Rice Today

www.irri.org
International Rice Research Institute
July-September 2009, Vol. 8, No. 3

Making rice less thirsty

Overcoming the toughest stress

Saving water with new technologies
The promise of Latin America
Uganda's rice revolution
Challenges for IRRI in 2010

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contents

Rice Today
Vol. 8, No. 3

On the cover:
A boy harvests NERICA4 in Deve, Benin, West Africa. Rice is generally grown by smallholders in Benin, which is a net importer of rice from East Asia. Rice production, in particular upland varieties grown on dry land, has been boosted by the introduction of NERICA varieties by the Africa Rice Center.

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

TRT, for 19 years, brought its subscribers crucial, up-to-the-minute information on rice trade through its weekly publication, *The Rice Trader.* Acknowledged as the only source of confidential information about the rice market, this weekly summary of market data analysis has helped both the leading commercial rice companies and regional government officials make informed decisions, which are critical in today's market.

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

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

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

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

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Stressing the Solutions

We live in a stressful world. Indian farmers are no doubt stressed about delays in rice planting this year because of a lack of rain. Nations on the hunt for arable rice-growing land beyond their borders also surely feel the stress of providing rice for their people. Even getting *Rice Today* published on time has caused its fair share of stress! We all face stress, and rice itself is not exempted.

In this issue, we explore a key stress for rice—water scarcity. On a global scale, it is predicted that, within 25 years, 15–20 million hectares of irrigated rice will suffer some degree of water shortage. Solutions in the form of good land preparation and the use of aerobic rice varieties promise to make every drop count to help maintain sustainable rice yields. New drought-tolerant rice varieties bred by the International Rice Research Institute (IRRI) have also just arrived in India and the Philippines and, in the future, genetically modified rice varieties may also help farmers maximize the potential of drought-prone land. IRRI is screening experimental lines of genetically modified rice for drought tolerance. With drought considered one of the most difficult stresses to overcome, the IRRI team has made significant headway by identifying some promising lines that will be further tested and evaluated.

Three months ago, *Rice Today* reported on the collaboration to develop African drought-tolerant rice varieties. Africa is fast becoming a major rice producer. Uganda, in particular, has increased its production 2.5 times from 2004 to 2008 through government initiatives, private investment, and farmer support. This remarkable feat sees Uganda well down its path to rice self-sufficiency, and it may even be able to export rice one day.

As IRRI approaches its 50th anniversary, we take a look at the Institute's greatest challenges. We culled the views of former IRRI directors general, senior staff, and associates, and featured them in this issue's Pioneer Interviews section. From using biotechnology and finding IRRI's niche as our partners improve their capacity to addressing climate change and funding needs, many insights indicate how IRRI can achieve its aims as it looks to the future.

IRRI continues to strengthen its capacity-building programs, one of which is the Rice Knowledge Bank (RKB). This program is making inroads across many major rice-growing countries, providing them with a free and reliable repository of best-practice information. Many countries have adopted the concept of the RKB and have applied it nationally with great success. It is now used as a model for application with other crops and livestock.

Rice growers making the most of shared knowledge, such as that in the RKB and maybe even within the pages of *Rice Today*, can, we hope, find solutions to help them deal with the stresses their rice crops face and, indeed, with the stresses of growing rice. Although we cannot always avoid stress, we can certainly come up with ways to deal with it.

Sophie Clayton
Contributing writer

HIDDEN TREASURE

Time is an important element in life. A little over a year ago, the world screamed about food shortages as markets rallied to set new records and as rice prices rose above $1,000 per metric ton, sending the world into a flurry of rhetoric. The sad reality is that, fundamentally, the situation now is just as dire. Millions continue to face starvation. But, as prices today fall back to normal levels, many are lulled into a sense of false comfort—one that comes as a result of last year's events and one that, more importantly, begs focus on sustainability. On a personal note, the new team is now on its second issue of *Rice Today*.

The Rice Today team has been well positioned for this issue. Our recent visit to Miami, USA, for The Rice Trader Americas Conference 2009, allowed us to hatch the plans for this magazine's first-ever feature on Latin America. Also, the event saw a number of us on the team, namely, I (the publisher), Duncan Macintosh (associate publisher), and V. Subramanian (managing editor), take active roles in chairing sessions, delivering presentations, and networking with many rice industry representatives from South, Central, and North America, as well as the Caribbean. The conference dealt with significant themes such as sustainable development, the continued need for research for consistent growth in production, some detailed analysis of last year's amazing rice market developments, and a peek into the present and future of rice.

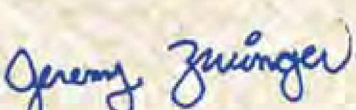
Former Governor and U.S. Secretary of Agriculture Ed Schafer (left in photo) graced the event, and he was honored with the first TRT Market Achievement Award. This award recognized the importance of government stewardship in food security, and emphasized the important role of food policy in the development of the rice industry.

With The Rice Trader Americas Conference 2009 concluded, we now shift our focus back to Asia, where the team is currently putting together The Rice Trader World Rice Conference 2009. This new event is set to be held in Cebu, Philippines, on 27-29 October 2009. As we work on this, we bear in mind some of the important lessons we have learned. There is a changing sentiment (a trade psychology that is often underestimated) and many question today what happened to rice demand. Quality has reappeared as a problem as lower grades find it hard to look for markets (the 25% grades market is just one example), and as stock-to-use ratios look unbalanced between rice origins and destination markets. With problems compounded by a financial crisis in which less credit is available, exporters struggle to register sales and importers prefer to take a cautious approach to stock-building. India's expected return to exports was felt as far away as South America, as sentiment points toward a lower rice price.

Moreover, the U.S. dollar is an important element within this equation, with future trends expected to have an impact on the future price of rice. Add specific regional demand-supply fundamentals to the analysis, and what is immediately clear is a "symmetric negative correlation," which suggests that a falling dollar will keep rice (and commodity) prices higher. This consequently unveils a major factor that cannot be underestimated. We expect a pitched battle between the current negative sentiment that draws prices lower—especially with India possibly returning to the export market soon—and the U.S. dollar, whose value is shaped by the global and U.S. economy. The result of this battle will mark price trends.

This issue's true hidden treasure reveals the U.S. dollar as a global concern, and one that I expect to weaken in the coming months. Technical factors suggest falls, as do market fundamentals, as the U.S. debt (considered the highest debt in relation to the gross domestic product since President Truman was in office in the late 1940s) and fiscal policy spending (set to be $1.4 trillion in the coming budget) put more pressure on an already weak dollar. Many already call this the "dollar trap," wherein the value of several countries' reserves (in U.S. dollars) will become lower as a resulting of the falling dollar.

Perception and sentiment often mask the truth. Today's media also hold a wide spectrum of views, in which finding the truth is akin to climbing a slippery mountain in the rain. Risk is a feature of the modern rice business, with every policymaker, businessman, and even farmers playing a game in which the stakes are higher and mistakes are amplified. Good, reliable information therefore holds the key to good decisions.



Jeremy Zwinger
Publisher

Letters

Dear Mia,

I wish to congratulate you, Jeremy Zwinger, and all your colleagues for the outstanding get-up and contents of *Rice Today* (Vol. 8, No. 2). I am happy to read your editorial, *Reasons for Hope*, and also Jeremy's piece on *Hidden Treasure*. I am also happy that you have highlighted the value of Scuba rice.

I am glad that Gene Hettel has begun revisiting the outstanding farmers I had identified, with the help of the late Dr. Dioscoro Umali, for the 25th anniversary of the International Rice Research Institute (IRRI). As the then director general of IRRI, I felt that an appropriate manner of commemorating the 25th anniversary was to honor 25 outstanding rice farmers in Asia (both men and women) and learn from their insights. My wife, Mina, had arranged to interview all of them, and compiled these interviews into a book, which was published by IRRI under the title *Insights of Outstanding Rice Farmers* (http://snipurl.com/L1HDE). This book was also translated into Tagalog and several other languages.

Mr. Hettel will do a great service by following the subsequent work of the other outstanding rice farmers of 1985. I was sorry that we could identify only 14 farmers. We wanted to honor at least 25 farm women and men.

I wish you continued success in making *Rice Today* the flagship of the movement for rice for all and forever.

With warm personal regards.

Yours sincerely,

M.S. Swaminathan
Chennai, India

Dear Mr. Hettel,

It gives me great pleasure to inform you that I got a copy of *Rice Today* (Vol. 8, No. 2) through a friend of mine from the International Rice Research Institute office in Delhi.

Once again, I thank you for publishing my two-page interview in your globally renowned magazine. Messages and telephone calls from old and new friends all over the world poured in like rain. You have made me very popular. My friends have observed that my photograph with Dr. Norman E. Borlaug and Dr. Gurdev S. Khush is rare, and they have advised me to take special care of it since such an event is unlikely to be photographed again.

As this issue of *Rice Today* is of great importance to me, I would like to request a few more copies for my library at home. I would gladly pay for these copies and other costs, if there are any.

How about your visit to India in the near future? I am very eager to meet you again soon.

With best wishes and personal regards,

J.S. Hara
Ludhiana, India

Dear Duncan,

I just finished the April-June edition of *Rice Today*. Great job!

I skim a lot of center publications, but I actually read and enjoy *Rice Today*. The story on rice-wheat was particularly interesting and informative.

