www.irri.org

Rice Today

International Rice Research Institute
April-June 2009, Vol. 8, No. 2

"Scuba rice"

New varieties save farms from floods

Zero-till hero

Drought-proof rice in Africa

Rice science in the digital age

Bangladesh copes with the hunger months

US$5.00 ISSN 1655-5422

contents

On the cover:
Flood-tolerant Sub1 rice lines thrive—in contrast to their non-Sub1 counterparts—even after 17 days' submergence in the field at IRRI headquarters in the Philippines. Learn about the importance of this "scuba" rice to flood-prone South Asia, beginning on page 26.

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. Potential contributors are encouraged to query first, rather than submit unsolicited materials. *Rice Today* assumes no responsibility for loss of or damage to unsolicited submissions, which should be accompanied by sufficient return postage.

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

cover photo **IRRI**

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**
Africa editor **Savitri Mohapatra (Africa Rice Center – WARDA)**
copy editor **Bill Hardy**
art director **Juan Lazaro IV**
designer and production supervisor **Grant Leceta**
photo editor **Chris Quintana**
photo researcher **William Sta. Clara**
advertising manager **Logan Wilson**
circulation **Lourdes Columbres**
Web masters **Forrest Orndorff, Serge Gregorio**
printer **Print Town Group, Philippines**

Reasons for hope

We were going over some old editorials of *Rice Today* and we came upon one that was written 3 years ago (see *A Time of Revolution*, page 4 of *Rice Today* Vol. 5, No. 1). It stated that rice production in Asia faced challenges not seen since the population explosion in the 1950s and that the region was staring at the prospect of massive land and water shortages as increasing urbanization and industry competed for dwindling resources. To top that, it warned us of the impending effects of climate change on rice production that threatened the ever-growing world population's food supply.

This piece struck us as we realized that no longer are we staring at the face of these problems, but we are actually standing now, if not caught, in the midst of these challenges. What used to be a dire prediction is now our reality.

What we have seen here at the International Rice Research Institute (IRRI) during our first 2 months as *Rice Today* editors, however, gave us reasons for hope. As you will read in this issue, new varieties of rice have been developed to counter stresses caused, in part, by climate change. Making big waves in South Asia, the region most often hit by floods, are the Sub1 varieties, which can survive up to 2 weeks of submergence and still provide good yields. In Africa, where dry spells destroy crops, rice scientists have developed a drought-tolerant variety. Moreover, developed and developing nations sacrifice their agricultural lands for urbanization and industrial growth, pushing farmers to farm unfavorable lands. In Bangladesh, farming families suffer from *monga* (hunger months), which occurs before the transplanted rice is harvested in December. To overcome these problems, IRRI has partnered with other organizations to share rice-growing technologies such as direct seeding of an early-maturing variety to help farmers get better yields and ease their hunger plight during the meager months.

The features in this issue are striking. More than recounting the advances in rice science, each narrative tells the story of people's resilience to the trials that life and nature throw at them and, more importantly, how everyone comes together to find ways to help each other improve the lives of the poor.

At the core of our reality, then, are not the problems we confront, but the opportunities that spring from them that allow us to learn, work together, and better face the next challenges when they come.

Mia Aureus

V. Subramanian

Hidden Treasure

With a bright future ahead, it is with great excitement that I write this article as the new publisher of the *Rice Today* magazine. As a producer of strategic trade, research, and policy publications as well as an organizer of global conferences, *The Rice Trader* is able to take a diverse look at commodities, especially rice.

The rice industry has existed for thousands of years, changing at times at a rate that rivals the most volatile moves in the stock market. As the rice market responds to the laws of economics on product distribution, it must also take into account the impact of politics and its potentially vast effect. I love the beauty of this industry, not only for its size but also for its incredible impact on the world. From the scientific to the marketing aspects, the diverse talents in this industry are impressive to witness firsthand.

Change

This word summarizes my thoughts over the past few months. There is a great sense of change throughout the world, and certainly in the commodity markets. A few months ago, an apt description of the atmosphere on the trade side was "hopeful and progressive." Today, it is more "fearful and pessimistic." The strong, new leadership in the United States and a shift in core beliefs suggest the potential for great changes in the course of international politics. We have seen a massive revision in strategies in dealing with the world banking crisis while seeking national stability. We have experienced an epic retraction in the global financial system, which has led many players to return to a "hand-to-mouth" buying mode. In turn, this may lead to greater purchases later in the year. There has also been a substantial shift in the perception of food security. People are again ignoring the gravity of food supply issues and the instability that can quickly result from such shortsightedness. Consequently, an impasse continues to exist between perception and reality. I hope that time will soon bridge this gap.

Furthermore, we have seen the Philippines confirm one of if not the largest transactions in the history of the international rice industry—1.5 million metric tons in a government-to-government deal with Vietnam. I believe this was a good deal for the Philippines, saving the country millions of dollars, especially compared with last year when continued competition stirred up many issues not only in the Philippines but also in many other countries.

Is this change good or bad?

In my previous editorial (see *Hidden Treasure*, page 4 of *Rice Today* Vol. 8, No. 1), I used an old Asian proverb that suggests that the true treasures are not precious stones, but rather rice crops in the field. In this piece, I believe the proverbial phrase that comes to mind is "May you live in interesting times."

The world is becoming more volatile. However, we must bear in mind that with volatility come great opportunities and challenges. For those who think ahead strategically, the gain will be immense. Those who think short-term, on the other hand, will face devastating effects. Prices are still slightly higher than in 2008 (a key issue that must be monitored) and, as this remains in the world's collective mind, we all cannot help but hope to find a more concrete direction in the future.

Jeremy Zwinger

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

ARIEL JAVELLANA

IRRI HAS helped rice farmers raise the productivity of their farms for almost 50 years, and plans to continue for many more.

50 years of rice research helps feed the world

The International Rice Research Institute (IRRI), Asia's largest and oldest international agricultural research institute, will mark its 50th anniversary in 2010.

In 50 years, IRRI's high-yielding rice varieties have helped significantly increase world rice production, especially in Asia, saving millions from famine while protecting the environment and training thousands of researchers.

"We look forward to celebrating this achievement and many others with all our partners," said IRRI Director General Robert Zeigler.

"We also want to thank our host nation, the Philippines, and recognize the hard work and commitment of the thousands of scientists and collaborators who have worked with IRRI," he added.

IRRI's Golden Jubilee comes as Asian and world food security face unprecedented challenges, and at a revolutionary time for rice research. The sequencing of the rice genome provides researchers with new knowledge that allows them to attack many old problems with new solutions.

Dr. Zeigler said IRRI's 50th anniversary celebrations would especially emphasize the enormous challenges faced by poor rice farmers and consumers. "We can never forget the struggles of the poor farmers," he said.

Several major events are planned for the anniversary, including

- The launch of IRRI's 50th anniversary by Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand, 17 November 2009, at IRRI in Los Baños, Philippines.
- HRH Princess Maha Chakri Sirindhorn will also open the 6th International Rice Genetics Symposium, 16-19 November 2009, in Manila.
- The 50th annual meeting of the Institute's Board of Trustees, 12-17 April 2010, followed by an alumni homecoming for all former IRRI staff and scholars, both in Los Baños.
- The 3rd International Rice Congress (IRC2010), 9-12 November 2010, Hanoi, Vietnam. The IRC2010, the world's largest gathering of the rice industry, has the theme *Rice for Future Generations*, and will include the 28th International Rice Research Conference, 3rd World Rice Commerce Conference, 3rd International Rice Technology and Cultural Expo, and other 50th anniversary activities of IRRI.

Other events are expected to be held around Asia in 2010 as each rice-producing nation celebrates its research and production achievements.

Dr. Khush donates to Punjab Agricultural University

Setting an example of a true alumnus, Dr. Gurdev Khush, former IRRI principal scientist, donated approximately US$700,000 to Punjab Agricultural University (PAU) in India. Dr. Khush, an internationally acclaimed rice breeder and geneticist, announced this after delivering his convocation address at the PAU College of Agriculture in January 2009.

"The amount," he said, "was accumulated from the prize money of various international awards that I have received." He asked that the donation be used for strengthening PAU's research work.

Dr. Gurdev Khush

CHRISANTO QUINTANA

New rice plant could ease threat of hunger for the poor

An ambitious project to re-engineer photosynthesis in rice, led by the International Rice Research Institute (IRRI) through a global consortium of scientists, has received a grant of US$11 million over 3 years from the Bill & Melinda Gates Foundation. As a result of research being conducted by this group, rice plants that can produce 50% more grain using less fertilizer and less water are a step closer to reality.

Currently, more than a billion people worldwide live on less than a dollar a day and nearly one billion live in hunger. Over the next 50 years, the population of the world will increase by about 50% and water scarcity will grow. About half of the world's population consumes rice as a staple cereal, so boosting its productivity is crucial to achieving long-term food security. IRRI is leading the effort to achieve a major increase in global rice production by using modern molecular tools to develop a more efficient and higher-yielding form of rice.

Photosynthesis, the process by which plants use solar energy to capture carbon dioxide and convert it into the carbohydrates required for growth, is not the same for all plants. Some species, including rice, have a mode of photosynthesis (known as C_3), in which the capture of carbon dioxide is relatively inefficient. Other plants, such as maize and sorghum, have evolved a much more efficient form of photosynthesis known as C_4.

According to IRRI scientist and project leader Dr. John Sheehy, in tropical climates the efficiency of solar energy conversion of crops using the so-called C_4 photosynthesis is about 50% higher than that of C_3 crops. Given the demands from an increasing population, combined with less available land and water, adequate future supplies of rice will need to come in large part through substantial yield boosts and more efficient use of crop inputs.

"Converting the photosynthesis of rice from the less-efficient C_3 form to the C_4 form would increase yields by 50%," said Dr. Sheehy, adding that C_4 rice would also use water twice as efficiently. In developing tropical countries, where billions of poor people rely on rice as their staple food, "The benefits of such an improvement in the face of increasing world population, increasing food prices, and decreasing natural resources would be immense," he added.

"This is a long-term, complex project that will take a decade or more to complete," said Dr. Sheehy. "The result of this strategic research has the potential to benefit billions of poor people."

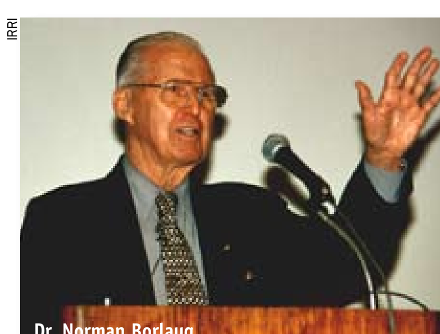
The C_4 Rice Consortium combines the strengths of a range of partners, including molecular biologists, geneticists, physiologists, biochemists, and mathematicians, representing leading research organizations worldwide. Members include Yale, Cornell, Florida, and Washington State universities in the United States; Oxford, Cambridge, Dundee, Nottingham, and Sheffield universities in Britain; the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian National University, and James Cook University in Australia; Heinrich Heine University and the Institute for Biology in Germany; Jiangsu Academy in China; the University of Toronto in Canada; and the Food and Agriculture Organization of the United Nations.

ARIEL JAVELLANA

DR. JOHN Sheehy, IRRI senior scientist, leads the project to re-engineer photosynthesis in rice to potentially double rice yields.

Nobel Laureate Dr. Norman Borlaug calls for second Green Revolution

IRRI



Dr. Norman Borlaug

Thomas Jefferson once said, "Every generation needs a new revolution."

If that is so, then Dr. Norman Borlaug, father of the original Green Revolution, is inviting this generation to begin a second, more extensive, rebellion against world hunger.

"The Green Revolution hasn't been won yet," said Dr. Borlaug, who turned 95 in March. "Developing nations need the help of agricultural scientists, researchers, administrators, and others in finding ways to feed ever-growing populations."

A Nobel Peace Prize laureate and Congressional Gold Medal recipient, Borlaug has been credited with saving more lives than anyone in history. His work has led to breakthrough high-yield, disease-resistant wheat harvests in Mexico, India, Pakistan, and countries throughout Latin America, Africa, and the Near and Middle East. As a result, hundreds of millions of people have been provided with an otherwise unavailable food supply.

Source: AgNews site of Texas A&M University

DUNCAN MACINTOSH

IRRI DEPUTY Director General for Research Achim Dobermann signed the MOU with Professor Barry Halliwell, deputy president (research & technology) of the National University of Singapore.

IRRI enters into two new rice research partnerships

IRRI has entered into two new rice research partnerships: one with the National University of Singapore and the other with the Indian Council of Agricultural Research.

The National University of Singapore and IRRI have signed a Memorandum of Understanding (MOU) to facilitate cooperation, research collaboration, and student exchange. Possible areas of collaboration include research into the biology of rice crops and the design of new rice strains to improve productivity, nutritional value, and resistance to hotter climate or harsh environments.

The MOU will help Singapore continue to engage in high-impact research and secure its food supply. This is especially important for Singapore as it relies on neighboring countries to produce food.

In India, an international agreement between IRRI and the Indian Council of Agricultural Research will support and facilitate India's rice research for the next three years, helping the nation's rice production at a time of unprecedented price volatility and subsequent need for the revitalization of food production.

The work plan includes agreements on three major projects supported by the Bill & Melinda Gates Foundation: Stress-Tolerant Rice for Poor Farmers in Africa and South Asia (STRASA), the Cereal Systems Initiative for South Asia (CSISA), and Creating the Second Green Revolution by Supercharging Photosynthesis: C_4 Rice.

Rats destroy rice crops in Bicol

IRRI rodent expert Grant Singleton and Ph.D. rodent ecology student Nyo Me Htwe traveled to the Bicol region on 6-8 February after receiving numerous reports of a rat population outbreak.

"Rodent damage to the rice crops in the 3 barangays we visited in Albay and Camarines Sur was severe," said Dr. Singleton. "Indications are that the losses at these specific sites will lead to major losses in yield."

JOSE RAYMOND PANALIGAN

Surrounding towns along the roads in Albay Province showed obvious signs of rodent damage. A subsequent visit by Nyo Me Htwe in March to Libon Municipality in Albay quantified rodent losses in 2 barangays as greater than 35%. Dr. Singleton recommends farmer participatory research into effective management of rodents, and a training and communication program on community-based ecological management of rats in the area.

From agricultural waste to useful energy

Who would have thought that rice husks, which are just thrown around and left to catch fire in fields, could be a source of abundant energy that would benefit people around the globe?

Engineer Alexis Belonio of Iloilo City in the Philippines realized that the by-product of rice could be used as fuel in his Rice Husk Gas Stove invention, a winning entry in the recent Rolex Awards for Enterprise.

"I thought of rice husk as fuel for the stove since there is an abundant supply of this biomass waste in our country," explained engineer Belonio. "This can be tapped as an alternative source of fuel for domestic cooking to help households cope with the high cost of conventional fuel like LPG [liquefied petroleum gas] and kerosene." His past experience in the mid-1980s at the International Rice Research Institute inspired him to invent things.

Source: *Business Mirror*

ARIEL JAVELLANA

Rice husks—an abundant source of energy.

BRIEFLY

$10 million scholarship program for young rice scientists

Monsanto Company has pledged $10 million to establish the Beachell-Borlaug International Scholars Program to identify and support young scientists interested in improving rice and wheat research through plant breeding techniques. The program honors the accomplishments of Dr. Henry Beachell and Dr. Norman Borlaug, pioneers in plant breeding and research in rice and wheat, respectively. Apply at www.monsanto.com/mbbischolars.

Critical gene for enhancing China's super rice yield identified

Chinese scientists have identified a gene, *DEP1*, and its mutant, *dep1*, which have played a key role in increasing the yield of China's high-yielding super rice. The *dep1* gene, which can accelerate the cell division of rice and lead to more grains per panicle, will become an important tool for rice breeding.

