

IRRI has provided the Philippines with more than 75 rice varieties. In 2009, three new stress-tolerant rice varieties, flood-tolerant, drought-tolerant, and salt-tolerant varieties, were officially recommended for approval for commercial cultivation in the country.

Smarter fertilizer use

Fertilizer has a significant effect on rice yield and accounts for about 20% of input costs in rice production—the biggest after labor. In collaboration with PhilRice and UPLB, IRRI has developed Nutrient Manager for Rice, which is a customized Web-based tool that helps Filipino rice farmers identify how much fertilizer to use, which type, and when to apply it to improve rice yields and save money.

Sharing seed

IRRI houses the International Rice Genebank, where more than 109,000 different types of rice are maintained to conserve genetic diversity and ensure that it is available to help improve rice crops in the future. Excluding IRRI-bred materials, the collection includes 4,670 rice samples from the Philippines, comprising around 4,070 traditional varieties, 485 modern improved materials, and 115 wild relatives.

IRRI can provide rice samples free of charge upon request under the International Treaty on Plant Genetic Resources for Food and Agriculture, which facilitates access to genetic diversity, while ensuring appropriate sharing of the benefits that arise from its use.

Water-saving technologies

In November 2009, the Philippine government agreed to the Guidelines for the adoption of water-saving technologies in irrigated rice production systems in the Philippines.

This agreement mandates the application of water-saving technologies, particularly alternate wetting and drying (AWD), in irrigated rice systems throughout the country. AWD can reduce water use 15–30%.

> *"Rural development, poverty alleviation, and eradication of hunger have been a shared mission of our respective institutions. We have become not just your [IRRI's] host but your partner. You are not our guest but a valued friend and our friendship will remain stronger as IRRI celebrates its golden anniversary."*
>
> *Luis Rey I. Velasco*
> Chancellor
> University of the Philippines Los Baños (UPLB)
>
> *"After 50 years of IRRI and almost 25 years of PhilRice, our two great institutions have developed an important partnership, which we want to build on into the future to bring about better rice productivity, profitability, sufficiency, and sustainability, through research and development in the Philippines."*
>
> *Atty. Ronilo A. Beronio*
> Executive Director of PhilRice

Conducted by Gene Hettel

GENE HETTEL (4)

The trouble with you economists!

On a hot day in July 2009 on the campus of Cornell University, Randy Barker and Robert Herdt, former agricultural economists at the International Rice Research Institute (1966-78 and 1973-83, respectively), got together to reminisce about their days at IRRI and to reflect on the evolution of research in the social sciences at the Institute. Doing his homework ahead of this dialogue that I arranged, Dr. Barker wrote down some key recollections, which are excerpted here.

When I was an agricultural economist at Cornell University in 1965, I agreed to go to Los Baños [Philippines] with my family for two years as part of the University of the Philippines College of Agriculture–Cornell Exchange Program (UPCO). Next door to the college was the newly established International Rice Research Institute (IRRI). The Ford Foundation representative on the IRRI Board, Frosty Hill, had insisted that there be a position for an economist. So, in 1963, Vernon Ruttan was hired as IRRI's first economist (in the mid-1970s photo *at right* with me and Bob Herdt, *left*). But, after two years, Ruttan had to return to the States. In mid-1966, Bob Chandler, the IRRI director general, offered me the position. IRRI and Cornell reached an agreement that I would work half-time for each until the two years were up in 1967, after which I would be full-time at IRRI.

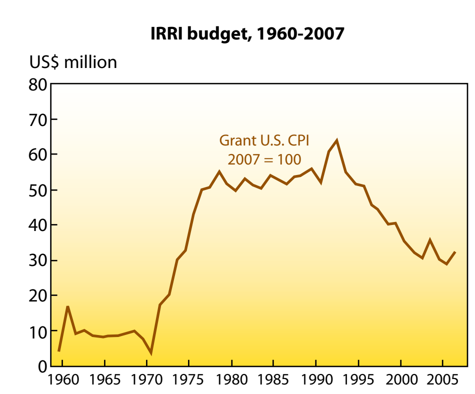
BARKER ARCHIVES

The early years

Ruttan had laid a good foundation for research and had established contacts with economists elsewhere in the Philippines, particularly at the University of the Philippines School of Economics in Manila. Even after joining IRRI full-time, I continued to teach one course a year at the College of Agriculture and an occasional course at the School of Economics—a good two hours or more drive from Los Baños. There was method in my madness. Through teaching, I was able to identify promising graduate students to come to IRRI to do their thesis research with us.

When I joined IRRI in 1966, no one had ever heard of the place, and many at the College looked across the railroad tracks and over the fence and wondered if anything useful would ever come out of the fancy buildings and housing. The establishment of IRRI reflected growing concerns about food security in Asia. Bob Chandler kept a tight grip on the reins and we had a sharply focused mission—increase rice production in Asia.

In August 1966, we released IR8, the first of the so-called semidwarf varieties, and that changed everything. Joining IRRI was like buying a penny stock that suddenly took off. The big jump in the IRRI budget came in the 1970s when Nyle Brady was director general (see IRRI's budget graph, 1960-



2007). Because of concerns about the consequences of the Green Revolution, there was even more money for the social sciences.

I joined IRRI at a time when the agricultural scientists, such as Norm Borlaug, thought that economists were part of the problem, not part of the solution. The last thing they wanted was to have an economist dealing with policy issues. So, my first task was to build some bridges.

Much of our research dealt with farm surveys. Lloyd Johnson, head of IRRI's Agricultural Engineering Department [1960-68], with the help of Stan Johnson [no relation], had initiated the "loop survey," a frequent survey of rice farms along the national highway in Central Luzon to observe their farm practices, particularly in land preparation. Stan Johnson [1966-68]—and later Bart Duff [1970-90]—was the economist assigned to the Agricultural Engineering Department to work specifically on the economics of mechanization. Covering the same loop in 1966-67, we initiated a farm household survey. This survey has been conducted about every five years, even to this day, to track changes in farming practices, yields, costs, and returns.

Also, in a number of years, we conducted an experiment on the experiment station. I argued with the administration that our objectives and experimental designs would be different from those of the agronomists; not the usual analysis of variance, but more points on the production function. One day, Bob Chandler, who had been out in the field with a visitor, called me in to his office because he wanted to know why there were so many weeds in some of our plots. I said those were my low-input treatments, and he seemed to be satisfied. After a while, Ronnie Coffman, IRRI plant breeder [1971-81], coined the acronyms ZIP (zero inputs), LIP (low inputs), and HIP (high inputs), but they never caught on with the agronomists. Conducting experiments helped me to better understand the problems and to learn the tricks of the other scientists.