Please send my congratulations to the team responsible for the publication's production.

Edward W. Sulzberger
Galveston, Texas, USA

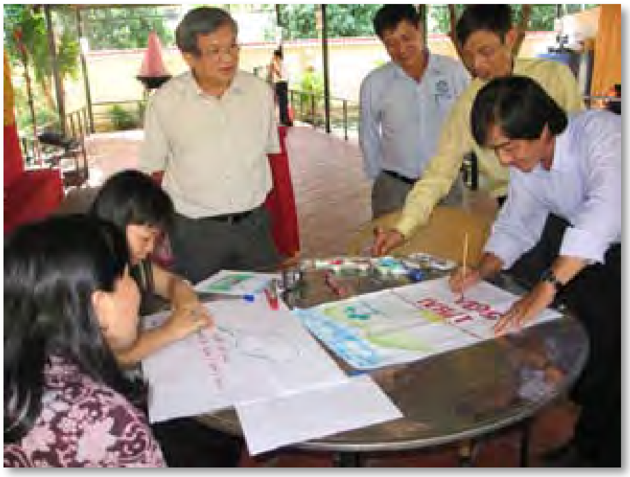
Letters should be sent with the writer's name, address, and e-mail address to mia.aureus@thericetrader.com or l.reyes@cgiar.org. Letters may be edited for length and clarity, and may be published in any medium. All letters become the property of Rice Today.

Rice Today around the world

1. ***RICE TODAY*** **publisher, Jeremy Zwinger (*standing*), shares the magazine to participants of the Rice Americas 2009 conference in Miami, Florida. Others in the photo (*from left to right*): Bob Papanos, Thomas Wynn, and Ramiro Velasquez.**
2. **KAJISA MAHARU, daughter of IRRI senior scientist Kei Kajisa, takes the magazine to the Lion City (Singapore).**
3. ***RICE TODAY*** **at Batad Rice Terraces, Philippines: (*front row, left to right*) Corinta Guerta, Vel Ilao, and Eric Clutario; (*back row, left to right*) Yeyet Enriquez, Zeny Federico, and Mike Jackson.**
4. **CAMBODIAN YOUTHS happily read *Rice Today*.**

Media campaigns used to communicate with farmers

IRRI



Following the success of the *Three Reductions, Three Gains (3R3G)*, or *Ba Giam, Ba Tang*, campaign in Vietnam, the An Giang Department of Agriculture and Rural Development (DARD) and IRRI, through the Irrigated Rice Research Consortium (IRRC), are working together to carry out the new campaign, *Five Reductions, One Must Do*, or *Mot Phai, Nam Giam*.

Three Reductions, Three Gains successfully used a radio drama, a television drama, a 30-second TV commercial, posters, flyers, and extension efforts to encourage rice farmers to reduce unnecessary insecticide, seed, and fertilizer use. The reduced inputs resulted in similar or higher rice yields and net incomes. *Three Reductions, Three Gains* has won multiple awards, including most recently the United Nations–Habitat Dubai International Award for Best Practices.

The new *Five Reductions, One Must Do* program adds recommendations on reducing postharvest losses and water use, and timely use of fertilizers. The one "must do" is to use certified seeds. An Giang Province has become a national model for implementing this program.

In a similar project, IRRI, as part of the Food Security for Sustainable Household Livelihoods (FoSHoL) project funded by the European Commission, has produced an experimental drama series for television that is being aired in Bangladesh.

Jiboner Jolchobi will be used to test the effectiveness of using a TV drama series as a means of communicating to Bangladeshi farmers and other stakeholders messages related to agriculture and livelihoods. *Jiboner Jolchobi* is now airing on ATN Bangla every Wednesday, except on 15 July, at 5:30 p.m. until 5 August 2009.

IRRI alumni homecoming

As part of IRRI's 50th anniversary celebrations, IRRI is hosting an alumni homecoming. All past employees and those who have worked with IRRI in other ways, as well as their families, are invited to return to participate in two weeks of alumni activities from 18 April to 2 May 2010.

There will be tours of local sites, including the IRRI campus, IRRI staff housing, the University of the Philippines Los Baños, and tourist sites in Laguna and Tagaytay. Tours elsewhere in the Philippines, including Banaue, Boracay, Batangas, and Palawan, will also be included as options.

Photo exhibitions, opportunities to meet the current batch of IRRI scientists, and Philippine cultural events—including food and dancing—are all on the program, making the IRRI alumni homecoming an entertaining event not to be missed by anyone with a connection with IRRI sometime in the past 50 years.

For more information, visit www.irri.org/alumnihomecoming2010.

Filipino farmers welcome new rice varieties

Three new rice varieties designed to help Filipino farmers grow more rice in difficult conditions have been officially recommended for approval for commercial cultivation in the Philippines and are expected to help the Philippines become less dependent on rice imports.

Bred by the International Rice Research Institute (IRRI), one variety is flood-tolerant, one is drought-tolerant, and one is salt-tolerant.

"In the Philippines, about 400,000 hectares of rice-growing land are affected by salinity, and in any year up to 370,000 hectares can be flood-affected," said Dr. David Mackill, program leader and plant breeder at IRRI. "Both these conditions can completely destroy a rice crop or decrease yield.

"Yield is also reduced by drought that occurs in upland and rainfed areas where rice is not irrigated. Having rice varieties that can cope with difficult growing conditions such as flood, drought, and salinity will be particularly helpful for poor farmers who rely on marginal land to grow their rice.

"Rice-growing land that has limited productivity will become more productive when these new rice varieties are used, and this will help Filipino farmers produce more rice."

"The Rice Technical Working Group of the National Seed Industry Council will now recommend the varieties for official approval, which is expected to occur sometime in late 2009," said Ms. Thelma Padolina, NCT national coordinator at PhilRice.

MOISES JOHN REYES

BRIEFLY

World hunger 'hits one billion'

One billion people throughout the world suffer from hunger, a figure which has increased by 100 million because of the global financial crisis, says the UN. The UN's Food and Agriculture Organisation (FAO) said the figure was a record high.

Persistently high food prices have also contributed to the hunger crisis. Jacques Diouf, FAO director general, said the level of hunger, one-sixth of the world's population, posed a "serious risk" to world peace and security.

The UN said almost all of the world's undernourished live in developing countries, with the most, some 642 million people, living in the Asia-Pacific region.

In sub-Saharan Africa, the next worst-hit region, the figure stands at 265 million. Just 15 million people are left hungry in the developed world.

"We urgently need to forge a broad consensus on the total and rapid eradication of hunger in the world and to take the necessary actions," said Dr. Diouf.

Source: BBC News

World far from halving poverty by 2015

The world is far from reaching the 2000 Millennium Declaration of halving the proportion of the world population facing poverty and undernourishment by 2015.

Such was the conclusion reached by the ministers of agriculture of the G8 countries when they met in Italy in April 2009 and received "alarming data" provided by relevant international bodies.

As part of their statement to world leaders, the ministers said that agriculture and food security are at the core of the international agenda. They called for increased support and action to alleviate poverty and hunger, encourage sustainable agriculture, avoid unfair competition, and increase investments in agriculture and research.

Source: www.g8agricultureministersmeeting.mipaaf.com/en/

Global food supply better this year

With the second-highest global cereals crop expected this year and stocks replenished, the world food supply appeared less vulnerable to [external] shocks than it was during last year's food crisis, the Food and Agriculture Organization said in its Food Outlook report released in early June 2009.

"International prices of most agricultural commodities have fallen in 2009 from their 2008 heights, an indication that many markets are slowly returning to balance," the twice-yearly report said.

In 2009-10, reductions were forecast for wheat and coarse grains, whereas the global rice crop may register another marginal increase. Sizable increases were expected in rice output in Cambodia, India, Indonesia, the Philippines, Sri Lanka, and Vietnam, the report said.

Source: www.hindu.com/2009/06/05/stories/2009060560332400.htm

Vietnam aims for biotech crops

Vietnam strives to turn its agricultural biotechnology into one of the best in Southeast Asia, as it aims to make the sector world-class by 2020, said Pham Van Toan, chief administrator of the Biotechnology Programme.

Based on the plan, new crop varieties developed by biotechnological techniques will account for around 70% of cultivated area across the nation—between 30% and 50% of which will be genetically modified plants.

Source: Viet Nam News

Asian rice producers offer support to double African rice output by 2018

Five Southeast Asian rice-producing countries as well as Egypt and Brazil offered their support for sub-Saharan Africa to achieve a goal of doubling annual rice output in the area by 2018 from the current level of about 14 million tons, officials of Japan's aid agency said.

Major rice producers Indonesia, the Philippines, Malaysia, Thailand, and Vietnam highlighted their experience in developing the staple food at a Tokyo meeting of the international network, the "Coalition for African Rice Development," which was set up in 2008 by Japanese and international agencies to help African nations realize the target.

Source: MCOT English News

Awards and recognition

IRRI Director General **Robert Zeigler** received the 2009 E.C. Stakman Award from the University of Minnesota Plant Pathology Department. Created in 1955 by E.C. Stakman, the award recognizes individuals for outstanding achievements in and contributions to plant pathology in research, teaching, outreach, international development, or any combination of these. Past award winners include Norman Borlaug, George Harrar, E.J. Wellhausen, Sanjaya Rajaram, and Sir Bent Skovmand.