Fu Xiangdong, a researcher at the Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, said that his team has found the gene *dep1* in high-yielding rice varieties mostly grown in the Yangtze Plains and northeastern China. Fu added that the gene can have a similar function in other crops such as wheat and barley, raising hopes of breeding high-yielding cereal varieties.

Source: Xinhua

GM rice that protects poultry from bird flu

Chinese university scientists in Hong Kong say that they have created genetically modified rice that can protect poultry against bird flu. The rice is modified using a gene from the Chinese plant Yuzhu, which is used in traditional medicine. Their research shows that a protein found in Yuzhu is a strong inhibitor of the bird flu virus H5N1, which has killed 248 people since 2003, according to the World Health Organization.

Source: *SciDevNet*

Gene found for rice root development

Scientists from the Huazhong Agricultural University in China found that a gene in rice, named *WOX11*, is involved in the activation of crown-root emergence and growth. In rice, the shoot-borne crown roots are the major root type and are initiated at lower stem nodes as part of normal plant development.

Source: *Plant Cell*

Modified rice may resist disease in Southeast Asia

Researchers at the Donald Danforth Plant Science Center say that they have discovered how to genetically modify rice to make it more resistant to a disease that is ravaging Asian rice farms. A viral disease, known as rice tungro, destroys about US$1.5 billion worth of rice every year in Southeast Asia. That's roughly 5–10% of the yield in major rice-growing areas in the Philippines, Malaysia, Vietnam, Bangladesh, India, and Thailand. Scientists from the Danforth Center have been looking for a solution for about 20 years.

Recently, they discovered that a transgenic, or genetically modified, rice produces certain proteins that are more tolerant of infection from the rice tungro virus. They announced their findings in January. "The breakthrough came when we understood how the virus made the plant sick," said Roger N. Beachy, president of the center. "Then we used that information against the virus." The technology is viable in the greenhouse and in the laboratory. The next step is to test it in the field.

Source: St. Louis Post-Dispatch

Agricultural policy of emerging economies analyzed

The most recent offering from the intergovernmental think tank, the Organisation for Economic Cooperation and Development (OECD), is a report titled "Agricultural Policies in Emerging Economies: Monitoring and Evaluation 2009." The years 2006-08 were marked by a significant increase in world prices for most, but not all, agricultural commodities. This report analyzes policy developments during this period in seven emerging economies: Brazil, Chile, China, India, Russia, South Africa, and Ukraine.

Source: *OECD*

New irrigation system cuts water use

The United States Agricultural Research Service (ARS) and cooperating scientists are studying a system that, in rice field tests, cuts water use by 24%. The system, called multiple-inlet rice irrigation (MIRI), involves laying disposable, thin-walled, polyethylene irrigation tubing to connect rice paddies as they are flooded with water. This reduces the amount of water wasted compared to the common method of discharging water directly into the highest paddy and allowing water to overflow into lower paddies.

Source: USDA Agricultural Research Service

Rice and electronic gadgets

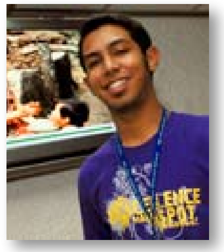
Next time your iPod or mobile phone gets wet, try nature's desiccant, rice, to revive it. That's what Ernesto Londoño of the *Washington Post* did to fix his BlackBerry when it got wet. His advice? Just turn off the device and cover it with uncooked rice to help absorb the moisture and prolong the life of your gadget.

Source: *Washington Post*

CHRISANTO QUINTANA

Awards and recognition

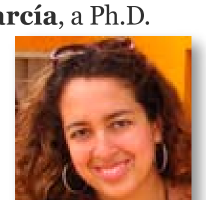
Chromewell Agustin R. Mojica, former intern in the International Network for the Genetic Evaluation of Rice, won Best Undergraduate Research for his thesis, *Molecular Mapping of Quantitative Trait Loci (QTL) for Heat Tolerance in Rice (*Oryza sativa *L.) During Reproductive Stage Using Microsatellite Markers*, by the Philippine Society for the Advancement of Genetics in November 2008. Another finalist in the competition, **John Eric B. Canicosa**, was also a former intern at IRRI. Both are graduates of the University of the Philippines Los Baños. Mojica has now joined IRRI as a researcher at the T.T. Chang Genetic Resources Center.



J.K. Ladha, senior scientist and Rice-Wheat Consortium coordinator, and **S.K. De Datta**, former IRRI agronomist and principal scientist (1964-91), were named fellows of the American Association for the Advancement of Science on 14 February in Chicago.

Jessica D. Rey, postdoctoral fellow at the T.T. Chang Genetic Resources Center, won the 2008 Outstanding Thesis and Dissertation Award (advanced S&T for biology and related fields) from the Philippine Council for Advanced Science and Technology Research and Development. Her thesis was titled *Quantitative resistance loci (QRL) against bacterial blight (caused by* Xanthomonas oryzae *pv.* oryzae*) and leaf blast (caused by* Pyricularia oryzae *Sacc.).*

Gisella Cruz García, a Ph.D. candidate from the Crop and Weed Ecology Group, Wageningen, and studying with the Weed Group in IRRI's Crop and Environmental Sciences Division, was invited to join the Women in Science Week (28 February-6 March) in Paris, France. She is one of 15 who received the UNESCO-L'Oréal international fellowship award for young women in the life sciences in 2007.



Betty Sarah R. Carreon, assistant manager in the Financial Operations Unit, will leave for Kansas, USA, on 5 April as a member of the 2009 Group Study Exchange Team of Rotary International District 3820. The GSE program is funded by the Rotary Foundation and is a unique cultural and vocational exchange opportunity for business people and professionals between the ages of 25 and 40 who are in the early stages of their careers.

Syed M.A. Jabbar, an affiliate Ph.D. research scholar at IRRI, was conferred a lifetime membership by the Gamma Sigma Delta Honor Society of Agriculture-University of the Philippines Chapter for his outstanding academic achievement in his Ph.D. program. Jabbar is pursuing his doctorate in soil science, with a minor in agronomy, at UPLB.

Keeping up with IRRI staff

Richard Bruskiewich, senior scientist (bioinformatics), was elected to an adjunct faculty position in the Department of Molecular Biology and Biochemistry at Simon Fraser University, Burnaby, British Columbia, Canada.

Kanayo F. Nwanze, former director general of the Africa Rice Center, or WARDA, has been appointed president of the International Fund for Agricultural Development of the United Nations. Nwanze becomes the fifth president of IFAD when he takes up his post on 1 April.

Sophie Clayton arrived from Canberra, Australia, in February to begin her work as IRRI's new spokesperson and media relations manager.

Newly appointed scientists at IRRI are **Sarah J. Beebout** (soil chemistry), **Ruben Lampayan** (water management), **Tao Li** (crop modeling), **Florencia Palis** (social anthropology), **Endang Septiningsih** (molecular genetics), and **Michael Thomson** (molecular genetics). **Jagadish Timsina** joined the IRRI-Bangladesh office in December 2008 as senior scientist. New associate scientists are **Ma. Socorro Almazan**, **Lolita Garcia**, and **Ma. Elizabeth Naredo**; new assistant scientists are **Crisanta Bueno**, **Teodoro Correa Jr.**, **Manuel Esguerra**, **Joie Ramos**, and **Dennis Tuyogon**.

Wei Zhou joined the Plant Breeding, Genetics, and Biotechnology Division as visiting research fellow. **Helal Uddin Ahmed**, **John Damien Platten**, and **Kurniawan Rudi Trijatmiko** are IRRI's new postdoctoral fellows.

Himanshu Pathak, senior associate scientist and co-facilitator of the Rice-Wheat Consortium at the IRRI-India office, left on 17 January after completing his 3-year stay and returned to his parent organization, the Indian Agricultural Research Institute in New Delhi, as senior scientist. **Virender Kumar** will take over from Dr. Pathak until the vacated position is filled.

Mohammad Asaduzzaman of the IRRI-Bangladesh office, **Cao Meng** of the IRRI-China office, **Somayanda Impa**, postdoctoral fellow, and **Obdulia Jolejole**, senior manager of Food and Housing Services, have left IRRI. Ms. Jolejole, though, will stay for a few more months in a consulting role until someone is identified to replace her.

Moving on

Hans-Jochen de Haas, former BMZ Germany representative to the CGIAR and member of IRRI's strategic planning external panel, passed away on 29 January.

Remedios Corral, who served as matron of Food and Housing Services for 29 years, passed away on 3 March.

TRAINING COURSES AT IRRI

Rice: Research to Production
IRRI Training Center, Los Baños, Philippines, 18 May-5 June 2009

The course aims to create a new generation of plant scientists that are well networked in the international community and understand the importance of innovative plant science in tackling global problems. Topics include an understanding of the basics of rice production in Asia; familiarity with the germplasm collection at IRRI and current issues related to germplasm exchange and intellectual property; an appreciation of the research issues of IRRI and its developing partners; hands-on skills related to rice breeding, molecular genetics, and genomics; an understanding of how to structure effective international collaboration; and a plan and personal contacts to work effectively as part of the international research community in the future.

Basic Experimental Design and Data Analysis Using CropStat (2nd offering)
IRRI Training Center, Los Baños, Philippines, 22-26 June 2009

The 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.

Rice Breeding Course: Laying the Foundation for the Second Green Revolution
IRRI Training Center, Los Baños, Philippines, 1-16 September 2009

The course aims to develop the next generation of rice breeders adept in using modern tools for enhancing the precision and efficiency of their breeding programs. It will provide the theoretical background on modern breeding methods and techniques, including the use of biotechnology; planning and information management tools and experimental techniques and software; the opportunity to share experiences with other rice breeders; and the latest updates on areas relevant to rice breeding and the worldwide exchange of rice genetic resources. The course is for breeders and agronomists working on variety development or testing in both the public and private sector.


MACKY MONTECILLO

Mixed Model Analysis Using CropStat
IRRI Training Center, Los Baños, Philippines, 5-9 October 2009

The course is designed to acquaint researchers with mixed model analysis and introduce CropStat's module on Mixed Model Analysis using REML (restricted maximum likelihood). It employs a combination of lectures and hands-on exercises on CropStat to help the participants become more familiar with basic statistical methods such as computing descriptive statistics, hypothesis testing, and analysis of variance.

Those interested in registering must have experience in data analysis and knowledge of at least one statistical software.

Leadership Course for Asian Women in Agricultural R&D and Extension
IRRI Training Center, Los Baños, Philippines, 19-30 October 2009

Topics include Asian women in the workplace, mainstreaming gender concerns in the workplace, leadership and management, personality development, developing work-related knowledge and skills, and relating to others.

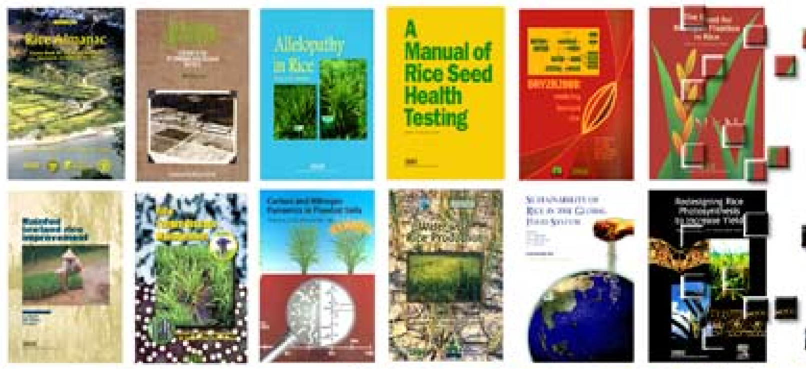
For more details, contact Dr. Noel Magor, head, IRRI Training Center (IRRITraining@cgiar.org) or see ***www.training.irri.org.***

3rd INTERNATIONAL RICE CONGRESS 2010 Hanoi, Vietnam

The 3rd International Rice Congress (IRC2010), set for 9-12 November 2010, in Hanoi, Vietnam, is the world's largest gathering of the rice industry. With the theme *Rice for Future Generations*, it will include the 28th International Rice Research Conference, the 3rd World Rice Commerce Conference, the 3rd International Rice Technology and Cultural Expo, and 50th anniversary activities of the International Rice Research Institute (IRRI). Watch for more details in future issues of *Rice Today.*

RiceToday around the world

1. *RICE TODAY* at Mt. Pinatubo, Philippines: (*front row, left to right*) Vivay Salazar, Mary Burac, Shiela Quilloy-Mercado, Tintin Doctolero, and EJ Azucena; (*back row, left to right*) Denis Diaz, Yohei Koide, Icoy Mercado, Darlene Sanchez, Pogs Manalili, Tanguy Lafarge, and Edsel Moscoso.
2. CALVIN, VICTORIA, and Craig, children of David and Mariju Dawe, pose with *Rice Today* at Napapiiri Arctic Circle, Rovaniemi, Finland.
3. MIA AUREUS, *Rice Today* editor, takes the magazine to Chinatown, Singapore.



RICE SCIENCE IN THE DIGITAL AGE

by **Henry Sackville Hamilton**

IRRI books move from dusty shelves to the virtual library. Need a book? Google it!

From its huge volume of research results on rice and rice-related subject matter, the International Rice Research Institute (IRRI) has, for nearly 50 years, generated and disseminated knowledge and technology as public goods to rice farmers via its partners in the developing and developed world.

Since 1962 (when IRRI began publishing), the Institute has produced some 500 scientific titles encompassing around 100,000 printed pages, in the form of monographs, workshop proceedings, field guides, and manuals. "These books have always been distributed for free or at minimal cost to our partners in the developing countries primarily through their institutional libraries," says Gene Hettel, head of IRRI's Communication and Publications Services (CPS). "Many titles are published solely by IRRI; some are copublished with reputable science publishers, such as World Scientific, Elsevier, Wiley, Kluwer, CABI, and others."

For a time during the 1980s into the 1990s, IRRI was undoubtedly the largest publisher of scientific books in the Philippines, according to Tom Hargrove, CPS head during those days and most recently coordinator of the Information and Communications Unit at the International Center for Soil Fertility and Agricultural Development in Muscle Shoals, Alabama, USA. "We published 18 to 25 books annually back then," he says. "By 1990, at least 130 editions of 33 books (particularly field guides and manuals) had been published by collaborating publishers in 29 countries and in 42 languages. The linchpin among these, *A Farmer's Primer on Growing Rice* (42 languages including 10 Philippine dialects), was easily the world's most widely published agricultural book."

A popular field guide in this impressive family of extension-type publications, *Friends of the Rice Farmer: Helpful Insects, Spiders, and Pathogens*, just had its tenth printing in English in March 2009, thrusting the total number of copies past the

100,000 mark when adding 25 non-English editions in Khmer, Burmese, Vietnamese, Tagalog, Tamil, Nepali, and others.

Although the number of IRRI-produced titles has tapered off somewhat in recent years due to

declines in scientific staff and budget reductions, the Institute has still produced more than 180 significant monographs, manuals, reports, and proceedings since 1995, including such recent titles as *Economic Costs of Drought and Rice Farmers' Coping Mechanisms, Water Management in Irrigated Rice: Coping with Water Scarcity, Technologies for Improving Rural Livelihoods in Rainfed Systems in South Asia*, and *Direct Seeding of Rice and Weed Management for the Rice-Wheat System of the Indo-Gangetic Plains.*

Mr. Hettel has observed some changes in IRRI's science publishing scenario since he became CPS head in 1997. "Back then," he says, "when determining the pressrun for a book, it often exceeded 1,000 copies and we had just started to consider occasionally producing a digital version for placing on a CD or on the Web. Today, we rarely print 1,000 hard copies (because of the now routine digital alternatives) and, while a digital version is a given, we have begun asking the question, 'Do we need to print any hard copies at all?'"