During this early period, I learned a lot from Lloyd Johnson, an engineer with a broad range of research interests—mechanization, water management, farm survey, and experimental design. Johnson was one of the first staff members hired by IRRI in 1960 to develop the 80-hectare experiment station. In 1967, USAID gave a large grant to IRRI to work specifically on mechanization. A short time later, Johnson left IRRI for the International Center for Tropical Agriculture (CIAT) in Colombia. This left a big hole, particularly in the area of water management.

In 1972, we had an opportunity to hire a second economist. We picked Tom Wickham, a young agricultural engineer at Cornell, who had a minor in economics. The engineers at IRRI were working on mechanization, but I figured that, if we were doing research on rice, we certainly should be doing research on water management. Wickham had done his thesis research in the Philippines as a part of the UPCO exchange program. Water management research was in the Agricultural Economics Department for two or three years, but, under Wickham, it soon developed into a separate department Wickham later became the first director general of the International Irrigation Management Institute (IIMI, now IWMI), established in Sri Lanka in 1984.

After hiring Wickham, and with my own activities, I felt that we were becoming too interdisciplinary. With the hiring of Bob Herdt, another up-and-coming Cornell economist, and later Yujiro Hayami, we restored the balance. In mid-1973, I returned to Cornell for a one-year sabbatical leave. Herdt was hired until I returned, and fortunately he decided to stay on for ten years.

Constraints and consequences

We had two main projects in the department—"constraints" and "consequences." Why weren't some farmers adopting the technology? Who were the farmers benefiting from the technology? There was a good deal of discussion and research on "consequences" and a number of conferences on the pros and cons of the Green Revolution both inside and outside of IRRI. And, as pointed out earlier, funding was adequate. Research on consequences produced some interesting results. Critics of the Green Revolution argued that only the large farmers and landowners would adopt and benefit. We found that the rate of adoption was just as high or even higher among small farmers and tenant farmers. In fact, the plots nearest the house seemed to give the highest yield.

The research on "constraints" was Bob Herdt's main focus and it led to a unique IRRI contribution in both methodology and research results. For four years, Bob and I worked with S.K. De Datta [IRRI agronomist, 1964-92] and Kwanchai Gomez [IRRI head statistician, 1968-1993] on "constraints to high yield." We called ourselves "the gang of four" (photo below shows gang reunion at Cornell in 2000) and conducted experiments in farmers' fields in six different countries to see if the yields from our level of inputs would beat their yields. Most farmers, in general, were doing quite well though in spite of underinvesting in fertilizer in the dry season. However, the expenditure on insecticides in most years did not justify the cost, a finding that would be proven time and again in the future.

In 1974, I convinced my Iowa State University classmate Yujiro Hayami to come to IRRI for two years. I consider Hayami to be, perhaps, the best agricultural economist in Asia. Not only is his mind better than mine, he can also beat me on the tennis court. What distinguishes Hayami is his ability to do very macro development research and very micro farm-level research. Even after returning to Japan and writing his seminal book with Vern Ruttan, Agricultural Development: An International Perspective, he has continued his research involvement at IRRI. With Masao Kikuchi, he published A Rice Village Saga: Three Decades of the Green Revolution in the Philippines.

BARKER ARCHIVES

Hayami and I delved into the policy area in the mid-1970s, advising the Philippine government (secretaries of finance and agriculture) on fertilizer pricing. It was just a matter of understanding the fertilizer/rice price ratio. Some may have forgotten that we had an energy crisis in the 1970s similar to what we have experienced recently. The Philippine government had rushed out and imported a lot of fertilizer, which couldn't sell at the purchased price. Then Agriculture Secretary Arturo Tanco invited me to a meeting where they planned to make a decision. I declined, saying that this was their decision. I read the next day in the papers that they had lowered the fertilizer price. This was, I believe, the only time in my life I had a direct influence on policy.

After I left IRRI in 1978 to return to Cornell, Herdt took over as head, who, in turn, departed in 1983 to become science advisor to the Consultative Group on International Agricultural Research Secretariat. Later, he joined the Rockefeller Foundation as director of agricultural sciences and he now works "in retirement" at Cornell.

IRRI continued to obtain the services of excellent social scientists: John Flinn [IRRI economist, 1978-91]; Christina David, whom I hired as a research assistant, went on to earn her Ph.D. under renowned economist Peter Timmer at Stanford and, after leaving IRRI, is still doing quality research on the Philippine agricultural economy; Prabhu Pingali, who left IRRI for the Food and Agriculture Organization (FAO) and is now the head of agricultural policy at the Bill & Melinda Gates Foundation; David Dawe, another of Peter Timmer's students, who left IRRI to join FAO; and Mahabub Hossain, who left IRRI to become executive director of the Bangladesh Rural Advancement Committee (BRAC), which today is one of the largest Southern development organizations, employing more than 120,000 people.

"Back home" at IRRI

Recently (June 2007 to June 2008), I had the opportunity to return to IRRI as acting head of the Social Sciences Division (SSD). Mahabub Hossain had returned to Bangladesh and IRRI was searching for a new SSD head. So, here I was 30 years later in the same old job—well, not quite.

Many people asked me, "What was it like to be back in Los Baños again and working at IRRI?" I looked at this question from two perspectives: you can't go home again—back home to the old form and system of things, which once seemed everlasting but is changing all the time (Thomas Wolfe, 1940, You Can't Go Home Again), and "the more things change, the more they stay the same—and you can go home."