William Padolina, deputy director general for operations and support services, received the 2009 Communication Excellence in Organization Award (academic, research, and training category) from the International Association of Business Communicators. The CEO Excel Award is given to senior executives who have successfully used communication for the goals of their organization.

The 2008 IRRI Awards for nationally recruited staff went to associate scientists **Anita Boling** and **Alvaro Pamplona** for their outstanding scientific achievement, research technician **Anicio Macahia** for his outstanding research support, and the Program Planning and Communications (PPC) team for its outstanding administrative support. The PPC team members are **Corinta Guerta**, **Zeny Federico**, **Velinda Ilao**, **Eric Clutario**, **Marileth Enriquez**, and **Sol Ogatis**.

DR. PADOLINA (2nd from left) receives the CEO Excel Award.


2008 IRRI NRS awardees

Keeping up with IRRI staff

New BOT member. **P. Stephen Baenziger**, a professor at the University of Nebraska-Lincoln (UNL) Department of Agronomy and Horticulture, has been selected as a member of the IRRI Board of Trustees and he will begin his 3-year term in January 2010. Dr. Baenziger is the primary small grains breeder at UNL, where he has worked since 1986. He studied biochemical sciences and graduated *magna cum laude* from Harvard University. He received his master's and Ph.D. degrees in plant breeding and genetics in corn from Purdue University.

Elizabeth Humphreys is now a senior scientist (water management specialist) in the Crop and Environmental Sciences Division. She will lead IRRI's field-scale research on water-saving irrigation techniques and conservation agriculture systems, with emphasis on South Asia and China. **Mahesh Kumar Gathala** (research platform coordinator) of the IRRI India Office is also now a senior scientist. A new scientist at IRRI headquarters is **Jauhar Ali,** who is the regional project coordinator (Asia) for Developing Green Super Rice. New scientists at the IRRI India Office are **Parvesh Kumar Chandna** (remote sensing and GIS), **Virender Kumar** (co-facilitator, Rice-Wheat Consortium), and **Sharma Sheetal** (soil health). **Mr. Alfred Schmidley** joined IRRI as consultant on Grain Quality, Nutrition, and Postharvest.

New senior associate scientists are **Violeta Bartolome, Nancy Castilla, Mary Jacqueline Dionora, Antonio Evangelista, Alvaro Pamplona, Rodolfo Toledo,** and **Joel Janiya; Ireneo Pangga** is a new associate scientist; and **Rowena Castillo** and **Arlene Julia Malabayabas** are new assistant scientists.

Yashpal Saharawat, a new postdoctoral fellow based in New Delhi, India, is working as part of the Cereal Systems Initiative for South Asia.

Moved on. IRRI bid farewell to postdoctoral fellows **Matthieu Conte, Yann Chemin** and **Jacob van Etten**.

Rice Thesaurus now on the Web!

Rice scientists and students no longer have to tediously flip through an entire book when they do literature research. Now available online is the *IRRI Rice Thesaurus*, a searchable electronic database of terms related to rice. It is accessible at http://agclass.nal.usda.gov/irri/rice_search.shtml.

The *Thesaurus*, which went online in April 2009, contains more than 3,200 standard terms pertaining to rice and other related subjects. It is a controlled vocabulary source for subject descriptions of books, journal articles, conference papers, and other information materials. The system also makes comprehensive searches possible by providing the contexts or subjects in which a term is used, and by including all the other related terms as well.

The International Rice Research Insitute's (IRRI) Library and Documentation Services (LDS) and Communication and Publications Services (CPS) joined forces in December 2006 and worked for a year and a half to produce the *Thesaurus*. Since then, the team has continued to work on its content development through the funding support of CPS, which also funded the compilation of the initial volume.

The publication of the *Thesaurus* is the product of an agreement between IRRI and the National Agricultural Library (NAL) of the Agricultural Research Service, U.S. Department of Agriculture. LDS provides the content while NAL enables Web access, using servers in Beltsville, Maryland. The collaboration came through the initiative of Ms. Lori Finch, thesaurus coordinator of NAL, and Ms. Mila Ramos, chief librarian of IRRI.

TRAINING COURSES AT IRRI

Rice Breeding Course: Laying the Foundation for the Second Green Revolution

IRRI Training Center, Los Baños, Philippines, 24 August-8 September 2009

This 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 (a) theoretical background on modern breeding methods and techniques, including the use of biotechnology; (b) planning and information management tools and experimental techniques and software; (c) opportunity to share experiences with other rice breeders; and (d) 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 the public and private sector.

Rice Technology Transfer Systems in Asia

Rural Development Administration (RDA), Suwon, South Korea, 14-25 September 2009

This training workshop was developed and implemented in view of the Rural Development Administration's (RDA, Korea) and IRRI's common interest in enhancing the capacity of developing countries to improve their rice productivity and profitability through better technology transfer. The course will be held in Korea to showcase the country's success in technology transfer. Workshop participants will see the model first-hand, and that will help them better understand the processes involved in successfully moving technology from its development, by researchers and successful farmers, to its adoption by farmers. Moreover, by being appraised of each other's technology delivery systems, the participants will be able to identify success factors, compare results, and analyze their respective systems and recommended ways to improve their effectiveness.

Mixed Model Analysis Using CropStat

IRRI Training Center, Los Baños, Philippines, 5-9 October 2009

This course is designed to help researchers know when and how to perform mixed model analysis. It also introduces CropStat's module on Mixed Model Analysis using restricted maximum likelihood (REML). It employs a combination of lectures, and hands-on exercises on CropStat.

Participants should be familiar with basic statistical methods: computing descriptive statistics, hypothesis testing, and analysis of variance. They should be familiar with Windows and must have experience in data analysis using at least one statistical software.

Leadership Course for Asian Women in Agricultural R&D and Extension

IRRI Training Center, Los Baños, Philippines, 12-23 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.

Rice Post Production Course

IRRI Training Center, Los Baños, Philippines, 19-30 October 2009

The course is action oriented and consists of introductory lectures followed by hands-on practices in which participants are assigned tasks to accomplish during the practice. Participants will be supported by Asian Development Bank (ADB) and Irrigated Rice Research Consortium (IRRC) projects. The course aims to cater to project counterparts of the two projects and tries to get a mix of participants from the public and private sector.

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.*

Making rice LESS THIRSTY

by **Lanie C. Reyes**

New drought-tolerant lines developed at IRRI give hope to farmers in drought-prone areas in eastern India and the Philippines

Since the dawn of agriculture, drought has been the bane of farmers, especially those who grow rice, a crop that has special water requirements. Drought stress severely limits rice productivity in the rainfed ecosystem in which farmers often experience total crop failure because of a lack of water at one critical plant growth stage or another, according to Arvind Kumar, a plant breeder at the International Rice Research Institute (IRRI).

IRRI (2)

Most rainfed areas receive a reasonable amount of rainfall during the growing season. "However," says Dr. Kumar, "its erratic distribution and shortage, particularly at flowering and again at grain-filling, can seriously curtail productivity." He adds that Asia alone has around 23 million hectares (20% of the total rice area) that are prone to drought under these conditions and where climate change may make matters, particularly water scarcity, only worse.

Without assured irrigation, farmers are completely dependent on rainfall to water their crops. The possibility of drought has made rice farming a risky endeavor. Because of the risk, farmers do not invest enough in inputs to increase rice production.

To help farmers cope with water scarcity, IRRI has bred several new lines that are as high-yielding as any normal varieties with sufficient water. They have a 0.8 to 1 ton per hectare yield advantage whenever drought occurs. Two of these drought-tolerant breeding lines have been recommended for official release: IR74371-70-1-1 in India and its sister line IR74371-54-1-1 in the Philippines.

"IRRI has intensified efforts to develop drought-tolerant and aerobic cultivars to cope with this looming water shortage," says David Mackill, leader for IRRI's rainfed program. "Drought has been a complex trait to improve, and I am very happy to see the recent advances and progress in developing drought-tolerant lines at IRRI."

Most farmers in rainfed/drought-prone areas grow varieties bred for irrigated conditions such as IR36, IR64, Poornima, MTU1010, Lalat, Swarna, and Sambha Mahsuri, among others. Unfortunately, these varieties are highly susceptible to drought. Whenever a severe drought occurs, these irrigated varieties suffer high losses and farmers are lucky to harvest even half a ton per hectare from them. "With the cultivation of the newly bred drought-tolerant lines, in normal-rainfall years, farmers will have the same high yield of irrigated varieties, and in drought years they can harvest 1.5 to 2 tons from 1 hectare," says Dr. Kumar.

IRRI works with the national agricultural research and extension systems (NARES) for the evaluation of newly developed breeding lines. Before a breeding line is identified for release, it undergoes testing in the national system and is recommended for release after its superior performance in the national trials. The newly developed drought-tolerant lines IR74371-70-1-1 and IR74371-54-1-1 outperformed the current varieties in national trials in India and the

Philippines and have been recommended for release for farmers' cultivation. The two breeding lines also performed well under aerobic and alternate wetting and drying (AWD) situations (see *The big squeeze*, pages 21-31 of *Rice Today* Vol. 7, No. 2 and *Every drop counts*, pages 16-18).