According to Mr. Hettel, since January 2008, CPS, with the help of IRRI's Information Technology Services (ITS), has been posting most of its new books on *Google Book Search (GBS).* This involves a special presence for IRRI on the facility even with its own URL: http://books.irri.org. "The new books join nearly 300 historic titles from the Institute's rich publishing history," he says. "Envisioning a time when it would be fundamental to have our scientific books—current and historic—available digitally via our own Web site, we began scanning titles in our archives in 2000. This was a slow process because we were scanning at a high resolution (300 dots per inch) and doing optical character recognition (OCR) at 99% accuracy. This process started long before there was a GBS, but just as we finished a critical mass of the project, there GBS was—online and ready for the 'perfect marriage.'"

According to Erik Hartmann, head of GBS Strategic Partnership Development for Southeast Asia, IRRI's presence on Google was a collaborative effort in which a "co-branded book search" site was set up. "This basically means using a GBS back-end to provide a custom user-interface for a single publisher, so the search results are restricted to that single publisher's books and the appearance is designed to match the look and feel of the publisher's own Web site," says Mr. Hartmann. "In IRRI's case, they designed a very beautiful background image and they built a page on their own Web site, which allows users to download book PDFs from their site. This page is dynamic, receiving an ISBN, which is passed from the GBS page and then redirects the user to the appropriate PDF download."

Mr. Hartmann points out that the IRRI Web team did some really nice extra touches, which he thinks helps make this site so successful. "IRRI made all their copyrighted titles 100% viewable and searchable on GBS rather than the default 20%," he says. "And, IRRI changed the text of their 'Buy this Book' link on GBS to 'Free PDF download.' The exciting thing about this change is that the rate at which people click the 'Buy this Book' link shot up overnight. Previously, about one in 100 people would click that link, but, after the change, the click-through-rate shot up to more than 10%, which is higher than any publisher we have ever worked with. IRRI was the first publisher on GBS offering PDF downloads of its books and has led the way for other centers in the Consultative Group on International Agricultural Research (CGIAR) to follow suit."

"We are elated over the public's response to IRRI books on GBS," says Mr. Hettel. "Since January 2008 when our books went online at GBS, Google Analytics has recorded more than 200,000 book visits, around 2.5 million page views, and more than 15,000 PDF downloads."

This collaboration with Google goes hand-in-hand with IRRI's new copyright policy announced by the Institute's Board of Trustees after its September 2006 meeting, which, in part, reads, "IRRI will release its information products (software, documents, multimedia, data), as much as possible, under a suitable open content license. Such license shall allow copying, distribution, and (usually) the creation of derivative products; prohibit commercialization; and require attribution as well as the release of derivative products under the same license as the original product was released by IRRI, hence, some rights reserved."

This new Creative Commons (CC) policy, which covers *Rice Today* as well as spelled out at the bottom of the contents page, doesn't really change IRRI's long-standing policy of always granting permission to use its information products for noncommercial purposes. "This new policy simply bypasses the 'permission requirement' altogether and clarifies and enhances the Institute's intention where sharing of information is concerned," says Mr. Hettel.

In addition to placing books on GBS, IRRI has embraced this policy by placing this same CC statement on its Web site (http://irri.org) and featuring some 4,500 images on the public photo management facility, flickr (www.flickr.com/photos/ricephotos), and some 60 videos and counting on YouTube (www.youtube.com/irrivideo), which compositely have had some 75,000 views.

According to Marco van den Berg, ITS manager, the digital distribution of IRRI information and photos achieved via GBS and flickr gives access to audiences that have been difficult to reach using traditional methods, for a variety of reasons. "Among the top 25 countries that have downloaded books from our co-branded GBS site are Vietnam, Iran, Indonesia, Pakistan, Bangladesh, Sri Lanka, and Myanmar," he says.

Anyone can now obtain, repurpose, distribute, and even modify the content (self-service publishing) of IRRI publications, photos, and videos with proper attribution using CC licenses.

However, IRRI's CC policy has presented the CPS staff with some new challenges when they deal with science publishers looking to copublish some of IRRI's books, most of whom still request exclusive publication rights if not downright copyright assignment.

According to Bill Hardy, IRRI senior science editor and publisher, some conflicts with potential copublishers that are not on the CC bandwagon include the outside publisher's interest in having hard-copy commercial sales and a perpetual license. IRRI, on the other hand, has primary interests in delivering global public goods and providing free online access to its communication products. "Even so," says Dr. Hardy, "IRRI is tackling these issues by drafting some creative contractual arrangements and compromises with some flexible copublishers, such as World Scientific in Singapore, with which IRRI has recently copublished *Rice Genetics V, Charting New Pathways to C_4 Rice,*

IRRI books for Africa and Asia

With the recent closing down of the CPS book storage facility at IRRI headquarters, about 38,450 IRRI books (with a retail value of US$384,000) were shipped via sea freight to Africa and Asia. One shipment of 17,000 books topped off a container shipment of agricultural equipment to Mozambique at no extra charge. These books arrived at IRRI's East and Southern Africa Region office in Mozambique, the Africa Rice Center's (WARDA) office in Nigeria, and IRRI's 11 country offices in South and Southeast Asia.

They are being redistributed to needy national libraries across these regions. New IRRI publishing policies in the digital age, which will require lower book pressruns in the future, negate the need for a book storage warehouse at headquarters.

GENE HETTEL

GLENN GREGORIO

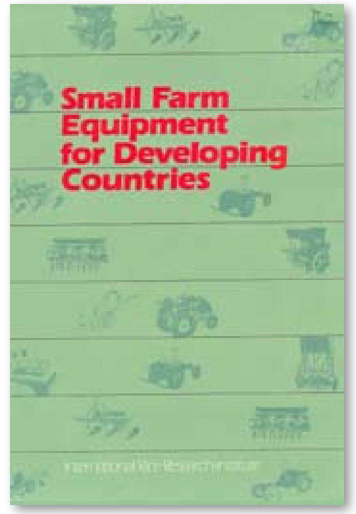
In the photo at left, Glenn Gregorio, IRRI's rice breeder for Africa based at the WARDA office in Nigeria, determines some of the titles to ship to West Africa in consultation with Anna Arsenal, former CPS marketing and fulfillment specialist.

The photo above shows some of the books being used in one of their new homes, the IRRI-Office library at the WARDA Nigeria station of the International Institute for Tropical Agriculture in Ibadan. The users are trainees of IRRI and WARDA coming from different Nigerian agricultural universities. Says Dr. Gregorio, "Friday afternoon is a special time for them because they attend lectures on rice breeding and biotechnology and they get to use the library. Books on rice statistics, the Rice Almanac, and biotechnology titles are their favorites."

and *Drought Frontiers in Rice* (see *New Books*, below).”

There is a lot of interest in the publishing world in how institutions such as IRRI are adopting CC and dealing with publishers who still prefer “all rights reserved.” In February and March 2009, Mr. Hettel gave presentations on *Adopting and Utilizing Creative Commons to Facilitate the Dissemination of Rice Knowledge and Technology* at the Regional Conference on Creative Commons in Manila and the Symposium on Common Use Licensing of Publicly Funded Scientific Data and Publications in Taipei, respectively.

According to *Internet World Stats*, as of 31 December 2008, only 17.2% of Asia’s population and 5.6% of Africa’s use the Internet. “Because so many of our clients on these continents are not yet wired to the Internet,” says Dr. Hardy, “traditional book production will be in IRRI’s future for some time to come, albeit in a much smaller volume. We will continue to distribute traditional books to our nearly 300 institutional depository libraries and to others around the world indicating a need. When we recently liquidated the inventory in our closed-down book storage facility on the IRRI campus, we made special efforts to distribute these books to needy libraries instead of shredding them.” (See *IRRI books for Africa and Asia,* on page 15.)



So, some may wonder, which IRRI book is, so far, the most popular among the more than 200,000 book visits and 2.5 million page views on GBS? Might it be about the latest on water management, coping with drought, or direct seeding of rice?

“None of those,” says Mr. Hettel, “although there is certainly interest in these important topics to be sure. With just over 5,600 book visits and more than 71,500 page views, *Small Farm Equipment for Developing Countries*, a 22-year-old out-of-print proceedings of a conference of the same name held at IRRI headquarters in September 1985, wins the prize! This just goes to show that newly digitized titles, which have not ‘seen the light of day’ for years in their traditional format, can still have value and useful information to reveal—all thanks to the digital age.”

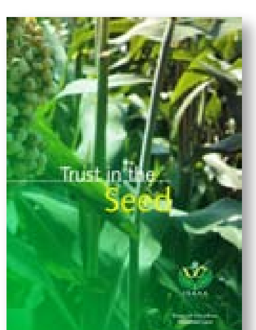
Mr. Sackville Hamilton is a former CPS intern.

NEW BOOKS www.irri.org/publications

Trust in the Seed

B. Chaudhary and K. Gaur; published by International Service for the Acquisition of Agribiotech Applications.

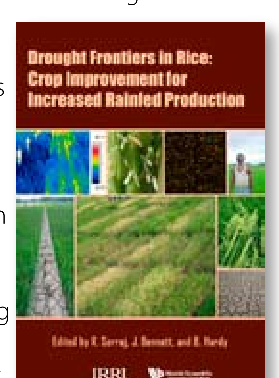
This book is the latest publication of the International Service for the Acquisition of Agribiotech Applications (ISAAA). It highlights the significance of the seed and new crop technologies. It captures three key development experiences in Indian agriculture that sustained its growth, helped increase food production, and eased the plight of the hungry. In essence, the book depicts the willingness of poor small farmers to embrace improved seeds and adopt technologies to overcome production constraints and increase their income. For orders, contact the ISAAA South Asia Office through b.choudhary@cgiar.org and k.gaur@cgiar.org. To download a PDF copy of the book, visit www.isaaa.org/resources/publications.



Drought Frontiers in Rice: Crop Improvement for Increased Rainfed Production

Edited by R. Serraj, J. Bennett, and B. Hardy; published by the International Rice Research Institute (IRRI) and World Scientific.

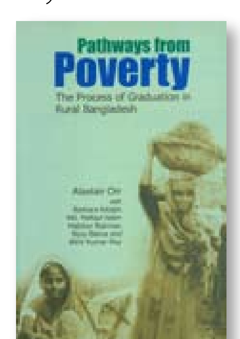
This book describes some of the recent advances in drought genetics and physiology and the integration of highly efficient breeding and genetics analysis techniques with functional genomics. The study featured in this publication paved the way for the launching of the Drought Frontiers project (http://seeds.irri.org/drought), which focuses on improving rice’s resistance to drought. For orders, email World Scientific at sales@wspc.com.sg.



Pathways from Poverty

A. Orr with B. Adolph, Md. R. Islam, H. Rahman, B. Barua, and M. K. Roy; published by The University Press Limited.

This book probes behind the statistics showing declining poverty in Bangladesh to explore the process of getting out of poverty. Using a variety of qualitative methods, including thirty household case studies, and based on research in three villages representing different rice ecosystems, the authors seek to understand this process from the inside. For orders, email University Press Ltd. at upl@bangla.net.



STRENGTHENING THE SYSTEM

Story and photos by **Adam Barclay**

For 15 years, the Rice-Wheat Consortium of the Indo-Gangetic Plains has been working to help South Asian farmers reduce their costs, increase their productivity, and help the environment

In the early 1990s, the northwestern Indian state of Haryana—one of the country's most agriculturally productive—faced a crisis. A weed, *Philaris minor*, had evolved resistance to all commonly available herbicides. This was particularly alarming because *Philaris* was causing havoc across the rice-wheat belt, responsible for the vast majority of the state's wheat production and employment. In the 1993-94 season, wheat yields crashed. The only solution seemed to be newer but more expensive herbicides.

Haryana's farmers and agricultural experts were desperate. In an attempt to reduce farmers' costs and make the new herbicides affordable, R.K. Malik and his colleagues at Haryana Agricultural University in Hissar convinced a few farmers to use a simple tractor-pulled planting machine that allowed wheat to be sowed without first tilling the land following the rice harvest. The usual practice was to till the land six to eight times before planting rice. Although zero-tillage wheat would undoubtedly save labor costs, previous efforts to test the method had failed to gain traction. This time around, however, things would turn out rather differently.

Jagdeep Singh Dhillon tows a Happy Seeder behind a tractor. Punjab State's first farmer to sow his entire wheat crop with a Happy Seeder, he has pledged to "never, ever burn rice residue again."

To Prof. Malik's happy surprise, not only did zero tillage cut costs, it also solved the *Philaris* problem—the weed seeds inhabited the upper 5 centimeters of the soil; any sort of tillage resulted in substantial *Philaris* emergence. Better still, it saved farmers 2 weeks after the rice harvest, allowing wheat to be planted at the optimal time in early November. When farmers spend time tilling the land after harvesting rice, wheat planting tends to occur later than is ideal, with the attendant lower temperatures leading to a yield penalty of around 50 kilograms per hectare for every day that planting is delayed.

"Although zero tillage wasn't a part of the management strategy for *Philaris*," recalls Prof. Malik, "the magnitude of the problem meant that farmers were desperate, and therefore very open to new technologies."

Prof. Malik says that this atmosphere converged with the establishment in 1994 of the Rice-Wheat Consortium (RWC), currently led by the International Rice Research Institute (IRRI) but led then by the International Maize and Wheat Improvement Center (CIMMYT) under soil scientist Peter Hobbs, now at Cornell University. With farmers open to change and the RWC bringing together researchers, policymakers, and the private sector, momentum built quickly.

FOR MORE than 15 years, agronomist R.K. Malik has advocated zero-till wheat in the rice-wheat region of Haryana State.

"The process of doing research changed," says Prof. Malik. "We went straight to farmers' fields and started to make farmers our partners. The RWC provided us with four zero-tillage machines, which we immediately used to plant trial wheat crops in four villages in different districts.

"We weren't even sure if the crop would grow," he added. "We visited some of the fields, about 70 kilometers away, every day. Our first observation was that not only did the crop emerge, but it emerged at least 2 days earlier than with conventional practice. With those four machines, we planted about 6 hectares, all of which performed wonderfully."

In the 1994-95 season, despite much initial resistance from farmers, Haryana Agricultural University, with the support of the RWC, expanded the zero-tillage trials to around 25 hectares throughout the rice-wheat area of Haryana.

Feeding half the world

What is the Rice-Wheat Consortium and why is it important?

More than 3.1 billion people living in South Asia and China—almost half of humanity—depend on rice and wheat production for food. In a rice-wheat "system," farmers grow at least one rice and one wheat crop on the same piece of land each year. In South Asia, the rice-wheat region occupies nearly 13.5 million hectares across the Indo-Gangetic Plains of Bangladesh, India, Nepal, and Pakistan. This region alone is home to 1.2 billion people, nearly 40% of whom live in extreme poverty. Rice and wheat account for 90% of the region's total cereal production and, with the population growing at more than 2% annually, there are more than 20 million additional mouths to feed each year.

Over the past 30 years, the rice-wheat system has emerged as the region's major production system, accounting for more than 30% of the total rice area and 40% of the total wheat area, and producing nearly one-third of the region's rice and more than half of its wheat.

During the Green Revolution era, production increases resulted from expansion in both rice-wheat area and productivity. Now, however, with little additional land available, future demand growth will have to be met mainly through increases in yield. Further, the average 2% per year rice and wheat yield increases seen from 1970 to 1990 have dropped off with a combination of environmental factors—such as declining soil health and access to irrigation—and reduced support for public agricultural research causing yields to stagnate over the past 2 decades.

The challenges are to produce more food at less cost and to improve water productivity. Farmers need alternatives to help them conserve energy and water resources, reduce greenhouse gas emissions, and improve the quality of life for farm families. To address these challenges, the Rice-Wheat Consortium (RWC) for the Indo-Gangetic Plains was established in 1994 by the Consultative Group on International Agricultural Research (CGIAR).