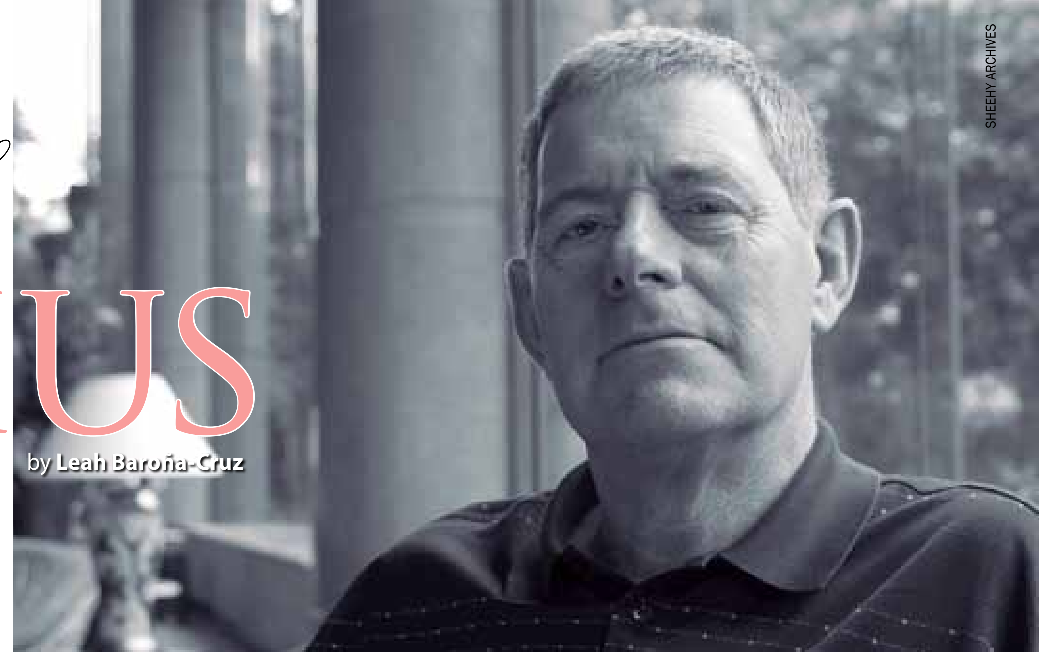
When I read the local Philippine newspapers, the Star, the Inquirer, the Bulletin, it seemed that nothing had changed. The same old families were running the country and arguing among themselves. Corruption was rampant. (Of course we have corruption in the United States, but much of it is legal). From the outside, IRRI—both the Institute and the staff housing—looked much the same as when we had left in 1978. There were a few additions here and there and, of course, the trees had grown. At the guest house, where I stayed, the Western-style menu for meals, I think, had been set back in the 1960s. Two of the staff there remembered my children from the 1970s. I began to think, "Maybe I can go home again." But that was before I went to the research center itself to see what was going on.

The trouble with you economists…

One day, about the time that rice prices were reaching unprecedented highs in February 2008, due, in large part, to the rise in oil prices and to the underinvestment in research over the past several years, I was in IRRI Director General Robert Zeigler's office. He started the conversation: "The trouble with you economists…" (I thought to myself, how many times have I heard that? But I never heard anyone say, "The trouble with you plant breeders or the trouble with you plant pathologists."). Bob went on: "The trouble with you economists is that you are always looking back, you are never looking to the future." I said, "Bob, you should feel lucky; we economists are very bad at predicting the future." To verify this point, economists failed to predict the current "financial crisis" that occurred just a few months later.

Go to www.irri.org/publications/today/Barker.asp for the full chronicle of Dr. Barker's IRRI reflections, including why perhaps one can't go home again, the importance of other social sciences beyond economics, a rundown of the excellent social scientists who have served IRRI over the years, and the new language of impact assessment. Also at this Web location, find links to selected clips and the full 1:15-hour video of the engaging and enlightening conversation between Drs. Barker and Herdt.

A legacy of GENIUS



SHEEHY ARCHIVES

by Leah Baroña-Cruz

John Sheehy's creative brilliance leaves more than just blueprints of a whole new kind of rice plant

Before C_4 rice even made it to the drawing board, John Sheehy was already quite famous among his peers for his insight, boldness, and "that perverse paper." Nevertheless, the time has come for C_4 rice, and John's name is now irreversibly entwined with it.

Improved rice varieties and technologies have more than once saved many nations from sure famine. However, as world population continues to grow and rice production struggles to cope, new ways of multiplying global food resources are needed.

The boy who cried C_4

Somewhere near London, during World War II, a boy to be named John Sheehy was born. More than 60 years later, the world finds him waving a flag, not in surrender to this era's woes, but to rally support for an idea that just might become this generation's best shot against hunger—C_4 rice.

C_4 rice is the ultimate goal of rice scientists' attempt to supercharge photosynthesis—the process by which a plant uses sunlight, carbon dioxide, and water to produce carbohydrates—in rice so that it yields more grain. Rice, a C_3 plant, uses these resources far less efficiently than C_4 plants (e.g., maize) do. A C_4 rice plant would use less water and fertilizer and produce at least 50% more grain.

A hairy idea

Hypothetically, if one can change an organism's metabolism so that more of the raw materials captured can form useful tissue and less goes to waste, crop yields would increase. Rice, the staple food of millions in Asia and Africa, must be first in line for the makeover.

The C_4 rice idea was met with measured enthusiasm and, quite predictably, much skepticism. But John always knew that this whole concept of modifying photosynthesis in rice needed some stout defending. So, he thought that a little "extreme breeding" couldn't hurt.

It was a brazen idea, like time travel, perhaps. The mere audacity of the project is hardly a selling point. But that of the proponent is another story.

John was convinced that C_4 rice was possible, and he made such a good case that a project and the C_4 Rice Consortium (http://C4rice.irri.org)—a group of brilliant scientists from advanced research institutions around the world—were soon established. In fact, this once big hairy idea is now supported by the Bill & Melinda Gates Foundation, which provided US$11 million to further the research.

Artsy academic

John was born of Irish parents, who met in England just before World War II broke out. His father was then in the Royal Air Force. During the war, John's mother took him to her family's farm in Ireland to escape the bombing. After the war, the family moved to Wales.

Despite spending some of his early years on an 80-hectare farm in Ireland, John did not have the remotest brush with agriculture in college. At the University College of Wales, he studied physics and went deeper into it before he picked agricultural botany as a Nuffield Foundation Fellow to study alongside physics for his Ph.D.

A FLAIR for drama. John (*right*) in one of his theater performances in university.

UCW DRAMA CLUB

Though largely an academic, John was always interested in the creative side of things. While steeped in physics in university, he also got involved in drama and dreamed of doing memorable work in advertising. And he eventually did his bit. A little-known fact is that he, with others on a public relations committee many years later, came up with the International Rice Research Institute's (IRRI) enduring slogan, "Rice science for a better world."