GENE HETTEL

DOZENS of promising drought-tolerant cultivars are being tested on the IRRI farm in the Philippines. Here, Dr. Kumar shows drought-tolerant rice on his right compared with a susceptible variety on his immediate left.

IRRI's System for Temperate and Tropical Aerobic Rice project under the Challenge Program for Water and Food has been building a network on participatory varietal selection (PVS) testing and evaluation since 2004. The project aims to develop prototype aerobic rice production systems for water-scarce environments.

According to Ruben Lampayan, water management scientist at IRRI, a major component of the project was to identify rice varieties with high yield potential under aerobic conditions from among IRRI's advanced lines through PVS. They tapped their project partners to collaborate in implementing PVS with farmers.

In the Philippines

Dr. Lampayan has found in Junel B. Soriano, director for research, extension, training, and production at Bulacan Agricultural State College (BASC), the heart and passion to reach out to more partners and stakeholders with aerobic rice and other water-saving technologies. Hence, in the Philippines, IR74371-54-1-1 has been tested at BASC since 2004 and in farmers' fields in Bulacan, La Union, Bataan, and Palawan since 2006.

Dr. Soriano recalls a time during the dry season of 2004 when a trial was conducted in a small testing plot at BASC in coordination with IRRI. They invited farmers, technicians, and researchers during the PVS.

During that PVS, one impressed farmer eagerly asked, "Can I reproduce that line on my farm?" That farmer was Nemencio Concepcion, 49, of San Ildefonso, Bulacan. He became interested in the drought-tolerant variety because it seemed tailor-made for his drought-prone upland area.

On his own initiative, he reproduced the line and was happy with the results. His neighboring farmers were eager to try it on their farms. Eventually, the line became popular among farmers, and is known among them as "5411" (instead of IR74371-54-1-1).

According to Dr. Soriano, 5411 matures 2 weeks ahead of their previously used variety, which takes 120 days to mature. The new line yields an average of 4.5 tons per hectare. Also, it is very resistant to pests and diseases and, so far, farmers have not experienced tungro or any other disease.

Mr. Concepcion proudly announces that the rice he planted in February was harvested in May. "Because of its shorter duration, it allows me to harvest not just two but three times a year," he says. "And, as this variety is tolerant of drought, I can plant the crop even during the dry season without any fear of crop loss."

Since his farm is on higher ground, he needs to pump in water. With AWD technology, he is thankful that he does not need to flood his paddies. He pumps water only a few times a month and only when necessary. "I save much on water and on gasoline for the pump, even during the dry season," Mr. Concepcion says.

His recent crop experienced more than 2 weeks of drought. So, he pumped water to his upland rice area. However, there was one rice area where he was not able to pump water because of insufficient available water. "I sacrificed that area and accepted its fate because the rice plants wilted already," he stated. But, when rain came, he was surprised to see that his plants recovered from wilting.


LANIE C. REYES

MR. CONCEPCION (*right*)— a farmer in Bulacan, explains to Dr. Soriano of BASC, that this part of his rice farm wilted because of drought. But, when rain came, it fully recovered.

Although the rice that recovered from drought is expected to be harvested about 2 weeks later than the rest of the 5411, it is still within an acceptable duration. Above all, he is just glad to be able to harvest rice despite the drought. (For drought-susceptible varieties, more than 2 weeks of drought in upland fields may yield almost nothing for farmers.)

Mr. Concepcion's experience is consistent with what Dr. Kumar says about the new drought-tolerant lines: "They withstand drought at any stage of the crop cycle. Moreover, they withstand drought even at the reproductive stage, when the plant suffers more loss due to drought."

"Since that line can be broadcast-seeded instead of transplanted, I saved a lot on labor costs," relates Mr. Concepcion. "I don't need to hire laborers to plant seedlings in the nursery, pull them from the seedbed, tie them together, and transplant them."

Every harvest, Mr. Concepcion earns around US$638 to $850 per hectare from his rice field (of 4 ha) planted with 5411.

Mr. Concepcion is indeed one happy and satisfied farmer. His influence on other farmers to adopt 5411 reaches Nueva Ecija and Pampanga provinces. Even if rice fields in these areas are irrigated, there is no problem because 5411 still performs well in wet areas.

According to Dr. Soriano, Mr. Concepcion is so effective in influencing other farmers to adopt 5411 and increase the productivity of their lands that he considers Mr. Concepcion not just a farmer cooperator but a partner in BASC's extension efforts.

Mr. Concepcion was one of the first 13 farmer cooperators in 2004. They increased to 50 in 2005, to 70 in 2006, and BASC now has more than 100 farmer cooperators. According to Dr. Soriano, the success of adoption can be attributed to farmer-to-farmer influence and support from the local government.

Dr. Soriano is more than encouraged in sharing the benefits of 5411 along with its management technologies, the aerobic system, and the AWD system in the Philippines, because he believes that more farmers can benefit from all this, particularly those in rainfed areas.

He plans to expand extension activities at BASC by involving other state universities and colleges all over the country. He has started to coordinate with other state universities such as Bataan Polytechnic State University, Palawan State University, and Mindanao Foundation College, among others.

In eastern India

Similarly, in eastern India, IRRI introduced a drought-tolerant breeding line, IR74371-70-1-1, which has also consistently performed well both at research centers and in farmers' fields. Since eastern India is one of the largest drought-affected areas, a variety that can cope with a dry spell is a welcome change in rice farming.

IR74371-70-1-1 was initially tested under an India-IRRI collaborative project, the Drought Breeding Network (DBN), whose partners are the Central Rainfed Upland Rice Research Station (CRURRS) in Hazaribag; Indira Gandhi Krishi Vishwa Vidyalaya, Raipur; Birsa Agricultural Univ., Ranchi; Narendra Dev University of Agriculture and Technology, Faizabad; Tamil Nadu Agricultural University, Coimbatore; University of Agricultural Sciences, Bangalore; and Barwale Foundation, Hyderabad, India. Courtesy of the DBN, researchers have identified this entry as promising for the drought-prone ecosystem.

Since this line is a product of a joint endeavor, the team from CRURRS suggested the name *Sahbhagi dhan*, which means, in Hindi, "rice developed through collaboration." Recently, the Variety Identification Committee (VIC) recommended it for release to the Central Subcommittee on Crop Standards, Notification, and Release of Varieties.

Nimai P. Mandal, a plant breeder at CRURRS, tested Sahbhagi dhan during the wet season of 2004. It has consistently performed well, better than any other entries of that duration, since then. "In 2007, we started testing this variety in farmers' fields in two villages near Hazaribag," he says.

Kailash Yadav, 34, and Naresh Paswan, 38, of Mahesha, Hazaribag, Jharkhand, are two farmers who had the opportunity to observe a demonstration using Sahbhagi dhan conducted by CRURRS and they tried it on their respective farms. As a result, they were delighted to harvest 4.5 tons of rice per hectare in a good monsoon year. Before using the drought-tolerant variety, they harvested only 3 to 3.7 tons per hectare. They are also pleased with its traits such as the ability to tolerate a month-long drought, early maturity, and good eating quality.

CRURRS (2)

MR. SHASHIKANT Yadav (*left*), CRURRS agricultural field assistant, interviews Mr. Naresh Paswan (*center*) and Mr. Kailash Yadav (right), farmers who have tested Sahbhagi dhan on their farms.

Farmers in rainfed areas such as Mr. Yadav and Mr. Paswan largely depend on rain for a good harvest. But, good years may be few and as unpredictable as the onset of drought. If the rains are poor, this can spell catastrophe for all. Mr. Yadav still remembers the 2006 drought that affected their village. Without any income from farming, he somehow managed some earnings from his small grocery store. But, many villagers migrated to town to work as daily laborers. One was Mr. Paswan. Though he describes the drought as “not so severe,” it still affected the people of his village. Finances were so difficult then that he needed to borrow money from another farmer for his transportation.

Sahbhagi dhan gave the two farmers opportunity and hope in rice farming. “I have confidence that this variety will be a blessing for farmers in drought-stress situations,” says Mr. Paswan. “And, we can manage the problem of drought by growing this variety,” adds Mr. Yadav. Because both are impressed by the qualities of Sahbhagi dhan, they are going to recommend it and share it with their neighbors as soon as they have sufficient seed.

“Drought-tolerant lines have received high farmers’ preference scores in both normal and drought trials and farmers look convinced of adopting such superior varieties,” says Dr. Stephan Haefele, IRRI soil scientist and agronomist who is responsible for testing the lines in farmers’ fields under PVS in India.

More farmers besides Mr. Paswan and Mr. Yadav will benefit from Sahbhagi dhan. According to Dr. Mandal, the rainfed upland area in India occupies about 6 million hectares. But the target area for Sahbhagi dhan could be more because it is also suitable for drought-prone shallow lowlands.


THE SOON-to-be-released drought-tolerant Sahbhagi dhan in eastern India thrives under drought conditions.

U.S. Singh, the regional coordinator for South Asia of the Bill & Melinda Gates Foundation-supported project on “Stress-tolerant rice for poor farmers in Africa and South Asia” and responsible for seed production and dissemination of Sahbhagi dhan, plans to have large-scale seed multiplication of this line in 2009 and produce 100 tons of seed to distribute to as many farmers as possible by the next wet season in India.