The consortium brings together the national agricultural systems of Bangladesh, India, Nepal, and Pakistan (with China as an associate member); CGIAR-supported centers, including the International Rice Research Institute (IRRI), the International Maize and Wheat Improvement Center (CIMMYT), the International Water Management Institute, the International Crops Research Institute for the Semi-Arid Tropics, the International Potato Center, and the International Livestock Research Institute; the Asian Vegetable Research and Development Center; and several advanced research institutes, including Cornell University, CABI, the International Agricultural Centre Wageningen, and Rothamsted Research. Currently, IRRI serves as the convening center.

The RWC's key roles are as an innovator and supplier of new knowledge for the rice-wheat system, a "clearinghouse" for new approaches and technologies, and facilitator and catalyst of research for development.

The development and dissemination of resource-conserving technologies are a key goal for the consortium. By the end of 2007, around 0.5 million farmers used such technologies on 4 million hectares of agricultural land: zero till, reduced till, surface seeding, and bed planting of wheat (1.94 million hectares); direct-seeded rice (0.19 million hectares); laser land leveling (0.07 million hectares); crop diversification (1.80 million hectares); the leaf color chart (0.06 million hectares); and unpuddled transplanted rice (0.01 million hectares).

The further development of the rice-wheat system received a boost in early 2009 with the announcement of a major new project named the Cereal Systems Initiative for South Asia (CSISA). With funding from the Bill & Melinda Gates Foundation and the United States Agency for International Development, the initiative will be led by IRRI in partnership with CIMMYT and the International Food Policy Research Institute.

"There was a huge gain in productivity," says Prof. Malik. "At the height of the *Philaris* problem, farmers would harvest 1.5, 1.6, maximum 2 tons per hectare. With zero tillage, they were harvesting 4.5 tons or more."

The technology provided additional opportunities for income, too. After the second year, some farmers bought machines and, as well as sowing their own fields, hired the machines out to their neighbors, a practice known as custom hiring.

Support for zero tillage grew among farmers as well as policymakers, with the state government in 1998-99 offering a 50% subsidy to farmers to buy their own machines. Commercial opportunities for the private sector were boosted accordingly—when subsidies were introduced, there were only two manufacturers of zero-tillage machines. By 2003-04, this number had reached 70 across Haryana and the neighboring state of Punjab, and in 2007-08 was close to 100.

With the RWC acting as a catalyst, national and international interest grew among research organizations, nongovernmental organizations, governments, and the private sector. More funding agencies came on board—particularly the Asian Development Bank, the Australian Centre for International Agricultural Research (ACIAR), the United States Agency for International Development, and the United Kingdom's Department for International Development—and the Indian Council for Agricultural Research put its weight behind the initiative. The number of RWC projects grew rapidly and, according to R.K. Gupta, former regional facilitator of the RWC, a critical mass of scientists turned their coordinated attention to the rice-wheat system.

In Haryana in 2007-08, 0.6 million hectares of agricultural land was planted using zero tillage. The figure across the rice-wheat region of the Indo-Gangetic Plains was almost 2 million hectares out of a total of almost 13.5 million hectares.

But it is not only the results on the land that have benefited farmers. Prof. Malik says that one of the most important things to come out of zero tillage and the accompanying movement, known as conservation agriculture, is the change in the way research is done.

"Scientists and policymakers are now convinced that the participation of farmers in research—the bottom-up approach—is really more fruitful," he says. "The management of site-specific issues *has* to be done in a participatory way."

In Punjab, immediately northwest of Haryana, scientists at Punjab Agricultural University (PAU) in Ludhiana are concerned about maintaining the high productivity enjoyed by farmers in this state, known as India's breadbasket. Despite relatively poor soils, Punjab achieves the country's best rice and wheat yields, but these have stagnated in recent years.

AGRICULTURAL ENGINEER Harminder Singh Sidhu, with an early-generation Happy Seeder, says that farmers must combine a range of resource-conserving technologies if they are to achieve the productivity gains required to meet growing demand.

"Punjab soils are characteristically low in organic matter," explains soil scientist Bijay Singh, "so, if we want to sustain high productivity, it's very, very important that farmers adopt resource-conserving technologies that can improve soil health."

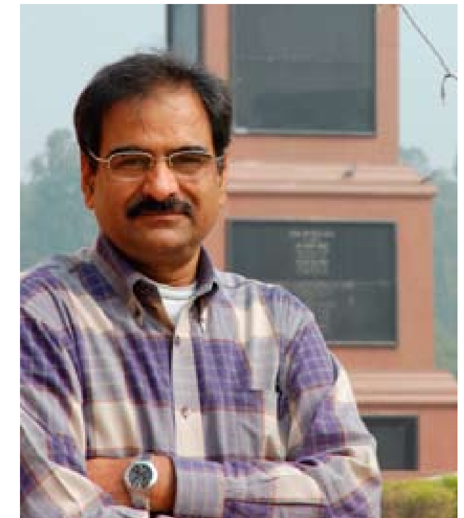
A FARMER inspects a seed drill at a Central Soil Salinity Research Institute field day in October 2005 at the institute headquarters in Karnal, Haryana.

Development and dissemination of resource-conserving technologies are a key plank of the RWC. As well as zero-till wheat, such technologies include a leaf color chart that allows farmers to easily determine when and how much nitrogen fertilizer should be added to their rice crop, and laser land leveling, which promotes better crop establishment and reduces water use by up to a third. This technology, which should be used once every 3 years or so, has been a big success in Punjab, with the number of leveling machines growing exponentially each year: one in 2005, eight in 2006, 150 in 2007, and 650 in 2008.

Another key resource-conserving activity—performed in combination with zero tillage—is returning to the soil rice straw left in the field after harvest, rather than removing or burning it.

"When you till, you lose organic matter, which leads to poor soil health," says Prof. Bijay Singh. "By avoiding tillage and keeping residue in the field, we return organic matter to the soil, which maintains or improves soil health."

Further, by returning residue to the soil, farmers circumvent what has become a major problem in the rice-wheat region of India. Despite laws (which are generally



J.K. LADHA, Rice-Wheat Consortium coordinator.

unenforced) to the contrary, most farmers deal with rice straw by burning it, with dire environmental and health consequences. The air in Punjab and Haryana in November, just before wheat is sown, is thick with an acrid smoky haze, the result of tens of thousands of hectares of burning rice straw.

The problem for Prof. Bijay Singh and his PAU colleagues Yadvinder Singh, a fellow soil scientist, and Harminder Singh Sidhu, an agricultural engineer, is that by avoiding tillage—which allows incorporation of rice residue into the soil—farmers were left with fields full of thick, hardy rice straw that needed to be removed. Their challenge was to enable farmers to sow their wheat while leaving their rice residue in the field.

"Early zero-till machines couldn't operate through rice residue," explains Dr. Sidhu. "Farmers wanted to adopt the conservation agriculture technologies but had no option other than to burn."

Enter the Happy Seeder. Through funding from ACIAR, the RWC and Punjab Agricultural University have worked to refine and distribute this machine, which can sow wheat seeds through rice residue into untilled soil while simultaneously applying fertilizer. The Happy Seeder was first developed in the early 2000s by John Blackwell, professor of agricultural water technology at Charles Sturt University in Australia,

Zero-till hero

Around 10 years ago, Indian rice-wheat farmer Raj Kumar planted his wheat without first tilling his soil. His neighbors laughed, telling him he had wasted his seed.

"Then, when they saw my crop," recalls Mr. Kumar, "they became converts to zero tillage themselves."

Mr. Kumar had been introduced to zero tillage by R.K. Malik, an agronomist at Haryana Agricultural University working with the Rice-Wheat Consortium (RWC). Now, most of Mr. Kumar's fellow farmers in his home village of Bainsi, as well as in many other villages in Rohtak District, Haryana State, use the zero-till approach.

In the 2008-09 wheat season, Mr. Kumar planted his entire 24-hectare farm using zero tillage. Using his "zero-till seed-cum-fertilizer drill," he was able to finish planting in the first week of November, around 20 days earlier than when he used to till the land six to ten times prior to sowing. As a result, the wheat is planted when temperatures are optimum and his yields are around 0.5 tons per hectare higher. Not only that, without the need to till, his tractor experiences less wear and tear and he spends less money on diesel.

Growing zero-till wheat costs Mr. Kumar 3,750 Indian rupees (US$75) less per hectare than when he tilled and his income is $200–250 per hectare higher. The seed drill itself cost $600 and he made that money back through increased profit in the first season.

"Other farmers in the district have had similar results," says Mr. Kumar. "The fact that more and more drills keep coming into the village is a sign of success."

With better incomes, farmers are able to buy more land and better vehicles, and send their children to good schools. It also means less drudgery. "My family feels good because I can finish sowing in 1 week and spend more time with them," says Mr. Kumar. "More income means our standard of living and overall happiness have gone up."

Mr. Kumar says that the participatory process fostered by the RWC, in which farmers work much more closely with scientists, is mutually beneficial. The farmers get access to new technologies and the scientists get excellent feedback on their work. In the case of zero tillage, Mr. Kumar has no doubt that it is the way of the future in this region.

"To progress, farmers in the rice-wheat system need to adopt zero tillage," he says. "If they don't, they'll be behind."

*Exchange rates are approximate for 14 January 2009.

RICE-WHEAT farmer Raj Kumar (*left*) stands in his recently planted wheat field with neighboring farmer Dinesh Kumar. Using a zero-till drill to sow his wheat seeds, Raj Kumar cuts his labor requirements and plants his wheat at the optimum time of year, around 20 days earlier than when he used to till.

RECENTLY PLANTED wheat seedlings emerge through rice straw in Raj Kumar's untilled field (see *Zero-till hero* on page 21).

who was at that time working at the Commonwealth Scientific and Industrial Research Organisation.

"I'd been asked to think about sowing wheat into rice residue," recalls Prof. Blackwell, "and there was no easy answer. Rice has very heavy yields of straw so any seed drill tends to get blocked. Using disks to cut the straw works for a while but the disks quickly lose their edge in rice straw because of its high silica content. Then the straw 'hairpins' and is pushed into the seed furrow by the disk so the seed sits on top of the straw and doesn't germinate. This is why burning is the preferred residue management method—it's so simple.

"Initially, I thought it was impossible but I had a 'Eureka!' moment. All around the world, people manage grasslands with something called a forage harvester, which picks up grass and carts it to cattle, or a silage pit, or whatever. So I thought, why not just use a forage harvester and mount a direct drill behind it, so the drill is presented with basically a bare surface."

The first Happy Seeder was built out of scrap at PAU and, although it worked, it was a large, cumbersome machine. Over the years, the concept has been refined to the point that the current generation works well in up to 10 tons of residue per hectare. Happy Seeders are now being commercialized in India and Pakistan, and there is interest in China. Prof. Blackwell notes that only a few hundred have been made, but, as more farmers use them, others are seeing the results and the rate of adoption is accelerating. "That's how it has to go; you can tell people how wonderful it is as much as you like, but they need to experience it," he says.

"If we can prevent burning in South Asia and China—what a marvelous achievement!" adds Prof. Blackwell. "The health problems associated with burning, both human and animal, are quite horrific."

As with zero-till seed drills, he notes that custom hiring and government assistance will be necessary if the machine is to be adopted widely: "A farmer can afford a match but not necessarily a Happy Seeder."

According to Dr. Sidhu, the combination of these technologies will allow farmers to make huge strides. "If we laser-level first, then use a Happy Seeder, the performance is much better—we have to superimpose these technologies," he says.

To do this, says Dr. Yadvinder Singh, "We need local champions—people like Jagdeep Singh Dhillon—to spread the word."

Mr. Dhillon, who grows rice and wheat on 6.5 hectares in Kanoi Village, Sangrur District, Punjab, was in 2008 the state's first farmer to sow his entire wheat crop with a Happy Seeder. For the previous 7 years, he grew zero-till wheat but, without a Happy Seeder, burned his rice residue. Now, the rice straw remains as mulch. Not only does he avoid the problems of burning, but the mulch, by trapping moisture and preventing weed growth, also saves one to two irrigations per wheat crop and allows Mr. Dhillon to avoid using herbicides.

So impressed was he with the results of the Happy Seeder that Mr. Dhillon visited his Sikh Temple and pledged to "never, ever burn rice residue again."

As a member of PAU's progressive farmers' club, an RWC initiative, Mr. Dhillon has been swapping ideas with the researchers there since the mid-1990s. As such, he is a prime example of the "farmer of the future," sorely needed across the rice-wheat belt. By adopting a suite of resource-conserving technologies—including laser land leveling, the leaf color chart for rice, the use of legume crops that act as green manures, and a tension meter that indicates when irrigation is necessary—Mr. Dhillon has achieved impressive results. In 2008, for example, as well as recording excellent rice yields of 9 tons per hectare, he has reduced the drudgery and cost of farm work substantially.

"Ten years ago," says Mr. Dhillon, "I spent all of my time from morning to evening on the farm. I was always busy. Now that I'm using resource-saving technologies, my production is up by 20% to 25%, and my labor requirements and cultivation costs are down. I have a lot more free time during which I can help other farmers."

Before working with the PAU and the RWC, Mr. Dhillon would hire three or four laborers to weed, irrigate, and apply fertilizer. Now, he hires one or two workers (a doubly good thing with many farm workers moving to the city to work in the industrial sector). By saving water, he saves money needed to buy diesel to work the irrigation pump. The leaf color chart has enabled him to reduce by 20% his fertilizer applications to rice.

Mr. Dhillon's improvements have not only saved him money but also helped him improve his income. With his spare time and money, he has also bought nine buffaloes and begun a dairy business. He plans to buy his own Happy Seeder and laser leveler, which he will hire out to other farmers.

According to J.K. Ladha, RWC coordinator and IRRI representative for India, one of the consortium's greatest achievements is bringing farmers into the research process as participators, not merely spectators or recipients.

"The RWC has applied a new model for farm technology development and dissemination," says Dr. Ladha. "We have encouraged farmers, researchers, and extension agents to work as teams, with farmers actively participating in testing, refining, and promoting technologies. Now, researchers often go straight to farmers' fields with promising innovations, rather than spending years in testing and refinement on research stations."

With the new Cereal Systems Initiative for South Asia (see *Feeding half the world,* page 19), the RWC is set to continue its evolution into a major force for agricultural development.

"The returns of the RWC far exceed the investment made," says Dr. Ladha. "The consortium must continue to broaden its scope to embrace the emerging challenges in South Asia."

Mr. Barclay is a freelance writer based in Australia and former Rice Today *editor.*

COMMERCIAL MANUFACTURERS such as National Agro Industries, which manufactures zero-till seed drills like this one, both help and benefit from the growth of resource-conserving technologies. The company, co-owned by Manmohan Singh (*far right*) along with his son Rajdeep Singh (*second from left*), employs 50 people.

J.K. LADHA (*center*) and R.K. Gupta (*second from right*), former regional facilitator of the Rice-Wheat Consortium, inspect direct-seeded rice infested by wild rice.

BEFORE PLANTING wheat, most rice-wheat farmers opt to burn their rice straw—with dire environmental and health consequences. The Rice-Wheat Consortium has developed alternatives, such as the Happy Seeder, that enable farmers to keep rice residue in their fields.

GENE HETTEL

International Rice Research Institute and University of California researchers visit the women and children of Harir Danga Village in northwestern Bangladesh near Rangpur. They are soliciting views on the flood-tolerant Sub1 rice varieties being planted in nearby fields. See following article on scuba rice.

GENE HETTEL (2)

Even after 17 days of submergence in IRRI research plots, Sub1 rice lines show their "waterproof" trait as they are still standing to the left, right, and further behind IRRI plant physiologist Abdel Ismail.