"Perverse scientist"

Some think that John Sheehy's signature peach and pink shirts and his easy manner are a ploy to dilute hostile attention. Those who know John beyond those gentle hues know that he is anything but mellow. A case in point is his quite popular 1999 paper, *The universe, the evolution of the perverse, and a rice problem*—John's 18-page treatise on how a scientist in this age of cost-efficiency and milestones tends to find more roadblocks than inroads to discovery and invention (see http://tinyurl.com/johnsheehy).

"That perverse paper," as it has come to be known, was also a commentary that reflected his unorthodox views on research, scientists, and organizations. John saw that, on the way to becoming a system and a structure, the science of the Consultative Group on International Agricultural Research (CGIAR) nearly lost its most valuable tool—creativity.

Creativity, John explains, is not continuous but occurs in bursts—something that modern science management somehow ignores in its institutions. Scientists have well-equipped laboratories and modern tools, but all too often too little room to think and maneuver outside of their assigned projects.

"Science is a highly creative discipline," he declares in the paper. John posits that scientists, if they are to be true to their vocation, must try to resist the tyranny of data accumulation (measure everything you can think of and the answer will be found) and discipline their thoughts to be creative—hence, perverse.

"Scientists who would be inventive tend to be difficult," John elaborates, "and great organizations like IRRI have to accommodate that."

The paper included an example of how a simple change in approaching scientific problems could overturn even long-held scientific theory, such as when John's team discovered that rice is triphasic and not biphasic, as universally believed.

It was not the first time that John disproved something that was somewhat set in stone in modern science. Previously, while he was in the UK, John and his team uncovered a major error in the technique widely used for measuring nitrogen fixation and went on to discover what controls nitrogen fixation in legume root nodules.

John believes that the genuine test of a theory would be an attempt to falsify it, and his penchant for questioning accepted theory did not exactly make him the darling of rice research. He confessed that, although some of his peers were impressed by his views, he also alienated himself. "I have had some lonesome moments," he laments.

Rock star

Despite John Sheehy's lone-ranger tendencies, the people who worked with him credit their strong and close-knit team to their former leader.

"John is the type of boss who listens," says Jacque Dionora, senior assistant scientist of the C_4 project. "He lets every member of his crew—down to the humble research technician—know that his tasks and opinions matter."

Naids Ferrer, assistant manager for the project, sheds light on an old coffee shop mystery in IRRI: "John always spends for our Christmas celebrations. But when the team grew in number, we could no longer let him shoulder the costs. So we started raising money by making everyone on the team wear a certain color for each day of the week and violators had to pay a fine.

"In those days, John often took the whole crew to the IRRI coffee shop," continues Naids. "People would stare because we were in line for coffee all wearing the same color. Such gestures increased team morale, and we developed a bond with John that we knew was the envy of many research staff. That was priceless."

JOHN IN the C_4 screenhouse with his loyal crew, once more showing solidarity, this time, in white.

CHRIS QUINTANA

After IRRI

John had already planned to keep himself busy in retirement—help his daughter run her PR company, learn more about his grandparents, enjoy good wine in Italy and learn the Italian language, polish his French, and hunt down old friends in Wales.

John will be at IRRI for three months each year as a consultant for the C_4 rice project and he resolves to continue to play golf on the side as much as tropical weather permits.

"Foresee"

At the beginning of his career, in his Ph.D. studies, John concluded that in the quest for higher yields it would be better to select for erect leaves rather than leaf photosynthesis. He finds it ironic that—although that strategy was correct—he ends his career seeking to supercharge photosynthesis to make the next quantum leap in yield.

Note that "C_4" is pronounced "foresee" in reverse. The idea holds great promise, and the fact that it is actually getting support is an example of the collective "fight" instinct of international agricultural research. How does John feel about this?

"It's nice to leave with a success," he says simply.

John retired in July 2009 as head of the Applied Photosynthesis and Systems Modeling Laboratory in IRRI. He leaves IRRI, after 14 years, with more than blueprints for a whole new kind of rice plant. He leaves a teaser for better times ahead.

R. RAMAN, AFRICARICE (2)

(*Left*) AfricaRice investigates the climate-resilient traits of the indigenous African rice, *Oryza glaberrima*. (*Right*) Most of the rice farmers in sub-Saharan Africa are women. Through participatory approaches, they have become very much involved in AfricaRice's research on stress-tolerant rice.

Adapting to change

by Savitri Mohapatra

Africa develops climate change–resilient rice technologies

For Glégnon Codjo, a smallholder rice farmer in Benin, climate change is not a matter of debate. It is fast eroding his source of livelihood. "Our seasons have gone crazy: either the rains don't come when our crops need them or there is so much rain that our crops rot," he laments. "I thought God was angry with us. But now, I am told that all this is happening because of climate change."

Like Glégnon, millions of smallholder farmers in Africa are increasingly grappling with the changing climate around them. Scientists predict that climate change will make extreme weather conditions—such as floods and droughts that can erode soil and lead to crop failure—more common.

When combined with the natural vulnerability and poor adaptive capacity in Africa, these impacts on agriculture could have devastating consequences for food security, poverty, and social welfare. Therefore, climate change is likely to have a far greater impact here than in other parts of the world.

Scientists, governments, and donors need to take urgent measures to improve the resilience of rural African communities to enable them to better adapt to climate change.

Rice is increasingly becoming important in Africa—both as a food and cash crop—and increased rice production will be crucial to achieving the necessary adaptation. Rice production in the region, however, is affected by such stresses as drought, salinity, and extreme temperatures, all of which are expected to worsen with climate change. To adapt successfully to climate change, farmers need rice technologies with greater tolerance of these stresses.

Since these stresses have always posed a significant threat to rice production, the Africa Rice Center (AfricaRice) has been developing for several years now rice varieties adapted to local stresses and more efficient farming techniques to help poor farmers better manage their use of the increasingly scarce water and fragile soil in Africa. Their efforts are now paying rich dividends.

The African cultivated rice species *Oryza glaberrima* is a rich reservoir of useful genes for resistance to major stresses. This discovery led AfricaRice scientists to cross the African rice species with the higher-yielding Asian *O. sativa*, which resulted in the birth of a generation of new rice varieties, called NERICA®. The NERICA varieties are promising for rainfed systems in Africa. Farmers like these varieties because they mature early and thus often escape drought.