National Food Security Mission of India, National Seed Corporation, various public- and private-sector seed corporations and companies, research organizations, and NGOs are interested in reproducing and disseminating Sahbhagi dhan seeds. “Our purpose is to take this variety to the maximum number of farmers in the shortest possible time,” says Dr. Singh.

As the scientist now responsible for developing drought-tolerant varieties, Dr. Kumar says that he is very lucky to witness the success of this teamwork.

When asked whether this is his greatest accomplishment as a scientist, he says, “This is IRRI’s achievement. Other scientists before me have been working for about 40 years to achieve this.” Dr. Brigitte Courtois attempted the crosses, which had led to the development of these two lines. And it was Dr. Gary Atlin, who introduced the concept, initiated and conducted experiments on direct selection for grain yield under drought stress. He combined high yield potential under irrigated situation with good yield under drought.

Forty years? What turning point along the way led to high-yielding drought-tolerant rice? IRRI scientists started working in a different way: working directly on improving grain yield in rice under drought.

Dr. Rachid Serraj, a drought physiologist involved in dissecting the mechanisms of drought tolerance and its genetic variation in rice, says that combining high yield potential and drought tolerance through direct selection for grain yield is one of the right approaches for developing drought-tolerant lines, in addition to marker-assisted selection (see *On your mark, get set, select* on pages 28-29 of *Rice Today* Vol. 3 No. 3) and GM (genetic modification) approaches (see *Overcoming the toughest stress in rice: drought* on page 30).

In the years before that, scientists had been working on improving the traits thought to be related to drought tolerance such as leaf rolling, rooting depth, and other traits. They believed that yield under drought could be increased by improving these secondary traits.

In 2004, IRRI breeders started to work on direct selection for grain yield under drought stress. At first, they were not sure that this would show results. But, subsequent experiments confirmed that this approach worked.

For a plant breeder like Dr. Kumar, “developing drought-tolerant cultivars is the most efficient way to stabilize rice production in drought-prone areas.” Higher yield of drought-tolerant lines in drought years should encourage farmers to apply more inputs such as fertilizer that further raise the productivity of the rainfed drought-prone system. Because of drought-tolerant lines, farmers will indeed lower their risks of investing their money and time in drought-prone areas.

Sahbhagi dhan and 5411 and other similar drought-tolerant lines that may be developed in the future will benefit and provide confidence to rice farmers not just in India and the Philippines but also in other drought-prone areas in Asia, Africa, and other parts of the world. In fact, a few other promising drought-tolerant lines and aerobic cultivars are now being tested in India, Bangladesh, Nepal, and the Philippines under projects supported by the Bill & Melinda Gates Foundation, Rockefeller Foundation, Generation Challenge Program, and Asian Development Bank.

Every drop counts

by **Bas Bouman** and **Mia Aureus**

Water scarcity is crippling the world's food supply balance. So, IRRI has developed water-saving technologies to help farmers cope with the problem and, more importantly, to sustain global rice production

Water makes up 70% of our planet. But in spite of this vast availability, our fresh water reserve is finite. Over the years, improper use has led many to waste this precious natural resource, unaware of its dire crippling effects on the world's food supply balance, particularly for rice—the staple food of about 3 billion people around the world.

Like all other plants, rice needs water to survive. However, unlike most plants, it needs twice as much water to produce good yields. For 1 kg of rough rice, for example, an average of 2,500 liters of water needs to be supplied by rainfall and/or irrigation (see *How much water does rice use?* on pages 28-29 of *Rice Today* Vol. 8, No. 1). About 1,400 liters are used up in evaporation and transpiration, while the remaining 1,100 liters are lost by seepage and percolation. A farmer, then, constantly needs to ensure that sufficient irrigation water is provided (to complement rainfall if that is insufficient) to match all these outflows. Note that transpiration (the process by which the rice plant absorbs water, takes it up to bring essential nutrients from roots to leaves, then releases it to the atmosphere) is the only productive water use, as it helps the plant stay alive and healthy.

BAS BOUMAN (3)

AN IRRIGATION canal in northern China dries up because of water scarcity.

Growing water scarcity

Fresh water for agriculture around the world, however, is becoming increasingly scarce, thereby threatening rice productivity and, consequently, the world's food supply. In the next 25 years, some 15–20 million hectares of irrigated rice are projected to suffer some degree of water scarcity, particularly the wet-season irrigated rice regions of China, India, and Pakistan. Dry-season irrigated rice areas everywhere in Asia rely on expensive irrigation water and need to be managed in the most water-efficient way. The causes for increasing water scarcity are diverse and location-specific. They include falling groundwater tables, chemical pollution, malfunctioning of irrigation systems, and increased competition from other sectors such as urban and industrial users.

In the face of this troubling reality, the International Rice Research Institute (IRRI) has developed several water-saving technologies to help farmers cope better with water scarcity in their paddy fields. Farmers primarily need to reduce the nonproductive outflows (percolation, seepage, and evaporation), while maintaining transpiration flows. This can be done during land preparation, crop establishment, and the actual crop growth period.

Get the basics right

In preparing the land—the foundation of the whole cropping season—it is crucial for farmers to "get the basics right." To establish good water management early on, they need to properly build field channels, level the land, prepare solid bunds, and effectively implement tillage operations (puddling).

In most irrigation systems in Asia, water flows from one field into another and there are no *field* *channels* to convey irrigation water to, and drainage water from, individual fields. So, farmers usually have a hard time controlling the flow of water in and out of the fields. Either the farm loses much of its water to other farms or it gets too flooded as water from other farms pours in. Water that continuously flows through the rice fields may also remove valuable nutrients. Constructing separate channels to convey water to and from each field will help improve individual control of water. This is the recommended practice in any type of irrigation system.

Another prerequisite for good water management is a *well-leveled field*. Logically, when fields are not even, water cannot be equally distributed. Some parts may suffer from water stagnation, while other sections may become dry. This results in uneven crop emergence, uneven early growth, uneven fertilizer distribution, and weed problems.

Most farmers puddle their fields to prepare the land for transplanting of seedlings. *Puddling* is the repeated harrowing of the soil under flooded conditions and it results in a muddy layer 15–20 cm thick. Before puddling takes place, farmers need to soak the land at the end of the previous fallow period. Sometimes, large and deep cracks are present in the soil and a lot of water is lost at soaking by water flowing down these cracks. A shallow tillage to fill the cracks before soaking can greatly reduce this water loss.

Puddling creates a so-called *plow layer* of some 5-cm thickness just below the muddy layer. This plow layer is very compact and it prevents water from percolating downward, where the roots of the rice plants cannot reach it anymore. Thorough puddling after soaking the field results in a more compacted soil. Puddling is especially effective in clay soils that form cracks during the fallow period.

Good bunds or *paddy dikes* also help limit water losses by seepage and underbund flows. Bunds should be well compacted. Any rat holes should be plastered with mud at the beginning of the crop

Saving water: **alternate wetting and drying**

Water scarcity

Worldwide, water for agriculture is becoming increasingly scarce. By 2025, 15 to 20 million hectares of irrigated rice may suffer some degree of water scarcity. Interventions to respond to water scarcity are called "water savings" and imply a reduced use of irrigation water.

What is AWD?

Alternate wetting and drying (AWD) is a water-saving technology that lowland (paddy) rice farmers can apply to reduce their water use in irrigated fields. In AWD, irrigation water is applied to flood the field after a certain number of days have passed following the disappearance of ponded water. Hence, the field is alternately flooded and not flooded. The number of days of nonflooded soil in AWD in between irrigations can vary from 1 day to more than 10 days.

How to implement AWD?

A practical way to implement AWD is to monitor the depth of ponded water in a field using a field water tube. After irrigation, the depth of ponded water will gradually decrease. When ponded water drops to 15 cm below the soil surface, irrigation should be applied to re-flood the field up to 5 cm. From a week before until a week after flowering, ponded water should always be kept at 5-cm depth. After flowering and during grain filling and ripening, the water level can be allowed to drop again to 15 cm below the surface before re-irrigation.

EDNA REYES (2)

A SAMPLE field water tube made from polyvinyl chloride. Note the holes on all sides.

THE SOIL inside the tube is removed after sticking it into the ground.

A farmer can start AWD a few days after transplanting (or with a 10-cm-tall crop in direct seeding). If there are too many weeds, AWD can be postponed for 2–3 weeks, until the ponded water suppresses weed growth. Local fertilizer recommendations for flooded rice can be used. Apply nitrogen fertilizer preferably on the dry soil just before irrigation.

Safe AWD

The threshold of 15 cm is called Safe AWD as this will not reduce yields. In Safe AWD, water savings are on the order of 15–30%. Once farmers feel confident that Safe AWD will not reduce their yields, they can try to drop the threshold level for irrigation to 20 cm, 25 cm, 30 cm, or even lower. This will help save more water, although production may be slightly affected. This minor setback may be acceptable when the price of water is high or when water is very scarce.

The field water tube

This tube can be made of a 40-cm-long plastic pipe or bamboo, with a diameter of 15 cm or more, to allow farmers to see and monitor the water table. Put holes on all sides of the tube. Stick the tube into the soil, but leave 15 cm above the soil surface. Remove the soil inside the tube so that the bottom will be visible. Make sure that the water table inside the tube is the same as that on the outside. The tube can be placed in a flat part of the field close to a bund so that it is easy to monitor the depth of ponded water.

season. Farmers need to also check for, and repair, new rat holes, cracks, and pores dug by earthworms throughout the growing season. Plastic sheets can be used to fix permeable sections of the bunds.