Scuba rice

Stemming the tide in flood-prone South Asia

by **Adam Barclay**

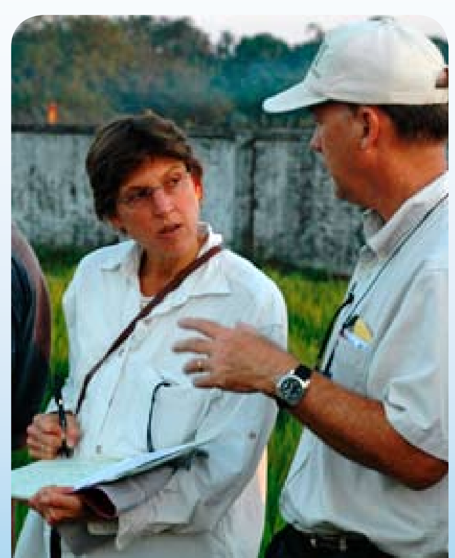
New versions of popular varieties of rice, which can withstand 2 weeks of complete submergence, are set to make a big impact in South Asia

Scientists had long known of an Indian rice variety, unromantically dubbed FR13A, that could handle a week or more of complete submergence and recover sufficiently to offer a reasonable harvest. Rice, although often grown in standing water, will drown like any other plant if hit with severe flooding.

Despite its remarkable properties, FR13A (FR stands for "flood resistant"), as a low-yielding traditional variety grown across limited areas in the Indian state of Orissa, was never expected to make a big impact on a wide scale. Nevertheless, rice breeders—including David Mackill, a young Californian plant breeder working at the International Rice Research Institute (IRRI) in the 1980s—saw the potential to breed FR13A's sought-after trait into some of the modern high-yielding rice varieties planted over vast flood-prone areas across Asia.

His reasoning, which emerged from discussions with IRRI deepwater rice breeder Derk HilleRisLambers, was that a flood-tolerant version of a popular modern variety could have an enormous impact. In Bangladesh and India, for example, farmers suffer annual crop losses because of flooding of up to 4 million tons of rice—enough to feed 30 million people. To the farm families and workers, and to the poor consumers who rely on rice for the bulk of their food, flooding can be truly disastrous.

So, the IRRI breeders—people who spend their careers mixing the genes of plants to develop new varieties that can handle harsh climates, or resist diseases and pests, or cope with problem soils—tried. And they succeeded. Sort of. They created higher-yielding rice plants that could handle major floods, but they never even got close to releasing them to farmers. During the breeding process, which transferred to the modern varieties whichever genes were giving FR13A its flood tolerance, too many unwanted genes moved across as well. The result was poor-tasting, flood-tolerant rice that yielded no more than existing varieties. And so the idea moved to the back burner.

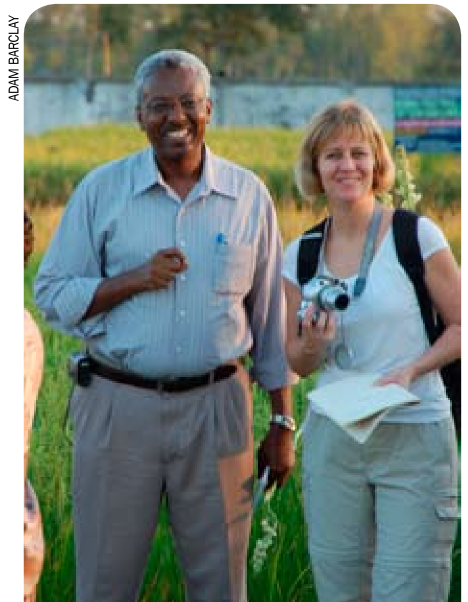


IRRI PLANT breeder Dave Mackill (*right*) swaps notes at BRRI's Rangpur station with UC Davis Professor Pam Ronald.

In 1991, Dr. Mackill left IRRI for the University of California (UC) at Davis. With FR13A still on his mind, he and his graduate student Kenong Xu took up the challenge of identifying the genes responsible for FR13A's scuba abilities. They eventually pinpointed the precise stretch of DNA that made the variety so interesting, and named the assumed gene *SUB1*.

The group subsequently teamed up with another UC Davis researcher, Pamela Ronald, an expert in isolating genes that give plants particular traits. Working in Dr. Ronald's lab, Dr. Xu and his wife, Xia, discovered a single gene, which they named *SUB1A*, and demonstrated that this alone was responsible for most of the flood tolerance.

Dr. Mackill, who by now had returned to IRRI, realized that the FR13A game was back on. By that time, 25 years after the first breeding attempts, agricultural science had come a long way. A new "precision-breeding" method, known as marker-assisted selection (MAS; see *On your mark, get set, select* on pages 28-29 of *Rice Today* Vol. 3, No. 3; also see *From genes to farmers' fields* on pages 28-31 of *Rice Today* Vol. 5, No. 4), allowed breeders to do much of their work in the lab. The new method shortened the breeding process and vastly improved the precision with which specific traits could be moved from one variety into another. He and his team were able to transfer *SUB1A* into widely grown modern rice varieties without affecting other characteristics—such as high yield, good grain quality, and pest and disease resistance—that made the varieties popular in the first place.



ADAM BARCLAY

DR. ISMAIL and UC Riverside scientist Julia Bailey-Serres share a laugh at BRRI's Rangpur station.

By 2006, the first Sub1 varieties were ready for testing at IRRI. The researchers set up plots of what they hoped would be flood-tolerant versions of several varieties—IR64, Swarna, and Samba Mahsuri—next to plots of their non-Sub1 counterparts. Once the plants had established themselves, the plots were flooded, completely submerging the rice for 15 days. Next, the water was drained to reveal muddy plots of limp, flattened, deathly looking plants.

Then, a remarkable thing happened. Within 2 weeks of the flood, almost all of the Sub1 plants recovered. They came back to life as if coached by Lazarus[1] himself. A few scattered clumps of the original versions made a comeback, but there was no comparison. At harvest, the Sub1 rice yielded more than twice as much as its neighbor (to view a dramatic time-lapse video of the experiment, visit http://snipurl.com/ebql8).

Around the same time, following Dr. Ronald's group's success in proving that *SUB1A* was indeed the right gene, Julia Bailey-Serres, a geneticist from UC Riverside who also worked on the gene's identification, began investigating exactly *how SUB1A* confers flood tolerance. It turns out that the secret is all about saving energy.

With colleague Takeshi Fukao, Dr. Bailey-Serres has determined that, when submerged, rice without *SUB1A* responds by increasing the pace of its elongation in an attempt to escape the submergence. Deepwater rice varieties are able to do this rapidly enough to succeed. In modern high-yielding varieties, however, the elongation is insufficient. If the flood lasts for more than a few days, the normal varieties expend so much energy trying—unsuccessfully—to escape that they're unable to recover.

Submergence of FR13A or any of the new Sub1 varieties, on the other hand, activates the *SUB1A* gene, which suppresses this elongation strategy, effectively shunting the rice plant into a dormant state until the floodwaters recede. Thus, the plants conserve their energy for a postflood recovery.

"Understanding things from this very basic perspective should allow us to achieve an even better plant more rapidly," says Dr. Bailey-Serres.

According to Dr. Mackill, the Sub1 project has shown the advantage of combining practical, applied work such as breeding and upstream, fundamental research.

""Knowing the exact gene responsible for a trait is not absolutely necessary for the MAS breeding approach, because a larger piece of the chromosome is transferred, normally containing many genes," he says. "However, by understanding the processes triggered by *SUB1A* in detail, "we hope to improve on the existing Sub1 varieties by identifying novel flood-tolerance genes that allow us to develop hardier plants that survive even longer periods of

[1]A Biblical name used to connote apparent restoration to life.

flooding, yet retain the characteristics that farmers want."

With the Sub1 concept well and truly proved, seeds were sent for testing and refinement to national organizations in South Asia, including the Bangladesh Rice Research Institute (BRRI) and, in India, the Central Rice Research Institute (CRRI) in Orissa and Narendra Dev University of Agriculture and Technology in Faizabad, Uttar Pradesh. The trial results there were also extremely promising.

In short, scientists had developed rice that could handle more than a week's flooding with almost no loss of yield (1 week is enough to severely dent the harvest of the nontolerant versions) and would recover to produce a reasonable yield after even 2 weeks' submergence (enough to almost wipe out nontolerant versions). Aside from the flood tolerance, the new varieties were virtually identical to their counterparts: farmers would be able to manage them in exactly the same way and, in the absence of flooding, achieve the same yield.

But, as any agricultural scientist will tell you, there is a vast gulf between the tightly controlled environment of the experiment station and the more capricious nature of a real farm. By 2007, the time had come to test the Sub1 varieties in farmers' fields. In this setting, there was no way of controlling when flooding would occur, how long it would last, or whether it would even happen at all.

ADAM BARCLAY (5)

BRRI SCIENTIST M.A. Mazid (*second from right*) speaks to onlookers about the success of farmer Mostafa Kamal's (*right*) flood-tolerant rice trials. Mr. Kamal's neighbor, Mohammad Shahidul Islam (*left*), is keen to grow the new varieties himself.

BRRI Former Director General Dr. Md. Nur-E-Elahi (*left*) and BRRI scientist M.A. Mazid explain the flood-tolerant rice trials carried out at BRRI's Rangpur station.

Moving forward to November 2008, to a small farm in Rangpur District in northwestern Bangladesh, researchers from IRRI, UC, and national institutes in India and Bangladesh commenced a South Asian tour to mark the completion of the project *From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments*, funded from 2004 to 2008 by Germany's Federal Ministry for Economic Cooperation and Development (BMZ).

If ever there was a country with flooding problems, Bangladesh is it. More than 1 million hectares—20%—of the country's rice lands are flood prone.

"In those areas where flooding occurs once or twice and recedes within 12–14 days," says BRRI Principal Scientific Officer M.A. Mazid, who has overseen the Sub1 trials at BRRI's Rangpur station, "the Sub1 varieties could survive and improve yields by up to 3 tons per hectare."

Given that Bangladesh is forced to import around 2 million tons of rice each year, BRRI Director General Mohammad Firoze Shah Shikder says that successful flood-tolerant rice could substantially reduce, if not eliminate, the country's imports.

"Sub1 varieties will add to the total production of the country," he says. "They will save a lot of money that would otherwise be used for importing rice."

Moreover, within that single, large-scale outcome, there would be thousands and thousands of equally positive, smaller-scale achievements. Many farm families, eking out a living on less than a hectare, could ensure that they had enough rice to eat year-round. Others would harvest enough to sell their surplus on the market and increase their income.

Mostafa Kamal is one of the farmers BRRI recruited to test the Sub1 varieties in his field. He and his brothers have a 6-hectare farm—large by Bangladeshi standards—that needs to produce enough rice each year to feed 22 members of the Kamal family. The farm suffers heavy losses because of flooding every 4 out of 5 years.

"In the past, many of my plots became fallow because they were flooded too often," says Mr. Kamal, referring to the lowest-lying 2 hectares of the farm. "If we can cultivate on these plots, it will help us produce rice to sell on the market.

Two extra hectares is a big jump."

So, how did the flood-tolerant varieties fare? Twenty-three days after the 8 July transplanting of the 2008 wet-season crop, the farm was hit by a 15-day flood. When the waters receded, Mr. Kamal witnessed a wonderful thing. In his Sub1 plots, 95–98% of the plants recovered. In the non-Sub1 plots, the figure was 10–12%. Many of his neighboring farmers, who were not involved in the trial, lost their entire crops. So encouraged was Mr. Kamal, he planned to give away—not sell—a kilogram of flood-tolerant seeds to each of his neighbors.

"When I saw Mostafa's field flooded, and then saw it recover, I was surprised—it was like magic," recalls Mr. Kamal's neighbor, Mohammad Shahidul Islam. The annual flash floods mean that Mr. Islam grows rice on only the upper half of his 1.6-hectare farm in the wet season. Each year, he needs to buy 1 to 2 months' worth of rice to cover his family's shortfall. He believes that flood-tolerant varieties will allow him to plant on his low-lying 0.8 hectare and cover that shortage. "These varieties," he says, "will mean more food, higher income, and a better livelihood."

FOLLOWING A 10-DAY flood, Orissa farmer Bidhu Bhusan Raut saw his Swarna-Sub1 recover well while his nontolerant Gayatri perished. "Better yielding is better living," he says.

"FORGET SWARNA! Go for Swarna-Sub1!" says Basant Kumar Rao, a rice farmer from Nuagaon Village near Cuttack in Orissa. Here, he stands in his crop of Swarna-Sub1, which recovered well after two floods hit his farm in the 2007 wet season.

Observing the success of the flood-tolerant varieties in Bangladesh was a watershed moment for Sigrid Heuer, an IRRI molecular biologist who contributed to the analysis of *SUB1A*.

"I knew all along *SUB1A* was working in any type of rice we put it in," she says. "I've seen it many times at IRRI and I've seen the data from the field experiments in India. But I'd never seen it in farmers' fields with my own eyes. Here, I've seen it after natural flooding for 15 days—the maximum time we think *SUB1A* should be able to withstand—and it's working. It's really fantastic."

A short flight away in eastern India, it is the same story. The states of West Bengal and Orissa, along with Uttar Pradesh in the northeast, have all seen equally promising trial results and plan to completely replace Swarna with Swarna-Sub1 as soon as it is officially released by state seed certification agencies. In West Bengal, Swarna dominates, with 80% of the rice area already planted to the variety. A move to Swarna-Sub1 would therefore be relatively easy and stands to have enormous impact.

"Forget Swarna! Go for Swarna-Sub1!" is the advice from Basant Kumar Rao, a rice farmer from Nuagaon Village near Cuttack in Orissa. "I trust Swarna-Sub1. I'll keep growing it. I got good money for it in 2007," he says.

That year, his farm was hit by two floods, one of 11 days and one of 7 days. The flood-tolerant rice recovered after both floods and, although he was able to salvage a little of his regular Swarna, it yielded nowhere near as well.

"Better yielding is better living," according to another Orissa farmer, Bidhu Bhusan Raut. In the 2008 wet season, Mr. Raut grew Gayatri, a popular Indian variety, and Swarna-Sub1 on his entire 1-hectare farm.

THE DEVELOPMENT and testing of flood-tolerant rice varieties—on show here at BRRI's Rangpur station—have attracted keen interest from plant scientists across the world.

A PATCH of the popular rice variety Swarna lies flattened and dying after several days of flooding. In contrast, the flood-tolerant version, Swarna-Sub1, rebounds to good health.

After a 10-day flood, the Sub1 plants recovered well, while the Gayatri plants perished.

According to CRRI Director T.K. Adhya, the release of flood-tolerant rice has become more and more important as India has grown economically.

"People used to grow rice in more favorable areas, where you had an assured source of water and good soil quality," he explains. "Now, those interior areas are being taken over by human habitation and industry, so farmers are forced onto marginal lands in the coastal areas where flooding, salinity, and many other problems occur. In the past, farmers simply had to face flooding and blame their luck if they didn't get a harvest."

IRRI plant physiologist Abdel Ismail, who is studying the mechanism of *SUB1A*'s action, says there is a strong case for rapid release of the new varieties.

"When you develop varieties using marker-assisted selection," he says, "you do not change the variety much. Because the *SUB1A* gene is very specific in its expression and action during submergence, the Sub1 varieties should not have any other problems—such as susceptibility to diseases or insects—that their nontolerant counterparts wouldn't have also. In the future, we expect many new varieties to come out as products of MAS. If you have a submergence-tolerant or salt-tolerant variety, for example, you want it to go to the field as quickly as possible, where it can make a big difference."

N. Shobha Rani, principal scientist at India's Directorate of Rice Research, says that traditionally bred rice must undergo testing for 3 years in all-India trials, but this has been reduced to 2 years for MAS-derived varieties.

"The second year of testing is 2009," says Dr. Rani, "so, April 2010 is the earliest time the Sub1 varieties could be recommended by the Central Variety Release Committee for national release." She notes, however, that release could occur on a state basis before then.