Using both conventional breeding and biotechnology, AfricaRice scientists continue to develop rice varieties that are even hardier than NERICA by maximizing the diversity of the African rice germplasm pool consisting of *O. glaberrima*, its wild relatives (*O. barthii* and *O. longistaminata*), and *O. sativa* landraces. These offer a massive potential for use as sources for resistances to major stresses in rice.

New scientific tools, such as molecular biology techniques, help speed up the development of new stress-tolerant rice varieties as they enable AfricaRice breeders and their partners to more efficiently identify and select genes that control stress tolerance. Because of this, the scientists can then successfully transfer the desirable traits from the African rice gene pool into popular varieties.

This work is closely allied with the farmer participatory approach, which is highly effective in ensuring that rice improvement also takes into account farmers' valuable local knowledge. It is crucial for these new varieties to suit local needs and preferences.

"Thus, climate-resilient rice varieties resulting from this work have already reached farmers' fields, and more are in the making," said Dr. Baboucarr Manneh, AfricaRice coordinator for the IRRI-AfricaRice joint project on "Stress-tolerant rice for poor farmers in Africa and South Asia (STRASA)."

The STRASA project, which involves 14 African countries and three South Asian countries, is funded by the Bill & Melinda Gates Foundation through the International Rice Research Institute (IRRI). It aims to accelerate the development and delivery of improved rice varieties tolerant of five major stresses—drought, submergence, salinity, iron toxicity, and low temperature. Thanks to this project, new stress-tolerant rice varieties are now being evaluated in farmers' fields using the farmer participatory varietal selection approach.

However, integrated crop and soil fertility management strategies still need to be developed and disseminated to realize the full potential of climate-resilient varieties of rice and also to stabilize yields and reduce environmental degradation arising from climate change in rice ecosystems.

AfricaRice has developed an integrated crop management (ICM) approach for irrigated and rainfed lowlands. Significant gains in yields and profits from ICM have been obtained across the continent.

A study by AfricaRice demonstrates that a paddy irrigation regime that starts with the traditional flooding practice and then changes to alternate wetting and drying later on can save water with little or no yield loss in a Sahelian environment, provided weeds are controlled.

AfricaRice is closely involved in a multipartnership project on "Developing rice and sorghum crop adaptation strategies for climate change in vulnerable environments in Africa" (RISOCAS), which is led by the University of Hohenheim. This endeavor is carried out in partnership with the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) for crop modeling. It aims to deliver coping strategies for crops to adapt to changing climatic conditions, along with tools and methods that will enable stakeholders to develop such strategies further, or to apply them to other crops or environments.

As part of a new project to be launched in 2010, AfricaRice will initiate a study on the relationship between rice diseases and climate change. Two of the major rice diseases affecting the region are rice blast and bacterial blight. Both are greatly influenced by climate, especially temperature and humidity. Funded by Gesellschaft für Technische Zusammenarbeit, the project will be carried out in Uganda, Rwanda, and Tanzania in collaboration with German universities and IRRI.

"We are also planning to get climatologists and geographic information systems (GIS) experts more involved in environmental characterization," explained Dr. Paul Kiepe, the focal person in charge of climate change–related research at AfricaRice. "More precise predictions of future climate patterns are needed in this research that aims to develop climate-resilient, rice-based technologies."

AfricaRice continues to find and improve technologies for resource-poor farmers in Africa that are suitable and effective in reducing the negative effects of climate change on rice production and marketing.

The global rice market: WHERE IS IT GOING?

IRRI steps up its rice research to provide better analysis concerning global rice markets

by **Samarendu Mohanty** *Head, IRRI Social Sciences Division*

Global rice prices started moving upward in November 2009 after months of steadily declining since reaching their all-time high in May 2008. Supply problems in some major rice-producing countries, namely, India and the Philippines, have been the primary reason for this reversal of price trend. Two major typhoons hit the Philippines in late September and early October, causing damage to rice crops on the ground and also in storage to the tune of one million tons. Similarly, the worst drought in India since 1972 is estimated to have reduced the 2009 kharif (wet-season) crop by at least 15 million tons from a total of 85 million tons in the previous kharif season. The supply problem has been compounded by major floods caused by torrential rains in the southern states of Andhra Pradesh and Karnataka. Unfortunately, Andhra Pradesh, one of the major rice-growing states in India, was affected first by drought and then by flood. According to the Hindu Business Online last 17 October 2009, the state government placed the current kharif crop at 4.8 million tons compared with 8.3 million tons in 2008.

Three tenders from the Philippines amounting to 1.5 million tons and three small tenders from Indian state trading agencies amounting to 30,000 tons rattled the market in November 2009. Although India later canceled these tenders, citing higher price as the reason, the fact that India is in the market to purchase rather than to sell is likely to have a large effect on the market. In response to these fresh tenders, global rice prices increased by 15–20 percent during November 2009, with the Thai 5% rice price rising by almost 18 percent (Fig. 1).

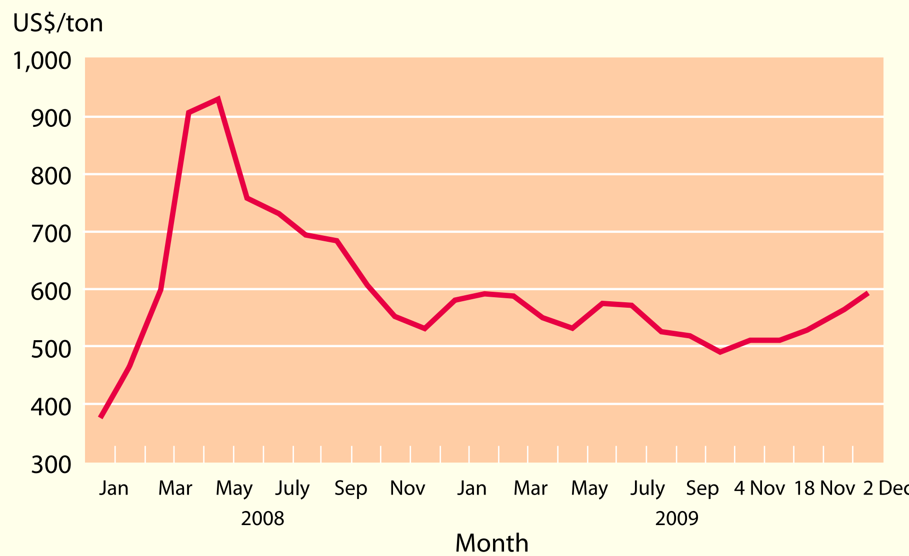


Fig. 1. Thai 5% rice price.
Data source: World Bank and Thai Rice Exporters Association

How high can the price rise? Will it reach the magic number, "US$1,000 per ton," that was witnessed during the last crisis? Frankly speaking, it is difficult to predict future price movement, but one thing is very clear: current global rice stocks are much higher than in 2007. In the last two years, stocks have increased by more than 16 million tons, from 75 million tons in 2006 to 91.5 million tons in 2009, with China, India, Indonesia, and Thailand accounting for most of the increase (see Fig. 2). This may imply that the market should be more stable now than in 2007. Unfortunately, most of these additional stocks, with the exception of Thailand, will not be available to the market in case prices start to rise. Note, however, that even though Indian stocks are not available to the international market, these stocks provide much-needed relief to the market—Indians do not have to turn to imports, at least in the near term, because they have enough at their disposal.