During the crop growth period, farmers are best advised to keep their ponded water at a 5-cm depth to minimize the loss of water by seepage and percolation. This is also the advised level in another water-saving technology called alternate wetting and drying (AWD) (see *The big squeeze* on pages 26-31 of *Rice Today* Vol. 7, No. 2).

AWD, also known as controlled irrigation, does not require rice fields to be continuously flooded. Farmers flood the fields up to 5 cm for a few days, and then let them dry to a certain extent, before re-flooding them. This cycle goes on throughout the season, but with a period of continuous flooding during flowering to prevent sterility from occurring. In the practice of safe AWD, farmers use a field tube to monitor the underground water level in the field: when the ponded water has dropped to 15–20 cm below the surface of the soil, it is time to flood the field again. It was found that this technology reduced the amount of water required by a quarter and, more importantly, it did not reduce yields.

FARMERS PUDDLE their fields to prepare the land for transplanting seedlings.

FARMERS MUST make sure that the bunds are well compacted to limit water loss.

Aerobic rice

When water is really very scarce, and there is not enough water to even intermittently flood the field such as in AWD, the system of *aerobic rice* may be useful (see *High and dry* on pages 28-33 of *Rice Today* Vol. 7, No. 2). Aerobic rice is a production system in which especially developed "aerobic rice" varieties are grown in well-drained, nonpuddled, and nonflooded soils. With good management, aerobic rice can produce up to 4–6 tons per hectare while using less than half the water required in flooded paddy rice.

Every drop counts

Today's problem of water scarcity reminds everyone of water's finite nature. IRRI continues to further develop and refine water-saving technologies to help farmers cope. As water scarcity increases and climate change aggravates the problem, IRRI is also stepping up its efforts in disseminating these technologies to farmers. Outreach efforts include an array of training activities and the production of information materials such as leaflets, brochures, posters, manuals, and eventually e-learning courses to reach out to as many people as possible. New partnerships are being forged among scientists, extension agencies, irrigation system managers, and farmers to jointly tackle the problem of water scarcity and implement solutions. To help the fate of water-scarce farmers and to ensure global food security, every drop of water counts.

Dr. Bouman is a senior water scientist and head of the Crop and Environmental Sciences Division at IRRI.

A LOW-COST, farm-level dryer is tested at a farmer's house in Savannakhet Province, Lao PDR.

MARTIN GUMMERT (2)

Working together to save grains

by **Martin Gummert**

IRRI plays a crucial role in revitalizing global rice production by engaging the public and private sector in helping farmers reduce postharvest losses

Even though rice prices have come down considerably since the food crisis in 2008, the fundamentals have not changed. The decline in yield growth across Asian countries, continued population growth, and the conversion of prime rice land to other uses threaten the global rice supply. The immediate challenge is to revitalize global rice production. An annual growth rate of 1.2% is needed to ensure food security. To further boost production, farmers need to reduce yield gaps and grain losses that occur during harvest, storage, and processing of rice.

During postharvest, about 15–20% of the grains are lost because of delays in harvest; labor shortage; unsuitable traditional sun-drying practices, especially in the double-cropping system in which one harvest takes place in the wet season; pests; moisture absorption in traditional open-storage systems; outdated and poorly maintained rice mills that yield as low as 60%; and drastically reduced head rice.

Moreover, grain quality is also lowered, causing farmers to lose out on income because they have to sell their paddy at a 20–30% discount. Additional income loss is incurred from not adding value to the rice by selling in the off-season at a higher price or by receiving a discounted price because of low quality.

Over the past 15 years, the International Rice Research Institute (IRRI) and its partners have developed and evaluated numerous new harvest and postharvest technologies that are designed to reduce yield losses and improve grain and seed quality. These key technologies are a low-cost paddy moisture meter, quality assessment toolkits, mechanized harvesting technologies, mechanical rice dryers, and hermetic storage systems that provide insect control without using pesticides.

IRRI works with national postharvest stakeholders—national research institutions and the private sector—to develop and scale out these technologies to farmers. Although there is no standard partnership recipe between the public and private sector, both can collaborate in many ways depending on their objectives and the type of technologies to be used. In recent years, IRRI has seen three successful cases of public-private partnership, which involved joint storage technology development and verification, a transfer of proven drying technologies across countries, and collaboration for technology adaptation and extension.

Joint storage technology development and verification

In 2000, IRRI evaluated hermetic storage cocoons with a 5-ton capacity in collaboration with the Cambodian Agricultural Research and Development Institute. Results showed that hermetic or airtight storage extends germination from a few months to 9–12 months. This

IRRI


A TRADITIONAL way of milling rice in the Philippines.

allows farmers enough time to prepare for the next year's planting season. The evaluation, however, found out that the cocoons were too expensive and that farmers preferred individual storage rather than group storage. IRRI then started working with Grainpro (the manufacturer of hermetic storage systems) in 2004 to develop the "Super bag," a hermetically lined bag for a traditional bag-handling system that can store up to 50 kilograms of seeds or grains. Successive participatory technology verification with farmers in villages in Indonesia, Vietnam, Cambodia, and Lao PDR demonstrated that farmers can reduce their seed rate by up to one-third by using the Super bag. In the meantime, commercial seed producers use Super bags (see *Seal of approval* on pages 36-37 of *Rice Today* Vol. 8, No. 1).

Transfer of proven drying technologies across countries

Research institutions across Southeast Asia have a long history in developing rice dryers—only a few of which were successfully commercialized. Instead of re-inventing existing drying technologies, the Postproduction Work Group of the Irrigated Rice Research Consortium (IRRC)[1] teamed up with the postharvest group of Dr. Phan Hieu Hien of Long Nam University in Ho Chi Minh City, Vietnam, and organized training on dryers for manufacturers and postharvest technicians from Cambodia, Lao PDR, and Myanmar in Vietnam in 2006. The course focused on simple but appropriate flat-bed dryers with a 4-ton capacity and included field trips to successful dryer users in the Mekong Delta. When they returned to their home countries, the dryer manufacturers built prototypes for demonstration and subsequently released models for commercial use. Now, more than 48 dryers are installed in rice mills and used by farmers' groups in Myanmar, along with 22 in Laos and 7 in Cambodia. By working directly with manufacturers from the beginning, and by providing additional technical assistance for modifications to the dryers based on users' needs, the public sector made a sustainable introduction of the technology with the help of the private sector (see page 6 of *Rice Today* Vol. 5, No. 1).

Collaboration for technology adaptation and extension

Dr. Myo Aung Kyaw, secretary general of the Myanmar Rice and Paddy Traders' Association (MRPTA), participated in the dryer training in Vietnam. When he went back to Myanmar, he led MRPTA's impressive awareness campaign on postharvest losses and stressed the significance of increasing rice quality as a basis for improved milling yields; capacity building for farmers, millers, and extension workers on postharvest management; and promotion of newly introduced dryers. Many of the association's activities were conducted in close cooperation with public-sector institutions such as the Plant Protection Division of the Myanmar Agriculture Service.

This case shows that private-sector stakeholders can be good partners in technology development as they can provide extension services to farmers that complement those that the public sector has (see *Ripple*, August 2006, page 8).[2]

Building on these and IRRI's experiences with the Postproduction Work Group of the IRRC and the project[3] *Bringing about a Sustainable Agronomic Revolution in Rice Production in Asia by Reducing Preventable Pre- and Postharvest Losses*, multistakeholder platforms take the form of learning alliances that include public and private players.

Dr. Gummert is a postharvest specialist at IRRI.


A MODERN rice mill in Long An Province, Vietnam.

[1] The IRRC is funded by the Swiss Agency for Development and Cooperation.
[2] IRRC Newsletter: http://snipurl.com/kz86s.
[3] This project is funded by the Asian Development Bank.

TAREKE BERHE, SASAKAWA-GLOBAL 2000 (3)

A NERICA4 seed multiplication field in Namutumba District, eastern Uganda.

UGANDA'S RICE REVOLUTION

by **Savitri Mohapatra**

Sub-Saharan Africa's "new kid on the block" positions itself as the rice granary of the region by adopting the right policies and appropriate technologies, strengthening capacity building, and engaging both the public and private sector

Compared with other West African countries such as Mali and Senegal, which have been growing rice for centuries, Uganda is just "a new kid on the block."

Yet, in 2008, when the government of Mali was desperately trying to procure for its farmers large quantities of seeds of the New Rice for Africa (NERICA®) varieties developed by the Africa Rice Center (WARDA), it was Uganda that offered to supply Mali. Not bad for a country where, only 15 years ago, rice was considered a special dish for Christmas.

According to the Ministry of Trade, rice production in Uganda has increased 2.5 times since 2004. In 2008, the country's paddy (unmilled rice) production was estimated to be 180,000 tons, which was 11% more than in 2007.

Moreover, records from the Uganda National Agricultural Research Organization showed that Uganda's rice imports dropped from 60,000 tons in 2005 to 35,000 tons in 2007. This is a remarkable achievement, considering that 40% of sub-Saharan Africa's (SSA) demand for rice is met by imports, which cost about US$3.6 billion in 2008.