In fact, on 27 February 2009, only a few months after Dr. Rani talked to *Rice Today*, the Uttar Pradesh State Varietal Release Committee officially released Swarna-Sub1. Being nearly identical—apart from its flood tolerance—to Swarna, this inaugural release of a Sub1 mega-variety occurred very quickly: only 6 years after the first cross was made at IRRI.

A quick release is also possible because plants developed through MAS are not transgenic (that is, genes of interest are transferred to the target species or variety using particular biotechnological tools rather than conventional breeding). Therefore, the new Sub1 varieties are not subject to the regulatory testing that can delay release of transgenic products for several years.

ADAM BARCLAY (4)

EXAMINING TRIALS at BRRI headquarters in Gazipur, K.M. Iftekharuddaula (*right*) has bred flood tolerance into popular Bangladeshi rice variety BR11, which accounts for more than one-third of the country's wet-season plantings.

The Sub1 trait also came along with an additional bonus, a gene linked to *SUB1A* that turns the normally golden color of the hull of Swarna into a straw color. Although the hull color is not considered an important varietal requirement, this allows the seeds of Swarna-Sub1 to be easily distinguished from those of Swarna. This will be useful to maintain seed purity as seed producers start ramping up the production of foundation seed for distribution to farmers.

Another success to emerge from the Sub1 work has been the strengthening of national organizations such as BRRI and CRRI.

"In India now, MAS has a lot of support from the government," says Dr. Ismail. "In Bangladesh, BRRI has its own lab for MAS, and not just for *SUB1*. In the national agricultural research and extension systems, the project has boosted capacity through resources and expertise, and also through government support."

BRRI researcher K.M. Iftekharuddaula is a good example. He carried out his Ph.D. research under Dr. Mackill's supervision at IRRI headquarters in the Philippines, developing a flood-tolerant version of popular Bangladeshi variety BR11, which accounts for more than one-third of the country's wet-season plantings. After completing his thesis research, he returned to Bangladesh, where he is now the BRRI breeder responsible for refining BR11-Sub1 varieties for official release.

"We are very much hopeful that we'll be able to release at least two varieties from our efforts," says Mr. Iftekharuddaula, who is also working with IRRI to incorporate disease resistance and salinity tolerance into BR11-Sub1.

As Sub1 varieties are officially released over the next 2 years, the key will be dissemination to smallholder farmers in flood-prone areas. IRRI is leading this initiative through the project *Stress-Tolerant Rice for Poor Farmers in Africa and South Asia*, funded by the Bill & Melinda Gates Foundation. IRRI is also collaborating with national organizations to test Sub1 varieties in Southeast Asian countries, including Laos, Thailand, Cambodia, Indonesia, Vietnam, and the Philippines, through a project funded by Japan's Ministry of Foreign Affairs.

Dr. Ismail adds that *SUB1A*'s effectiveness offers hope for research into tolerance of other so-called abiotic stresses, such as drought and salinity.

"The general notion with abiotic stresses used to be that it would be very difficult to find a single gene that can make much difference," he says. "This work has shown that you can get a single gene of great agronomic value. I think this has set the tone for solving other major difficulties in the field, such as problem soils."

The story of the *SUB1* research underscores the capacity of science to improve people's lives, as well as the power inherent in a gene. It seems a long and unlikely journey from experimental plots in the Philippines and the laboratory benches in California to a small farm in Bangladesh.

For Drs. Ronald and Bailey-Serres, the chance to get out of the lab and see the Sub1 varieties in farmers' fields has been a profound experience.

"It was amazing to see that this detailed genetic and physiological analysis ultimately has potential for a grand impact on people who are often living in pretty desperate situations," Dr. Bailey-Serres says.

Even Dr. Heuer, who, through her work at IRRI, is no stranger to Asia's rice fields, has been moved. "I had no idea about the impact we can have before seeing it with my own eyes," she adds. "I've learned about the power of agricultural research here. I think it will have a huge impact."

Mr. Barclay is a freelance writer based in Australia. See www.irri.org/flood-proof-rice.

IRRI MOLECULAR biologist Sigrid Heuer (*center*) with her Ph.D. student Namrata Singh (*left*) and IRRI assistant scientist Darlene Sanchez at the Chinsurah Rice Research Station, in West Bengal, India.

EASING THE PLIGHT OF THE HUNGRY

by **Trina Leah Mendoza** and **David Johnson**

Monga (hunger months) occurs every year in Bangladesh. Researchers revisited the country in 2008 to find out how some farming technologies were able to help families cope during these tough times

A FARMER takes a break from weeding his field and eats lunch brought by his wife. For many farming families, lunch consists of just rice and curry.

TRINA LEAH MENDOZA (2)

In Bangladesh, hunger and poverty are part of the sad reality. Here, in one of the poorest and most densely populated nations in the world, millions of people suffer from severe hunger each year. The streets of Dhaka City are dotted with men, women, and children begging for alms. In the north, however, life is even harder. In five districts (Rangpur, Nilphamari, Kurigram, Gaibandha, and Lalmonirhat) 7 hours away from the country's capital, a famine known as *monga* occurs from September to November each year.

Monga (hunger months) occurs after the previous season's food has run out, before the transplanted rice is harvested in December. Millions of rural families who rely mostly on farm work for their livelihood are jobless and cannot afford to buy food in the market. In Rangpur, one farmer shared that he simply tries to sleep off the pangs of hunger during this period. He gets up only when he needs to check his field and if he has money to buy food in the market.

A team from the Irrigated Rice Research Consortium (IRRC) journeyed to these districts in October 2007 to learn more about the yearly famine and to see how some management options could help soften the blow on the people. The IRRC is a regional partnership program of the International Rice Research Institute (IRRI), with 11 countries committed to developing rice-growing technologies and disseminating these to farmers across South and Southeast Asia (see *Hungry for knowledge*, pages 32-33 of *Rice Today* Vol. 7, No. 2).

The IRRC teamed up with the Bangladesh Rice Research Institute (BRRI) and a local alliance called the Northwest Area Local Forum, which is composed of government institutions and nongovernment organizations (NGOs), including Rangpur Dinajpur Rural Service, Solidarity, Intercooperation, and Grameen Atto Unnayn Sangstha. Together, they are promoting earlier harvests through the use of a shorter-duration rice variety (BRRI dhan 33), direct seeding, and weed control options.

Compared with the traditional practice of transplanting, with direct seeding of rice, seeds are sown directly into an unflooded field, either as dry or "wet" pregerminated seeds. But, without the flooding of

A MOTHER feeds her daughters rice and curry for lunch.

fields, weeds are a major problem, and timely and appropriate weed management is essential to avoid drastically low yields.

On two visits to these districts in Bangladesh, Florencia Palis, IRRI agricultural anthropologist and IRRC social scientist, interviewed landless and marginal farmers about their hardships during *monga* and how they cope during these tough times.

Joshna, a 35-year-old farmer from Nilphamari, used to transplant rice in her small upland and lowland fields (a combined area of less than one-third of a hectare). In 2006, she harvested a meager 243 kilograms of rice from her upland field sown with Swarna, a traditional variety. But floods damaged her lowland fields. Heavily in debt, Joshna sold her two goats and a few small trees for wood to be able to buy food for her family.

Ironically, while Bangladeshi farmers suffer from annual floods, they also rely heavily on monsoon rains to prepare the land for rice. If the rains are too late or too little, farmers may not be able to plant the crop on time. Transplanting especially requires large quantities of water to flood the fields. For Joshna, there was not enough rainfall to quench the thirst of her fields.

In 2007, Joshna decided to try dry direct seeding using a *lithao* (a traditional hand-drawn tool) to sow the short-duration BRRI dhan 33. This decision changed her family's life. At harvest time, her fields yielded 560 kilograms of rice and gained an additional US$50 gross income. Now, her family no longer goes hungry. Joshna was able to pay her debts and buy a pregnant cow. Most Bangladeshi families consider cows very special investments that provide them with milk and cow dung (manure) for fertilizer. Aside from being able to buy meat and fish, Joshna is able to send her children to school and buy them other things such as notebooks, books, clothes, pencils, and bags.

Following the establishment and dissemination of rice-growing technologies among the farmers in Bangladesh, the IRRC came back

MD. AHADAT HOSSAIN

DR. FLOR Palis, IRRI agricultural anthropologist, interviews farmer Joshna Rahni about her struggles during *monga* and how direct seeding using an early-maturing variety has changed her family's life. Md. Anarul Haque (*far right*), a BRRI staff member, and Dr. M.A. Mazid (*far left*), head of the BRRI Rangpur station, translate for Dr. Palis.

in July 2008 to probe deeper into how these technologies benefited the farmers. They saw how things have improved and found out that the farmers are now singing a happy tune. These changes were captured in the video *Easing the plight of the hungry*, available in English (http://snipurl.com/d2018) and Bengali (http://snipurl.com/d2ufv).

Moreover, other than Joshna, Panchu and his family also benefited from these technologies. At first, Panchu's wife was hesitant to try direct seeding in their small field in Rangpur. But Panchu convinced her that, if they tried direct seeding using BRRI dhan 33, they could make use of the growing season and eventually harvest three crops such as rice, potato, and maize. True enough, they saw good yields at harvest time and appreciated the benefits of direct seeding. Now, they worry less about what they are going to eat next or where they can get money for their children's needs.

Other farmers tried the technologies for the same reasons: they can harvest earlier, sell at a higher price, and grow crops such as potato, maize, and chickpea.

IRRI agricultural economist and IRRC team member Arelene Malabayabas trained local interviewers to collect rice and other crop production data from 200 farmers through household surveys. BRRI dhan 33 direct-seeded during the *aman* (wet) planting season from June to July is harvested 30–37 days earlier on average than transplanted long-duration varieties. The early harvest generated employment of about 60–63 person-days per hectare, which means that landless laborers can earn wages during *monga*.

Direct seeding of an early-maturing variety combined with proper weed management has helped ease the suffering during *monga*. This has increased people's access to an early food supply, created jobs for the landless, and generated income for farmers to buy food for their families, and has significantly improved the quality of their lives. The Bangladeshi government has adopted these approaches and technologies for a national program for *monga* mitigation with a 3-year (2008-10) action plan.

Linking government organizations with NGOs that have active programs in the countryside and working closely with farmers' groups and rural communities have improved technology transfer.

Thanks to these developments and the active participation of the local partners, the farmers lead happier and healthier lives as they no longer worry about where to find food and employment when *monga* comes.

Ms. Mendoza is a communication specialist with the IRRC. Dr. Johnson is a senior weed scientist in IRRI's Crop and Environmental Sciences Division.

Conducted by Gene Hettel

GENE HETTEL (3)

In the Punjab—an outstanding farmer revisited

On 5 June 1985, the International Rice Research Institute (IRRI) honored 14 exceptional farmers in 10 Asian nations—truly pioneers in their own rite—by inviting them to the Philippines to participate in a special multilevel symposium that brought together outstanding scientists, farmers, and political leaders—all part of IRRI's 25th anniversary celebration. As IRRI approaches its 50th anniversary in 2010, we are trying to locate these same farmers 25 years later to find out their progress and get some updates. The first one we found is Sardar Jagjit Singh Hara who farms in Punjab, the breadbasket state of India. In November 2008, departing Rice Today *editor Adam Barclay and I visited him on his farm about 12 km outside of Ludhiana. He was billed as a progressive Punjabi seed farmer 25 years ago. Since his recognition then, Mr. Hara has often been visited by agricultural researchers and leaders who have come to see and evaluate his farming practices. Perhaps the most dramatic visit was the simultaneous appearance of a Nobel Peace Prize Laureate and a future World Food Prize Laureate on the same day.*

Something I had never dreamed of

My father, S. Ram Singh, was a progressive farmer and I would say that I inherited from him the gene that bestowed upon me my love for agriculture. After earning my master's degree in economics in 1960, I worked full time on this farm to produce seeds, as my father had. I also continued to grow various crops [wheat, potato, corn, ground nut]. In 1966, when the rice revolution came, I started to grow rice, not only as a commercial crop but also for seed production.

In 1985, to my great surprise, I got a big honor when I was recommended for an IRRI award as an outstanding farmer. My wife, Surjit, was also invited but, because of family reasons, she couldn't accompany me. It was a great occasion. I was so excited and elated that such a huge international honor would come to me—something I had never even dreamed of. It was gratifying to meet the 13 other Asian farmers recognized that day. I was unique [among that group] because I was a seed producer.

ADAM BARCLAY

I returned home with a "charged battery" because I had seen so many field trials at the IRRI research center—how to add fertilizer, the latest hybrid rice technology, etc. I wanted to share those things I learned with my fellow farmers here. I acquired this culture of sharing experiences from the International Farm Youth Exchange Program in America, which I attended in 1966. Generally, people want to keep their knowledge to themselves, maybe to put it in book form and sell it. But I had a commitment, a vow, to share my experiences, such as those I had at IRRI. When I came back from IRRI, around 100 farmers came to me and asked many questions, which I tried to answer. So, I would say I was married to IRRI.

Two more memorable occasions

On 22 April 1987, one great occasion happened. Norman E. Borlaug [the 1970 Nobel Peace Prize Laureate] visited me on my farm and, just by coincidence Gurdev S. Khush [IRRI's then principal plant breeder and future 1996 World Food Prize Laureate] also came. So, hanging on my wall now is a unique and rare picture (*photo opposite page*) of these two world-renowned scientists—a wheat breeder [Borlaug center] and a rice breeder—with one fortunate farmer. It is difficult to describe in words how I felt that day.

In September 1991, [the then IRRI director general, 1988-95] Dr. Klaus Lampe visited the nearby Punjab Agricultural University (PAU), an institution I am deeply associated with. They told him about me, that I am an IRRI outstanding farmer awardee, and so he came to see me. When he saw my setup, he invited me to come to IRRI again. I told him, "Dr. Lampe, some of my farmer friends want to come with me." He said, "Okay, we cannot pay your airfares, but all other arrangements for your stay will be taken care of by IRRI." Six of us came to IRRI in September-October 1992. It was a wonderful occasion. In my life, I have had many great experiences, but my two visits to IRRI and the visits of Drs. Borlaug and Khush to my farm on the same day are the most memorable ones.

HARA FAMILY ARCHIVES

Hara farm—a showcase for the rice-wheat rotation

Today, our farm is a joint family venture of 60 acres (around 25 hectares). Since my brother works in California, in the U.S., as an electrical engineer, I manage things around here. This is a large-scale demonstration farm, which is still in the process of resolving a big controversy. There is an ongoing debate in Punjab and all over India concerning whether or not wheat and paddy can be profitably grown in rotation. But when disbelievers come to my farm, I can prove to them that these two main cereals can be grown together.

Prior to the Green Revolution, rice was not popular in Punjab. It was grown only in the low-lying areas along the riverbeds and was not a regular crop like wheat, cotton, corn, etc. But, with the arrival of IR8 in India in the 1960s, along with the package of practices for the Punjab cropping pattern, the crop has been grown here ever since even though the water table is getting lower in this part of the country.

Previously, government experts couldn't convince farmers to transplant late. They transplanted early because there was a lack of mechanization, and diseases and insect pests were less of a problem. Recently, the government persuaded many farmers not to transplant before 10 June. Now, this year [2008], the results are very good. The water table is recharged and, luckily, the monsoon has also been favorable.

Wheat and rice are like two wheels on the same vehicle. If one wheel goes down, the other wheel cannot function either. I think these two "wheels," wheat and rice, complement each other. This year, the yields and the price of both crops have been good, rice with a slight edge over wheat, I think. Most importantly, we are feeding the people. I feel proud that I'm producing good-quality seeds for my farmer friends so that they can have better and better yields (For more on South Asia's rice-wheat cropping system, see *Strengthening the system* on pages 18-23).

Convincing the young that agriculture is a noble profession

[In his 1985 interview, Mr. Hara said that he would not pressure his son, Gurshaminder, to follow in his footsteps on the farm. And, true enough, "Dr. G. Hara" is a senior consultant surgeon at the Oswal Cancer Treatment and Research Foundation in Ludhiana. Now nearing 70, Mr. Hara worries about who will take over the family farm—maybe his grandson, Tejeshwar, but that is by no means certain.]