Nevertheless, market sentiment is very upbeat right now. It is safe to say that the rice price is not going back to $300 per ton any time soon and is likely to remain around $600 per ton in the near term. Ultimately, the extent of the price rise will depend on how countries respond to market hype. In the larger interest of global food security, rice-importing countries should refrain from making large purchases at one time and should import in smaller volumes as need arises. On the same note, rice-exporting countries should ensure a steady stream of supply to the market and refrain from using export restrictions or any other form of intervention to keep domestic supply out of the international market.

The commentary presented above merely reflects my opinion—not any rigorous analysis. Information such as this will continue to play a vital role in swinging the market one way or another. For rice, a staple source of nutrition for more than half of the world's population and a source of livelihood for two billion people, the wild swing in prices is a serious concern for policymakers in developing countries. The recent rice crisis is an example. The tripling of rice prices between November 2007 and May 2008 pushed an additional 100 million people below the poverty level.

We at the International Rice Research Institute (IRRI) are frequently asked about current crop conditions and how things are likely to pan out in the near future, as well as other market-related information. Now, we do not have the analytical capability to provide information on rice

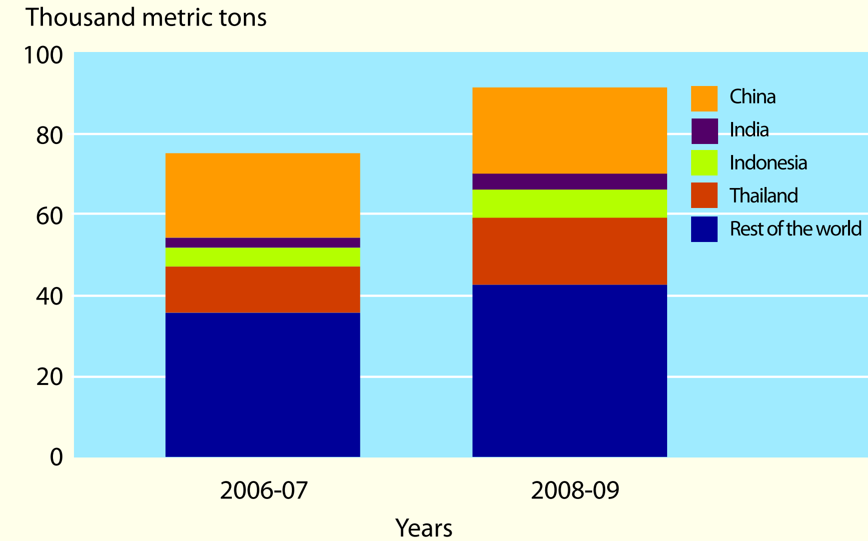


Fig. 2. Global rice stocks.
Data source: USDA.

supply, demand, and markets. However, as the premier rice research organization in the world, IRRI is uniquely positioned to provide unbiased and accurate information on the current and future conditions of the global rice market, policy impacts, and food security. IRRI also has the advantage of having field-level data and information on current crop conditions, disease problems, and other issues affecting the rice crop in various Asian countries that have implications for the global rice market. More importantly, IRRI's constant awareness of ongoing technological and varietal developments and their possible effects on future rice yield growth makes us a leader in this area.

Earlier this year, IRRI started a new initiative to develop a digital rice information gateway. This gateway aims to provide a real-time crop monitoring and forecasting platform by combining modern techniques such as satellite-based remote sensing with weather and crop modeling, and econometric modeling. The system will be capable of generating short- to medium-term projections of production, consumption, trade, and prices under different domestic and trade policy regimes and macro conditions. In addition, policy simulations and assessments of the impacts of technology interventions can also be conducted using the framework.

Expected impacts

Through this project, we hope to be able to provide real-time information on rice area and production that will lead to a smooth functioning of the global rice market. This will also allow us to promptly alert policymakers against impending crises should we find supply levels unstable. Moreover, the regular updating of medium-term supply, demand, and price projections will assist government agencies, agribusiness, and others in their respective medium-term planning. As this initiative will ensure the timely availability of policy briefs, policymakers should be able to make more informed decisions. Finally, it will also contribute to the capacity-building of national agricultural research and extension system partners for rice market outlook studies and policy analysis.

Progress so far

The initial phase of the work has involved developing a structural econometric model of the global rice market. We intend to continue expanding the econometric model and also expect to start working on other components of the rice information system, GIS, and remote sensing and crop growth models, as soon as funds are secured. Our target is to make the complete system operational by mid-2011. In the meantime, we will be using the econometric model to develop medium-term market outlook and policy analyses.

A snapshot of our recent preliminary medium-term outlook suggests that rice prices will continue to rise as production fails to keep pace with demand growth because of low yield growth and limited area expansion. The deficit will be met by drawing down buffer stocks. This is different from what happened in the past, wherein yield growth lagged behind consumption growth and area expansion supplemented production to meet global needs (see Fig. 3). Since area expansion has slowed down significantly in recent years and current global rice area is at an all-time high, it is logical to assume that rice area will remain at this level or even decline in the future because of water scarcity and competition from other agricultural and nonagricultural uses such as industrialization and urbanization. This reaffirms our long-time argument that productivity growth needs to be revitalized to keep rice affordable in the future.

For regular updates on market and policy briefs, visit us at www.irri.org.