Uganda is so keen to boost its rice sector that it became the first country from eastern Africa to join WARDA as a member in 2007. Uganda is also one of the focal countries of the new East and Southern Africa Rice Program (ESARP), a partnership between IRRI and WARDA. ESARP started in 2009 and it focuses on

- Rice breeding, varietal release procedures, and seed production systems
- Crop production and postharvest practices
- The rice value chain and agricultural policy
- Improving rice production at the village level
- Capacity building related to rice production, processing, and marketing

Today, Uganda is fast positioning itself as a potential rice granary of the subregion, as its traders have started selling home-grown rice to Congolese, Kenyan, and Sudanese markets.

In early 2009, the government of Uganda and the Japan International Cooperation Agency (JICA) signed an agreement to establish a national rice research center. The center is expected to become a key partner in the ESARP.

Right policies and appropriate technologies

Ever since 2004, when President Yoweri Museveni launched the Upland Rice Project, rice cultivation has boomed in Uganda. At the core of this project are upland rice varieties, particularly NERICA upland varieties, which Vice President Professor Gilbert Bukenya has actively promoted throughout the country as a means to reduce poverty. NERICA4 was released in 2002 and NERICA1 and NERICA10 were released in 2007. "We promote rice as something that brings food and also money," he said.

The Food and Agriculture Organization of the United Nations (FAO) attributes Uganda's rice success to the re-introduction of a 75% import duty under the East Africa Community common external tariff, and to the dissemination of NERICA varieties. These measures have fostered large private investment by the rice industry, including millers and traders, and have also encouraged many local farmers to take up rice cultivation.

For Henry Kaddu, a Ugandan rice farmer, the main reason is the premium price that rice fetches. In fact, some farmers have already switched from tobacco to rice, as they realized that growing rice was more profitable. Kaddu said that profits from the sale of his NERICA rice harvests have enabled him to build two houses, send his children to school, and buy four cows. The *Ugandan Daily Monitor* reports that NERICA varieties have turned many local rice farmers into "USh[1] millionaires."

Public-private partnerships and capacity building

One of the outstanding factors behind the rice success story of the country is the role of public-private partnerships.

Key partners of the national agricultural research and extension system include JICA, which has been at the forefront of rice promotion in SSA; USAID-funded nongovernment organizations such as the Investment in Developing Export Agriculture (IDEA) and the Agricultural Productivity Enhancement Program (APEP); Sasakawa-Global 2000; FAO; Alliance for a Green Revolution in Africa; and companies such as Tilda Uganda and Nalweyo Seed Company (NASECO).

The potential of rice as a cash crop quickly captured the attention of Uganda's seed companies, such as NASECO, which has been an integral part of the nation's rice success story. Another rice company that has become well known is Tilda Uganda, which sells rice in the subregion under its brand.

In partnership with the government agencies, Sasakawa-Global 2000, IDEA, and APEP have focused on the capacity building of young scientists, field technicians, extension agents, farmers, and processors. Areas covered are improved seed production; crop, soil, and water management; the use of agricultural machinery; and postharvest handling techniques.

Extension manuals on upland rice were produced and disseminated. Rice farmer learning videos produced by WARDA and its partners were widely used. In northern Uganda, for instance, APEP showed the videos to 7,000 farmers living in refugee camps to revive agriculture in war-torn villages.

The National Cooperative Business Association, in partnership with APEP, also provided training to rice farmers and processors in organizational, financial, and marketing skills.

The importance of capacity building in Uganda is confirmed by the article *How revolutionary is the "NERICA revolution"? Evidence from Uganda* (published in 2006). "Strengthening training, extension, and other supporting systems is the key to the success of the NERICA revolution in Uganda," the article stated.

Public-private partnership also helped provide credit to farmers, linked them to input and output markets, and encouraged them to form cooperatives so that they could have stronger bargaining power. It facilitated the establishment of rice mills and introduced agricultural machinery.

According to Robert Anyang, rice seed systems consultant at WARDA who was formerly with APEP, all these efforts have paid rich dividends. By early 2007, 36,000 organized rice farmers were linked to nine medium-capacity rice processors.

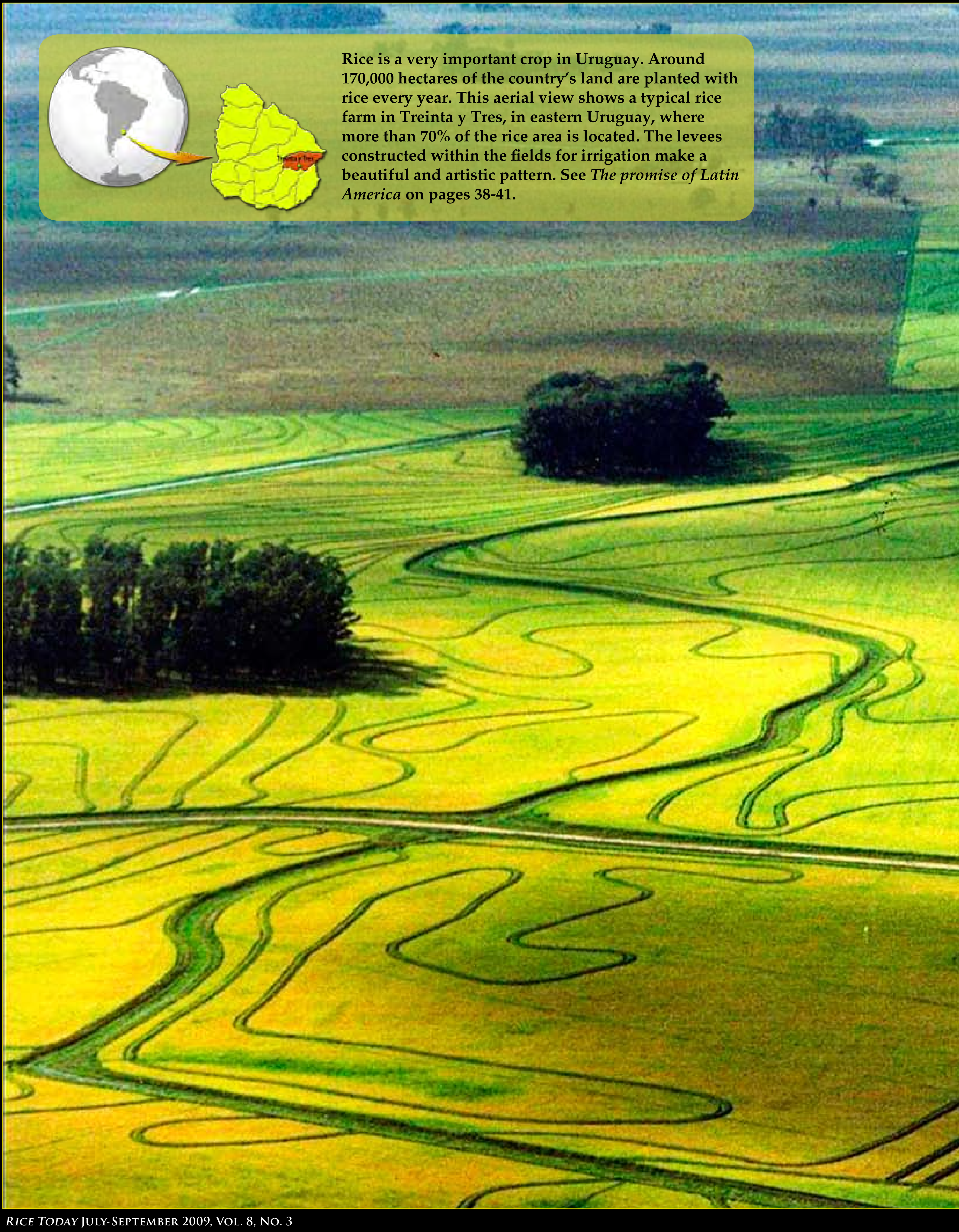
For the government of Uganda, however, this achievement is not enough. Its ultimate aim is to ensure that rice becomes not only a foreign exchange saver but also a foreign exchange earner by capitalizing on the country's excellent agroecological conditions.

MZE WILLIAMS Sentogo, an 81-year old rice farmer, shows the NERICA4 rice planted in his field in Nakaseke District, central Uganda.

SENTOGO'S FAMILY in the NERICA4 field.

[1]Ugandan shilling.

Gonzalo Zorilla



Rice is a very important crop in Uruguay. Around 170,000 hectares of the country's land are planted with rice every year. This aerial view shows a typical rice farm in Treinta y Tres, in eastern Uruguay, where more than 70% of the rice area is located. The levees constructed within the fields for irrigation make a beautiful and artistic pattern. See *The promise of Latin America* on pages 38-41.

Challenges for IRRI: a cross-section of opinions

In a departure from presenting excerpts of a single pioneer interview, this installment presents a diverse cross-section of responses to one question: As IRRI approaches its 50th anniversary in 2010, what do you see as the Institute's greatest challenge? Interviews were conducted between June 2006 and June 2009. More will be added online as interviews continue

Randy Barker, IRRI agricultural economist and head, Economics Department, 1966-78; acting head, Social Sciences Division, 2007-08

When I first came to IRRI in 1966 just before IR8, people at that time looked at IRRI and said, "that's a nice set of buildings," but they didn't think the Institute would ever produce anything. There was a real skepticism about whether IRRI would ever amount to much. Joining IRRI was like buying into a stock that all of a sudden took off.