It is a burning issue these days that no young educated, dedicated person wants to be in agriculture. Why? First, it is a very hard job. Second, opportunities for growth are limited. Most importantly, agriculture in developing economies like India's is considered as a way of living, not as a profession. When trying to persuade my only son to stay on the farm, I suggested that he would get an opportunity to go abroad to see farms in America and Australia and to observe the research trials and experiments at IRRI. But he ultimately still said, "No. What is life on the farm? You work like a horse and there is no social life."

Indeed, professions in the city are more glamorous and the current generation is more money-minded rather than service-oriented. Why am I in agriculture? I wanted to be independent and to not be tied to the monotony of the same chair in the same office with the same job. And, secondly, God is my boss. I learned to drive on a John Deere tractor when I was 13 years old and that hooked me on agriculture despite the drudgery and the risk.

Now, the situation is changing; the world is crying for food security. I hope good sense will prevail and that, someday soon, the world will declare agriculture to be a noble profession just like medicine, law, and education.

In the complete transcript of this interview at irri.org/today/Pioneer_Interviews.asp, Mr. Hara discusses mechanization, water management, economics, and the major challenges today in Punjabi agriculture.

Asian consumption to drive markets in 2009

by **V. Subramanian**

World Grains Trade Summit sees Asian consumption driving the world grains market in 2009

V. SUBRAMANIAN

JEAN CRAVEN, Export Trading Corporation, detailing the finer points of trading with Africa.

The global financial crisis may have slowed the consumption of various commodities, but Asian demand for grains (as food and feed) remains strong. The first World Grains Trade Summit held on 17 to 18 February 2009, organized by the Centre for Management Technology in Singapore, reported that demand for 2009 will largely come from Asia.

As the world continues to recover from the effects of the 2008 crisis, the Summit expressed concerns about the current grain market riddled with risks and slowed by the world economic downturn. The participants hoped for the market to be less volatile, but the Summit reports indicated that this year's market will be affected by policies, climate changes, and other factors that may disrupt supply such as pests and natural calamities.

The growing Asian population

According to Diego Barber, global head of grains at Noble Group, Asia is home to 60% of the world's population, which continues to grow at 1–1.4% per year. He stressed that the region will play an important if not critical role in bringing more demand to trade in grains. In these volatile times, Asian grain demand has been upheld by population growth, rising per capita incomes, strong food policies, as well as decreasing energy and food prices, which helped reduce the risk of inflation.

"Global inflation reversed its sharp upward trend after 2008 as energy and food prices fell as a result of the economic slowdown," Barber said. "Lower inflation rates and declining food prices gave Asian consumers some relief, which helped maintain consumption patterns."

Challenges emerged, however, from the global credit crunch, the declines in economic growth rates in key emerging markets (the economies of China and India were expected to drop by 3–5%), and increased awareness and policy initiatives to ensure food security.

Nevertheless, the changing nutritional trends in the emerging Asian markets and the regional governments' efforts to maintain and protect strategic reserves have created a positive demand for grains, which would help drive consumption trend.

False sense of comfort

Rajeev Raina, head of Olam International's Rice Division, said that, following the market developments of 2008 and their impact on trade this year, rice markets may offer the world a false sense of comfort.

Not known to many, the world saw high production from 2003 to 2008. This increase in production is misleading because, for 4 years (2003-06) within that period, consumption exceeded production. Stock amounts also rose since late 2008 on the back of food security measures. Since 1991, yields have been falling behind population growth, which suggests that the production comfort zone has, for 18 years now, been eroded by the rising tide of consumption. Raina said that the world needed a 1.5% yield increase every year for the next 12 years just to retain the current balance.

Production increased last year in Thailand, India, Pakistan, and even Vietnam because of the rice price hike. Prices subsequently went down, which gave consumers a relative sense of security. This false sense of relief may be further exacerbated by India's possible return to the market. India banned exports of nonbasmati rice last year following the food crisis. If it lifts the ban soon and releases its rice stocks, chances are prices will come further down. Many fail to realize, however, that the fundamentals have not changed. The world continues to consume at a rate faster than production growth. The market needs efforts to overcome this gap. But, results do not happen overnight. It may take more than 10 years to see the results from any research initiative; hence, we can expect rice availability to be tight over the next decade.

In addition, although buffer stocks are rising, amounts remain relatively low. Hence, potential short-term imbalances in supply and demand are becoming more pronounced. Government export restrictions as well as climate changes can easily tip this finely balanced situation over to the critical side.

The Summit cautioned the participants against the possible risks of today's market. Among the many key features that would affect trends were the financial crisis, how investment funds will react or when they will return, the long-term promise of research, and the potential benefits offered by genetically modified crops. The event's presenters pinned much hope on Asia's strong consumption trend, which would help keep demand firm. Prices and policies, however, will still greatly determine the market's capacity to meet these future needs.

MAPS

Water mapping with SATELLITES

by **Yann Chemin** and **Robert Hijmans**

Rice is often produced in the lowest parts of the landscape. These are good places to grow rice because of the clayey soils and the relatively humid conditions because the groundwater is nearby. However, this low position, often in the floodplain of a river, makes the crop prone to flooding. If excessive water causes the crop to submerge, serious yield losses can occur. It has been estimated that, in Bangladesh and India alone, approximately 4 million tons of rice are lost every year. In South Asia, this is about equivalent to the amount annually consumed by 30 million people.

However, these estimates of production loss are rather uncertain because flooding is highly variable in time and space, and farmers have, in part, adjusted their cropping practices to expected flood occurrences. We would like to have a clearer understanding of where, when, and for how long flooding is likely to occur. This could help us understand where the benefits of submergence-tolerant varieties, which the International Rice Research Institute has developed (see *Scuba rice* on pages 26-31), would be greatest, and where these varieties would most likely be adopted by farmers.

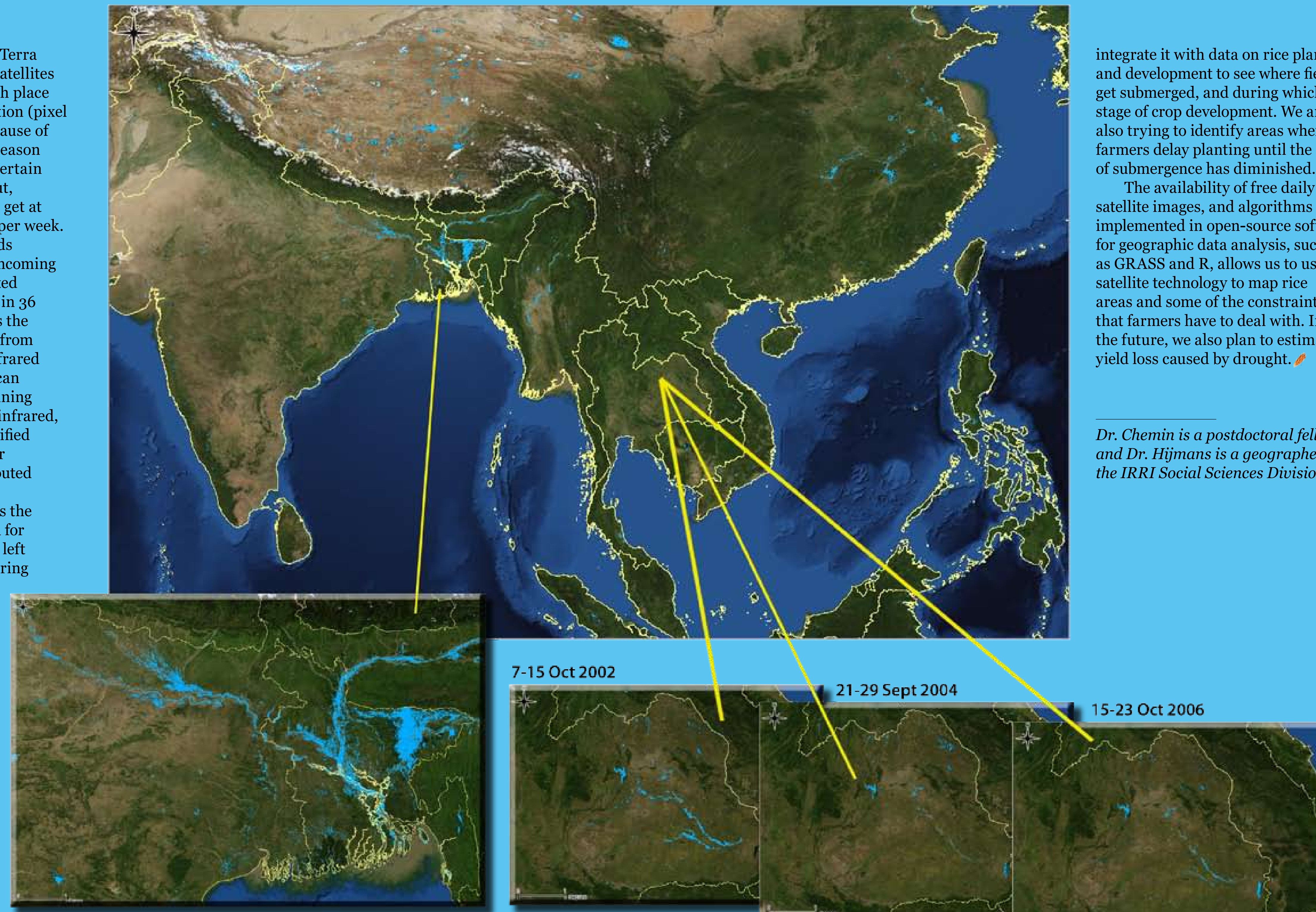
We use satellite remote sensing to map the area of rice production and the occurrence of flooding in Asia. We use freely available data from the Modis (Moderate-resolution Imaging Spectroradiometer)[1] sensor. This sensor is on board the Terra and Aqua satellites. These satellites create a daily record for each place on Earth at a spatial resolution (pixel size) of 250 to 1,000 m. Because of clouds, however, the rainy season can have many days when certain areas do not have values, but, generally, one can expect to get at least one good observation per week.

The Modis sensor records reflectance (the fraction of incoming radiant energy that is reflected from a surface of the Earth) in 36 different wavelengths across the electromagnetic spectrum—from the visible to the thermal infrared (0.4 µm to 14.4 µm). Water can be easily identified by combining reflectance in the red, near-infrared, and shortwave. Rice is identified using a combination of water and vegetation indices computed from the reflectance data.

The large map illustrates the results using the Modis data for identifying water. The lower left map shows surface water during 4-12 August 2007, when parts of eastern India and Bangladesh were affected by severe inundations. The three small maps of northeastern Thailand show areas with water in three different years: 7-15 October 2002, 21-29 September 2004, and 15-23 October 2006.

Identifying surface water is relatively simple. The challenge is to integrate it with data on rice planting and development to see where fields get submerged, and during which stage of crop development. We are also trying to identify areas where farmers delay planting until the risk of submergence has diminished.

The availability of free daily satellite images, and algorithms implemented in open-source software for geographic data analysis, such as GRASS and R, allows us to use satellite technology to map rice areas and some of the constraints that farmers have to deal with. In the future, we also plan to estimate yield loss caused by drought.



Eastern India and Bangladesh 4-12 Aug 2002

Northeastern Thailand

Dr. Chemin is a postdoctoral fellow and Dr. Hijmans is a geographer in the IRRI Social Sciences Division.

[1] See http://modis.gsfc.nasa.gov/ and http://onearth.jpl.nasa.gov/.

Drought-proof rice for African farmers

by **Savitri Mohapatra**

Research institutes, donor agencies, and community representatives collaborate to develop drought-tolerant rice for African farmers

It takes, on average, 2,500 liters of water (by rainfall or irrigation) to produce just 1 kilogram of rice using traditional cultivation methods. Considering the effects of climate change, can farmers continue to grow rice if the water supply becomes increasingly scarce?

Drought is particularly devastating to Africa's rice production since almost 80% of the region's rice area is rainfed. Many Africans still remember the terrible droughts of 1972-74 and 1981-84, which ravaged the Sahel and the Horn of Africa and caused immense suffering and severely affected farming—the principal source of livelihood for millions of poor people. Over the last four decades, Africa has suffered from seven major episodes of drought.

RV RAMAN (2)

THE AFRICA Rice Center gene bank conserves seeds of African rice species and shares them with rice breeders around the world.

Fortunately, rice has a significant genetic variation in traits related to drought tolerance, such as earliness, root architecture, and water-use efficiency. Scientists desperately look for these traits in varieties to be used in breeding programs and to develop improved high-yielding drought-tolerant varieties.

"One striking example of drought-tolerant local rice is *Oryza glaberrima*, which was domesticated in West Africa about 3,500 years ago," says Dr. Moussa Sié, program leader for Genetic Diversity and Improvement at the Africa Rice Center (WARDA). "It can recover after droughts when water is available again."

Plasticity and the capacity to regenerate quickly are the main advantages of African rice. "That is why, although it is not particularly high yielding, our rice farmers continue to grow it in pockets," Dr. Sié adds.

The development of drought-tolerant African varieties is one of the solutions to increase rice yields in drought-prone environments.

Generous support from donors, such as the UK Department for International Development and the World Bank, has allowed seeds of these precious varieties to be preserved in the WARDA gene bank, and then shared with researchers around the world through the International Network for the Genetic Evaluation of Rice-Africa.

This collection of African rice genetic resources was the key to the development of NERICA®—a cross between African and Asian rice varieties—by WARDA (see *In search of new seeds*, pages 30-31 of *Rice Today*, Vol. 6, No. 1). African rice farmers have shown particular interest in the early maturity of NERICA, which can be flexible enough to avoid drought and allow double cropping. Some NERICA varieties suited for rainfed production systems are now grown in several African countries.

In addition to the indigenous African rice, the African cultivated rice gene pools also have thousands of Asian rice (*O. sativa*) varieties. Although these varieties have just been introduced recently in the region, they have evolved long enough in Africa's harsh conditions and have developed a certain degree of resistance to local stresses such as blast and drought.

Now, WARDA scientists and their partners are investigating these gene pools. They are integrating phenotypic screening (physical characteristics) with molecular analysis (genetic composition) to unravel the secrets of drought tolerance.

Through molecular analysis, scientists identify the genes and/or the genetic regions (quantitative trait loci or QTLs) that possess drought-tolerance traits. After identifying these specific genes, scientists can then transfer them into improved varieties.

With support from donors such as the Rockefeller Foundation and the Generation Challenge Program, WARDA's research on drought has been carried out with several partners. These include national programs, the International Rice Research Institute (IRRI), Japan International Research Center for Agricultural Sciences, Cornell University, and Centro Internacional de Agricultura Tropical.

Scientists used a 3-pronged approach to improve rice varieties' tolerance of drought. It involved the characterization of drought profiles of rainfed rice production systems using GIS, the use of conventional breeding and marker-assisted selection (see *On your mark, get set, select* on pages 28-29 of *Rice Today* Vol. 3, No. 3; also see *From genes to farmers' fields* on pages 28-31 of *Rice Today* Vol. 5, No. 4) to develop drought-tolerant rice, and the use of integrated management options (manipulation of sowing dates, fertilizer regimes, and sowing density) to cope with the effects of drought stress.

As a result, several traits contributing to drought tolerance have been identified, along with the sources of drought tolerance. Work is under way to identify drought QTLs and produce drought-tolerant lines.

The threat of climate change, however, is greatly aggravating the drought problem. "The impact of climate change is already being felt in Africa through increased incidences and severity of droughts and floods," states Dr. Baboucarr Manneh, a WARDA biotechnologist deeply involved in drought research.

AFRICAN RICE is a rich reservoir of genes for resistance against local stresses.