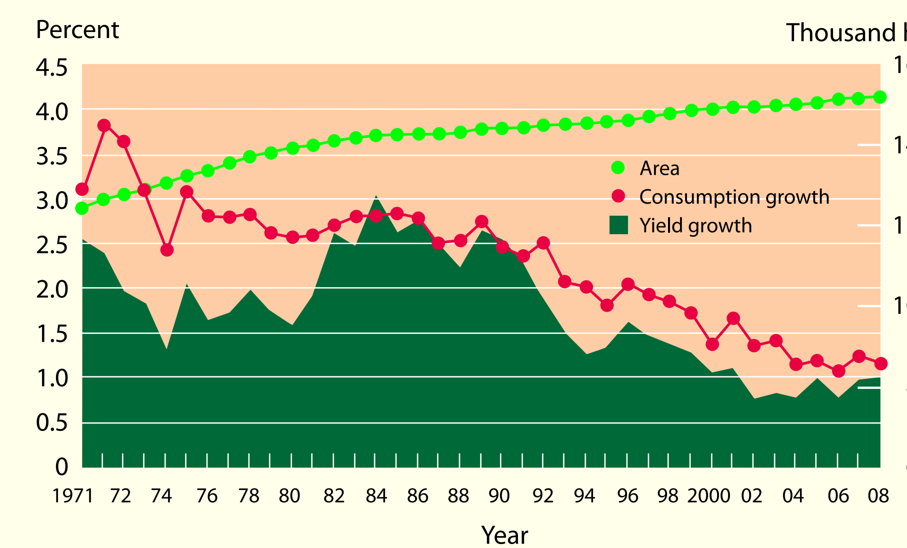


Fig. 3. Global rice food security: area vs. yield growth.*
*10-year moving average
Data source: USDA.

Climate change and supply concerns dominate World Rice Conference

by **V. Subramanian**

Emphatic call made for stronger food security foundations

The first World Rice Conference organized by The Rice Trader in Mactan, Cebu, Philippines, on 27-29 October 2009 featured extensive analysis of demand and supply scenarios from major and emerging rice exporters, and revealed the first rice tasting competition. The event was dominated, however, by speculation about India's future rice output and the Philippines' damage on the back of three tropical storms (two before the conference and one immediately after).

Philippine Secretary of Agriculture Arthur C. Yap kicked off the event with an emphatic call for stronger foundations for food security such as a global rice reserve. He said that the global rice industry has to deal with climate change and its impact on rice production vis-à-vis the mammoth task of ensuring food security and helping ease the plight of the poor. Citing the billions of dollars spent by the U.S. government to bail out a banking industry that caved in under self-created pressures, Secretary Yap was certain that even a small portion of that fund would do well in arming the global food industry with the necessary tools to counter food insecurity and the consequent commercial pressure on prices. Such an investment would also help power a second Green Revolution, which is an absolute necessity now. Pleased with the work of the International Rice Research Institute (IRRI) and its continued support for rice production initiatives, Secretary Yap called on members of the business sector to help fund rice research.

The global rice industry faced two massive blows to output in 2009—India's delayed monsoon and the tropical storms that damaged the Philippines' harvests. A stronger El Niño is expected to aggravate rice production uncertainties in 2010. In light of this, Secretary Yap was joined by a chorus of speakers who shared concerns about future output, weather anomalies, and their collective impact on a market already rattled by the series of events that led to the aptly named "rice crisis" of 2008.


THE RICE TRADER (3)

Mr. Jeremy Zwinger, President and CEO of The Rice Trader and publisher of *Rice Today*, said that as traders try to be cautious, delays in buying decisions coupled with disruptions in supply could put more pressure on market prices. Mr. Zwinger said that quick price movements reflect a fluid situation in demand and supply fundamentals, as prices constantly adjust to perceived surpluses and deficits that in fact simply reflect a finely balanced, or "thin," global market.

Highlighting India's significance in this trade balance, Dr. Samarendu Mohanty, senior economist and head of IRRI's Social Sciences Division, noted in his analysis that India could possibly import soon to satisfy food security needs given the shortfall in production caused by the delayed monsoon. As suggested by the conference speakers, more information about the harvest would shed more light on expected Indian demand. At the time of this writing, India's production expectations rose by 2.2 million tons and Indian government officials also began to challenge the need for imports. According to the Food Corporation of India's official statement on 22 December 2009, the new, revised production estimates suggest a more comfortable supply proposition together with an overall rice stock position of India at 22.9 million tons as of 1 December 2009 (against the buffer norm of 5.2 million tons).

More positive news came from emerging exporters from Cambodia and Myanmar, as Mr. Ny Lyheng, managing director of the Federation of Cambodian Rice Millers Associations, and Mr. Wing Aun, vice chairman of the Union of Myanmar Federation of Chambers of Commerce and Industry, disclosed that Cambodia and Myanmar offer strong rice production as well as new export availabilities because of the increase in paddy area and investments in milling and postharvest infrastructure.

African importers, who would be expected to be the most likely to feel the brunt of any supply uncertainties, were also described as well stocked to ride out the current shocks in the market. Many countries will continue to emphasize Africa's own investments in food production.

The road ahead, however, was described by conference delegates as bumpy at best. Most expect the issues from the Philippines and India to drive the immediate future of rice markets as El Niño and other weather phenomena are expected to have a strong influence on global supply.

Over the medium to longer term, climate change is seen as having the biggest influence on hopes for a sustainable food supply, and this challenges the global rice community tasked to feed the world.

THE RICE TRADER (4)

Cream of the crop

The Rice Trader introduces the Ariel Society and holds the first annual "Lord of Rice" and "Best Rice in the World" competitions

by **Logan Wilson**

During the 19th century, fast sailing ships traveled to and from various continents and established a flourishing commodities trade among nations. One of the famous ships was called Ariel and it was considered the first vessel that brought rice from Asia to America. Little did many people realize then how instrumental that voyage would be in forming the foundations of the international rice trade.

Today, rice is one of the most traded foods in the world. However, its significance, not just as a staple cereal for struggling economies but also as a versatile ingredient in culinary arts, has yet to be fully understood and appreciated. To help bridge this gap, Jeremy Zwinger, president and CEO of The Rice Trader (TRT), a company devoted to developing the global rice industry, founded the Ariel Society in 2009.

The Ariel Society was formed to emphasize the need for a sustainable approach to rice cultivation and also to showcase the many benefits of rice as a food. Moreover, Mr. Zwinger noted that this new organization, aptly named after the famed ship Ariel, was established to promote the production, trade, and consumption of rice on an international scale. A small group of chefs who have truly demonstrated a unique and individual approach to their art and who have shown commitment to sustainability and the principles of greening has been chosen as the inaugural members of this esteemed society.

The founding of the Ariel Society brought forth two major events—the first annual "Lord of Rice" and "Best Rice in the World" competitions. Mr. Zwinger believed that highlighting the growing and cooking of quality rice, in a way that had never been done before, would serve the global rice industry well.

Lord of Rice

The first initiative to promote rice was the annual culinary contest held on 4-6 October 2009 in Kansas City, Missouri, USA, in which Ariel Society chefs competed for the title of "Lord of Rice." This event aimed to raise awareness that rice is a significant ingredient in culinary arts. The chefs were evaluated on their development and preparation of an exceptional entrée and their personal selection of particular rice varieties to be used as the main ingredient. Their final dishes were judged on flavor, texture, balance of ingredients, innovation, and presentation.

Chef Jonathan Justus of Justus Restaurant near Kansas City (*at left in photo above right receiving his award from Mr. Zwinger*) won the contest and was named Lord of Rice. His winning dish was the Striped Sea Bass over Pea Shoot Salad, on Medium-Grain Rice Cake with Ginger and Basil Oils, Lemon Confit Anglaise, and Smoked Tomato Sauce. Patrick McDonnel of McDonnel, Kinder and Associates facilitated the judging.

Best rice

The second competition promised to name the "Best Rice in the World." This initiative aimed to encourage the development of better rice products through healthy competition. The contest was held in conjunction with the TRT World Rice Conference last 27-29 October 2009 in Mactan, Cebu, Philippines. Nineteen varieties from eight countries were submitted. A few members of the Ariel Society and the executive chefs of the Shangri-La Hotel comprised the seven-member judging committee. The group unanimously decided that the best-tasting rice in the world for 2009 was Royal Umbrella rice—a Thai jasmine (Hom Mali) variety. The award was received by Sumeth Laomoraphorn of CP Intertrade (*second photo from the left*), the producer of the winning brand.

Ariel Society banquet

The third initiative is a fund-raising banquet and its primary goal is to promote the sustainability of rice production. This event will feature some of the best rice dishes ever cooked and it will be held on the eve of each annual regional and world rice conference. Rice industry professionals who purchase seats or tables will be able to enjoy an evening of creative culinary tastings developed and prepared by Ariel Society chefs. The proceeds from this will be distributed by The Rice Trader to local organizations whose objectives are aligned with that of the Ariel Society.

COP15 sets the climate for change

BY REINER WASSMANN

COP15, or the 15th United Nations Climate Change Conference, was widely expected to pave the way for an agreement on climate change after 2012—when the commitment to the current political accord to curtail emissions, otherwise known as the Kyoto protocol, ends. We can now look at the outcome and assess what it means for agriculture and rice production in a forthcoming "post-2012" agreement.

The following key features of the agricultural sector set it apart from others in relation to climate change mitigation and adaptation:

- Agricultural production contributes 13.5% of global emissions without accounting for land-use change, which contributes 18%. At the same time, agriculture has a high technical mitigation potential due to much lower resource-use efficiencies than industry or transportation.
- About 75% of emissions from agriculture are from developing countries, which shows an opportunity to link climate change mitigation and adaptation to sustainable development policies and support.
- A large part of agricultural emissions are "non-CO_2" greenhouse gases, such as methane and nitrous oxide. Though these gases have not been given the same attention as CO_2, their global warming potential is 25 and 300 times higher than CO_2, respectively.
- Climate change mitigation and adaptation in agriculture entail a wide range of potential co-benefits (arguably more than any other sector) that are particularly related to food security and poverty reduction. This is significant because around 70% of the world's poor live in rural areas.

Despite the undisputed relevance of agricultural production in the context of climate change mitigation and adaptation, this sector was sidelined in discussion of the post-2012 agreement. The Consultative Group on International Agricultural Research organized an "Agriculture and Rural Development Day" as a side event of COP15, but the role of agriculture in future climate change policy was not mentioned in the final COP15 agreement—the Copenhagen Accord. In contrast, forestry and deforestation are widely referred to in this document.

In a broader context, the lack of precise commitments in the Copenhagen Accord now means more months and years of political negotiations. These negotiations will not be easy. It will be a difficult task to elevate agriculture to the place it deserves in the post-2012 agreement. As of now, there has been no decision yet to change the international accounting rules for mitigation projects, which currently exclude land use from mitigation opportunities through the Clean Development Mechanism.

The adaptation issue seems to have a broad consensus on the need to allocate specific funds for developing countries, but the size of these funds and the modes of distribution are still unclear. New financing and incentive schemes will be required to facilitate the transition to improved management practices that generate both climate change mitigation and improved agricultural performance under aggravating climatic conditions, or to compensate farmers in climatic extremes for yield losses.

What does this mean for rice production? The technological options for mitigation and adaptation of rice production are available. About half of the rice production area is irrigated, allowing judicious changes in water management to reduce emissions and help rice cope with less rainfall (see *Goodbye gas* on page 14 of *Rice Today* Vol. 6, No. 3). Improved rice cultivars have a proven track record for coping with the direct and indirect consequences of climate change; no other crop can so effectively deal with increasing flooding intensity due to extreme rainfall and sea level rise. Given the financial constraints of most rice-growing countries, however, the viability of mitigation and adaptation projects in rice production will rely on the availability of external funds from the developed world.

Around 90% of global rice production occurs in Asia and much of this is on small landholdings. Support for climate change mitigation and adaptation in these regions could come from flexible and diverse carbon markets. To obtain this, we will need to work closely with communities and national agricultural research and extension systems to establish consistent and accurate methods to measure, report, and verify emission savings. IRRI's work has shown that the impact of emission-reducing technologies in rice production can be quantified through standard established methods and supplemented with some field testing. Current research aims to facilitate the wide-scale uptake of water management technologies and assess impacts across larger areas. With such demonstrated potential to contribute to mitigation, we hope that methane reduction from irrigated rice will be eligible for offsets and other mitigation funding opportunities as an outcome of COP15. Such a move could spur the development of rice production systems in developing countries, thus helping make food production more sustainable and reliable.

Dr. Wassmann is coordinator of the Rice and Climate Change Consortium at the International Rice Research Institute. He was also a member of the Intergovernmental Panel on Climate Change group that developed the Guidelines for National Greenhouse Gas Inventories.