"One of the most viable options to enable farmers to adapt to climate change is the use of rice varieties with good tolerance of drought."

Dr. Manneh is coordinating the African component of an IRRI project on stress-tolerant rice for poor farmers in Africa and South Asia (STRASA), which was launched last year.

Funded by the Bill & Melinda Gates Foundation, the STRASA project aims to accelerate the development and delivery of improved rice varieties tolerant of five major stresses—drought, submergence, salinity, iron toxicity, and low temperature. It seeks to develop integrated management options that would mitigate the negative effects of climate change in rice-based systems in these regions. Ultimately, however, it hopes to increase rice yields and the incomes of resource-poor smallholder farmers.

International researchers from IRRI and WARDA as well as partners from national agricultural research institutes, government extension, and civil society groups in 17 countries are very much involved in STRASA.

WARDA is IRRI's main partner in implementing the African component of this project. STRASA's member countries in Africa are Benin, Burkina Faso, Gambia, Ghana, Guinea, Mali, Nigeria, and Senegal in West Africa, as well as Ethiopia, Madagascar, Mozambique, Rwanda, Tanzania, and Uganda in eastern and southern Africa.

In February 2009, stakeholders met at WARDA's regional station in Ibadan, Nigeria, to review the project's progress and plans for 2009. In this meeting, Dr. Manneh highlighted some of the achievements made in 2008: seed production of improved and stress-tolerant varieties that will be evaluated in the project countries through farmer participatory varietal selection; training of national scientists, technicians, and farmers in modern breeding approaches, improved seed production, and impact assessment; implementation of improved and standardized screening facilities at WARDA research stations for the different stresses; and the establishment of a network of national scientists and partners in the project countries. The plans for 2009 include participatory varietal selection methods, seed production mechanisms, impact assessment studies, and monitoring and evaluation.

Dr. Manneh felt that the meeting was special because, aside from the participation of representatives from 16 sub-Saharan African countries, Mrs. Penda Gueye-Cisse, president of the West and Central Africa Women Rice Farmers' Association, and a number of private seed producers also came to give their feedback on the project.

Local scientists and farmers will collaborate to field-test those new stress-tolerant varieties in some "hotspots" in Africa.

"We realize that drought is a complex problem and it has to be addressed on several fronts," Dr. Manneh explained. "But we are sure that this joint effort on stress-tolerant rice will have widespread application in rainfed systems in Africa."

GLOBAL RICE TRADE:

What does it mean for future food security?

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

Rice is different from other major field crops such as wheat, maize, and soybeans because of its high geographical concentration in production and consumption (around 90% in Asia), literally making it an Asian crop. Historically, a very small proportion, around 5–7%, of total rice production has been traded compared with 20% for wheat, 13% for maize, and 30% for soybeans. More importantly, four of the top five exporters, with a 70% share of total global rice trade, are from Asia, for which domestic food security comes first and trade is a distant second (Fig. 1). For these rice-producing countries, trade is an afterthought when domestic need and an adequate buffer stock are secured. However, on the import side, the top five rice import-dependent countries accounted for only 29% of the total trade in 2007-08 (Fig. 2). Even the top ten importers accounted for only 45% of the total trade in the same year.

After almost two and a half decades (the 1960s to late 1980s) of being stagnant, rice trade zoomed upward in the wake of trade liberalization by many countries in the late 1980s and the General Agreement on Tariffs and Trade (GATT) in 1994.

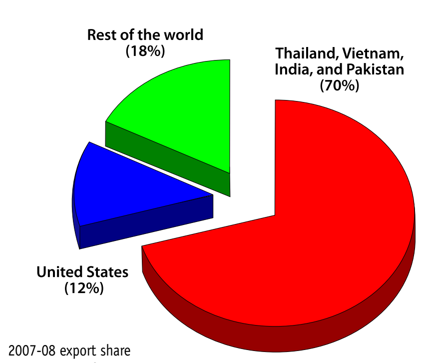


Fig. 1. Dominance of Asian rice producers in the global market.

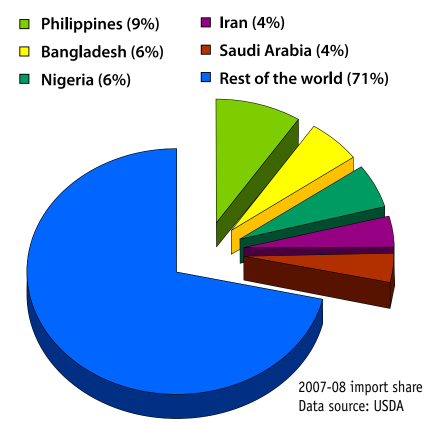


Fig. 2. Countries dependent on rice imports.

As part of the GATT market access commitments, countries partially opened up rice trade, which caused the volume to rise more than 50% in the past decade. Rising trade flows in the 1990s, characterized by a growing dependability between exporters and importers, contributed to the high degree of price stability during this period.

Political repercussions of the rice crisis

The recent crisis that triggered riots and protests in different parts of the developing world has put a big question mark on the future of global rice trade. The market was primed for such a crisis with the drawing down of stocks in the last few years to fill the supply-demand imbalance arising from the slowdown in yield growth, drought, and pest problems. However, the situation did not warrant the tripling of rice prices in the span of six months between November 2007 and May 2008. Rising wheat prices due to the expansion of biofuel crops put pressure on rice, which led to trade restrictions in many rice-producing countries and unprecedented rises in prices.

Measures taken by many exporting countries to ensure the availability of rice in the domestic market have affected many importing countries that rely on rice in the world market. In many rice-consuming countries, rice self-sufficiency has become a sensitive political issue, prompting policymakers to implement programs to reduce dependence on the global market.

Since rice is a staple food for about half of the world, it is understandable on the part of rice-consuming countries to protect domestic supply in uncertain times either by imposing trade restrictions or by expanding domestic production. These actions of both the exporting and importing countries are likely to reverse the recent upward trend in rice trade. The United States Department of Agriculture's rice outlook report now projects 2009 global rice trade to be 8% below the record level witnessed in 2007. All this points to lower trade and the risk of making shortages and high prices more frequent. It may sound odd to argue in favor of free trade in the face of the ongoing global financial crisis, but, for rice, which is highly protected and regulated, further protectionism can be severely damaging for the food security of millions of poor people.

What needs to be done?

The crisis has renewed the call for a second Green Revolution to revamp the sagging yield growth to feed the growing global population. In 2008, the International Rice Research Institute (IRRI) identified investment in agricultural infrastructure and rice research and extension as one of the keys to improving rice production. All members of the Association of Southeast Asian Nations have endorsed this position.

Several constraints, including land and water scarcity, environmental degradation, and high input prices, will make achieving higher rice yields challenging. But, we have proven our success in delivering research-driven solutions to farmers that increase yield and, with further investment, we can continue to do this. However, none of this is possible without supportive polices and institutions in place.

Apart from revamping the yield growth, the conduct of the world rice market, which played an important role in magnifying the intensity of the recent crisis, needs to be reined in if future crises are to be averted. The rice crisis starkly reminded us that the current structure, in which the majority of exporters are residual suppliers, does not bode well for the future of the global rice market. The future stability of the rice market clearly hinges on re-establishing the relationships between exporters and importers. It may be worthwhile to hold a summit of major rice-exporting and -importing countries to build those relationships, and at the same time collaboratively develop some basic rules in rice trading. Another option, which could be expensive but worth considering, is to rebuild buffer stocks in the major rice-producing countries, particularly in China and India, to have a calming effect on the market.

Aside from making investments and changes to increase rice yield within Asia, another potential long-term solution to this problem lies in developing rice exporters outside Asia where rice can be produced primarily for export. The transformation of the global soybean market three decades ago may give a clue as to what is needed in the rice market. In the soybean market, the United States used to be the big guy on the block, accounting for around 80% of world production and 95% of total exports throughout the 1960s and 1970s. The ban on soybean exports imposed by the U.S. in the early 1970s changed the entire landscape of soybean production and trade when other countries started looking for alternative suppliers of soybeans. Although the soybean crisis ended in a few months, the confidence in the U.S. as a reliable supplier was gone. Two South American neighbors, Argentina and Brazil, emerged from this crisis to become formidable competitors for the U.S. in the world soybean market. Currently, these two countries account for around half of the global soybean trade (Fig. 3). The emergence of multiple dependable suppliers also convinced many countries, including China, Japan, the European Union countries, Taiwan, South Korea, and others, to liberalize their oilseed sector and depend on imports. This is clearly evident for China, with 38 million tons of imports in 2007-08, accounting for 76% of the total domestic consumption (Fig. 4).

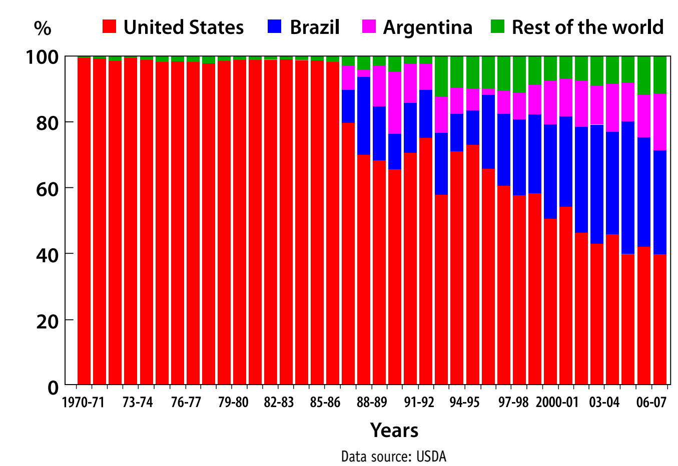


Fig. 3. Transformation of the global soybean market.

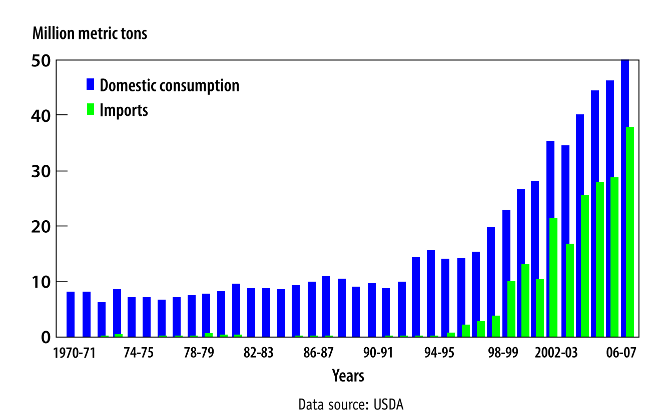


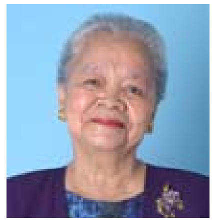
Fig. 4. Chinese dependence on foreign soybeans.

It is true that the current situation, in terms of land and water availability, is quite different from what it was in the 1970s and 1980s. Nobody expects countries to give up rice production and become dependent on the international market even if new suppliers emerge. But, more surplus rice produced by new suppliers could help stabilize the market and reassure the importing countries.

Within Asia, Myanmar and Cambodia potentially seem to have surplus rice production. Rice production in these countries can be expanded through intensification and by bringing additional fallow land into production. However, this is possible only under stable political and economic conditions. Outside Asia, the potential to increase rice production exists primarily in South America and Africa. Currently, South America is more or less self-sufficient in rice and has the land mass to expand rice production if the underlying economics make sense. Africa, on the other hand, probably has more potential than even South America because of its underused land and water resources. But, Africa requires a stable political environment and the necessary investment for infrastructure and market development to boost its rice production.

Nonetheless, the bottom line is that the rice supply needs to increase to improve future food security. Rice yields within existing rice-growing regions in Asia can be increased if technology-driven solutions are delivered to growers through effective extension mechanisms, and if investments are made. Better agricultural infrastructure and policies must support this to improve the reliability of supply. Finally, new international suppliers of rice could also play an important role in providing new sources of rice to importers.

grain of truth



CAN LESS FAVORABLE AREAS OBTAIN FOOD SECURITY?

BY GELIA T. CASTILLO

Rice is life. So, when the global rice crisis hit in 2008, it threatened many lives. The year became well remembered for the soaring prices, the long lines in the market, the panic, the blame game, and the social unrest in different countries. A sense of alarm grew when rice, known to be the most "affordable" food for the poor, suddenly became "unaffordable." It reminded the world of rice's crucial role in human existence. It also revived interest in agriculture.

Researchers often focus on farming on irrigated, favorable, and accessible farms. But we may fail to realize that many farmers contend with unfavorable areas just so their families can have enough rice to eat and survive. These so-called unfavorable areas are rainfed parcels; uplands; drought-prone, flooded, and submerged farms; farms with saline soils; etc.

For a long time, rice science did not favor investing in unfavorable areas as they were too diverse, complicated, and difficult. Compared with irrigated farms, these topographically, ecologically, and climatically challenged areas provided meager harvests. When the international development community adopted poverty as its flagship challenge, the opportunity came to establish the Consortium for Unfavorable Rice Environments (CURE) in 2002. Fostering cooperation between the national agricultural research and extension systems and the International Rice Research Institute, this initiative involves 10 countries: Bangladesh, Cambodia, India, Indonesia, Lao PDR, Myanmar, Nepal, the Philippines, Thailand, and Vietnam. As CURE focuses its research on the development of less favorable areas, the goal is to provide more food security for the poor families in the marginal and diverse rainfed environments in monsoon South and Southeast Asia, through more sustainable and resilient rice-based production systems.

Using an ecosystems paradigm, the research sites under the CURE project include drought-prone plateau uplands, drought-prone lowlands, salt-affected lowlands, sloping rotational upland systems, the submergence-prone environment, and the intensive upland systems with long growing seasons. The project uses a common approach to examine eight generic themes (germplasm improvement, rice varietal diversity, seeds and seedling management, crop establishment, cropping system enhancement, up-scaling activities, patterns of labor use, and food security) across the different sites, but the resulting technologies are specific to each ecosystem.

> *Using science in combination with local practices to meet the challenges of diverse rice environments, CURE made rice security in less favorable areas a realizable goal.*

Among these technologies, the primacy of seeds is the most recurrent. For the Filipino farmers in the Arakan Valley, for example, rice seed security is food security. When they run out of food, the people start to eat their seeds. Hence, they set up a community seed bank.

Through participatory varietal selection, farmers chose seeds among different varieties that performed well in the field compared with the traditional ones. Along with this, CURE introduced the concept of clean and healthy seeds, lower seeding rates, and quality seedlings. Direct-seeding technologies resulted in earlier crop establishment and harvest, less labor, and better weed control. With shorter-duration varieties and time-saving crop establishment, it also became possible to grow nonrice crops for cash and employment.

Anthropologist Stephen Zolvinski observed some of the technologies that resulted from the process. The submergence-tolerance gene known as *SUB1A* was transferred to Swarna, a popular variety in South Asia (see *Scuba rice, stemming the tide in flood-prone South Asia* on pages 26-31). The development of this variety is an example of how modern scientific tools are combined with locally popular varieties to produce improved varieties that are stress tolerant and acceptable to farmers. The *SUB1A* gene can now be found in Samba-Mahsuri-Sub1, IR64-Sub1, and Swarna-Sub1.

More importantly, these technologies have helped reduce the number of farmers who migrate to nonfarm jobs during the hunger months.

"If we have enough rice to eat, why would we leave the village?" the farmers said.

In summary, to achieve the goal of rice security, CURE's general strategy involves early-duration and higher-yielding varieties; improved labor-saving practices; and earlier crop establishment and harvest, which allow a nonrice crop to be sown on time and intensify system productivity, enhance food security, and generate income.

Using science in combination with local practices to meet the challenges of diverse rice environments through a common approach, CURE found the common denominators and made rice security in less favorable areas a realizable goal.

Dr. Gelia T. Castillo is a national scientist of the Philippines and IRRI consultant.


You want rice. We have rice.
Let's trade!