In the early days, the IRRI mandate was fairly simple and straightforward, increase rice production in Asia, and so the focus and the priorities were there. Since that time, we've gone from food security to environment and poverty and other areas. So, in many ways, the mandates of IRRI and of the other centers tended to expand.

The real challenge now is being sure that IRRI operates in the area where it has the greatest comparative advantage. For example, the challenge for upstream work is to have the appropriate connections with the advanced institutions for developing biotechnology research. When going downstream, this means, in part, the ability to transfer some of that biotechnology expertise and focus it on those areas that will complement what the NARES [national agricultural research and extension systems] are doing.

Nyle C. Brady, IRRI director general, 1973-81

I think IRRI needs to make effective use of biotechnology and other modern research tools to help the plant breeders develop rice lines that efficiently utilize plant nutrients, that tolerate adverse conditions such as drought, and that are resistant to insects and diseases, thereby reducing the need for pesticides.

To do this, IRRI must have linkages with scientists in both the developing and the more developed countries. This is an advice which the whole CGIAR [Consultative Group on International Agricultural Research] system could accept. I recognize the political reasons why this is difficult because some countries don't want biotechnology to be used for this purpose. But the developing countries need the improved crops much more than we do in the U.S. So, I think this is the direction in which IRRI and other such centers should and could go.

IRRI must also continue to push what it has been doing lately—more after I left than when I was there—to recognize the consequences of what we do to the environment in terms of pesticide use—and fertilizer use, that is, nitrogen getting into the water causing troubles later on. This is being done, but I think even more can be done. I think this is an opportunity for IRRI to develop high yields of quality rice in such a way that the soil, water, and atmosphere will not be adversely affected.

Ronald Cantrell, IRRI director general, 1998-2004

Clearly, it is the funding issue. What comes with the funding uncertainty is creating some difficulty in hiring staff. IRRI has been able to continue to hire good international staff. But there is uncertainty caused by restricted core funding and the threat of the loss of all USAID funding [in July 2008]. If you are a bright young scientist just out of

graduate school, do you want to take a chance on starting your career there? "There" meaning not necessarily IRRI but "there" meaning in that kind of system. So, unless there are some things that will stabilize the funding, it may create some problems for IRRI in the future of being able to hire international staff. I think that is the greatest challenge that IRRI will face. The culture of the Institute is rich; it's great. I just think it needs to have a more stable environment.

Kwanchai Gomez, IRRI head statistician, 1968-93; liaison for coordination and planning, 1993-96; consultant, 1997-98

I think IRRI's greatest challenge is to define clearly the kind of contributions it still can make to the rice world. IRRI cannot just keep doing the same things it did at the start. IRRI has come a long way [47 years as of the time of the interview] and the rice problems of the world have changed drastically. IRRI must define what its present goals are; who are its clients and what are their expectations? What does the rice world need and what and how can IRRI contribute?

It's true that IRRI is an aging institution, and it may not be easy to re-define its goal, its mandate, and adapt new strategies and directions at this point in time. But, unlike old people, it is still easier to revive and renew an old institution. And I think IRRI should be able to find the way.

IRRI has a new strategic plan, *Bringing hope, improving lives*. Some see it simply as a patch-up job of what it is doing now or maintaining a status quo. Whenever a strategic plan is developed purely by the people from inside the institution, it carries too much baggage; it's heavy. Who will work on a strategy and work plan that will put them out of their jobs tomorrow? Nobody, of course! I myself had worked closely with the first IRRI strategic plan; I should know.

Ronnie Coffman, IRRI plant breeder, 1971-81; currently chair, Department of Plant Breeding & Genetics, and director of International Programs, Cornell University

Global warming and the rise of sea level could prove to be the greatest challenges for IRRI, for plant breeding, and for rice science in general because, as you know, the majority of rice is found in the large low-lying river deltas of Asia. The Ganges, the Brahmaputra, the Irrawaddy, the Mekong, all those big deltas are, in some cases, only a few inches above sea level. So, right now, the minimum prediction for sea-level rise is a conservative projection of 38 inches by the middle of this century. This will obliterate places like Bangladesh, West Bengal, and the Mekong Delta.

This is huge. So, what will happen, slowly, or maybe not so slowly, is that brackish water will get pushed up the rivers and affect the growth of the rice. And you get less and less fresh water coming down because glaciers are melting in the Himalaya at the rate that people can't believe. So, you're going to get a scarcity of fresh water and then the rising sea level that pushes in the brackish water. That's going to push the cultivation of rice way back in a gradual, or maybe not so gradual, manner. So, salinity tolerance might offer some help. But I think the global warming and the resulting rise in sea levels—and remember that 38 inches is the minimum prediction; others are predicting more and faster—that portends a real crisis in rice cultivation.

M.S. Swaminathan, IRRI director general, 1982-88; currently chairman of the M.S. Swaminathan Research Foundation

There are challenges and I'm sure IRRI is aware of them as it modifies its mandate. During its first decade [1960s], IRRI's challenge was to improve productivity. The second decade had the challenge of putting it into a farming systems background. During my decade, we had the challenge of mainstreaming considerations of ecology and equity in technology development and dissemination and also building national rice research institutions, including one in the Philippines.

IRRI's greatest challenges today are against the backdrop of globalization. The UN Millennium Development Goals (MDGs) present a challenge for IRRI because, for 40% of the world's population, rice is a staple. So, the very first MDG, reducing hunger and reducing poverty, depends greatly on IRRI's work, along with its national partners. So, there is a great responsibility. Then, of course, MDG number 3 is gender equality and empowerment of women, where again IRRI has been the flagship of the gender equity movement in the world, the first scientific institution, which started strong gender mainstreaming of its work. I would say the number-one challenge is this new vision for IRRI, which places poverty alleviation and hunger elimination at the top of its agenda.

Another challenge is dealing with the public/private partnerships in an IPR [intellectual property rights] environment. As they commonly say, the "Green Revolution" was a public-sector enterprise, while the "Gene Revolution" is a private-sector enterprise. So, how are we going to develop this new kind of partnership between the public and private sector without compromising IRRI's commitment to help poor farmers? Social inclusion for access to new technologies should be the bottom line of IRRI's technology dissemination policy.

Tom Hargrove, IRRI editor and later head, Communication and Publications Services, 1973-91; most recently coordinator of information and communications, International Center for Soil Fertility and Agricultural Development

IRRI's greatest challenge is to continue to do the work it is doing and keep the money coming in so that it is able to carry out the plan. The world is changing so much right now that we don't have any idea of what really is going to happen. There's obviously not just a food crisis, which has been building up for a long time. Then, these different factors hit all at once: a decrease in funding for research and the demand for food and fuel with 30% of the U.S. corn crop going into ethanol. At the same time, Indians and Chinese are achieving higher incomes and they want to drive cars too and, as incomes rise, they eat less rice and want more meat.

Of course, fertilizer (nitrogen, potassium, and phosphorus) is essential to the nutrient production needed to make the ethanol and to feed the livestock to accommodate the changing food habits of China and India. All of these things are coming together. A farmer in Togo or Mali in West Africa who grows rice or any other crop, a couple of years ago, had to pay twice what a farmer in Iowa has to pay for a kilogram of urea. Now, with the price of fertilizer doubling, tripling in the United States, I think it's going to be almost impossible in Africa. This could be one of IRRI's greatest challenges in Africa if indeed there's to be an African Green Revolution.

Gurdev Khush, IRRI rice breeder and principal scientist, 1967-2001; currently adjunct professor, University of California, Davis

As the national programs have become stronger, IRRI has started putting emphasis on certain areas where it has a comparative advantage, such as in molecular biology and biotechnology. IRRI stopped naming varieties because the national programs have become strong enough so we only need to supply them with germplasm. The challenge will continue for IRRI to find new techniques, which can help the national programs.

In breeding, I think we have to continue to find approaches to increase yield potential and to identify new sources of disease and insect resistance so that they can be supplied to the national programs. Also, IRRI needs to use the new genetic engineering technology. The environment for accepting genetically modified crops is not as good as it should be, but eventually, I think, in a few years, the national programs, the farmers, and the NGOs will start accepting genetically modified materials. Molecular biology techniques to use include molecular marker-aided selection and identifying QTLs [quantitative trait loci] for difficult traits, such as drought. So, the challenge is to work with national programs to incorporate all these techniques into breeding approaches. This should lead to rice improvement efforts that focus on increasing the yield potential and developing varieties with novel traits.

S.K. De Datta, IRRI principal scientist and head, Department of Agronomy, 1964-92; currently associate vice president for international affairs and director of the Office of International Research, Education, and Development at Virginia Polytechnic Institute and State University

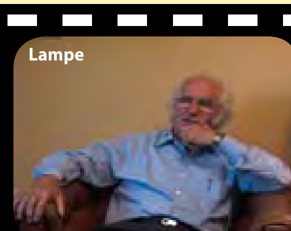
When I was at IRRI, I didn't realize until I left how inward-looking we were. Somehow, we felt that our donors will continue to support us no matter what we do. I think IRRI scientists have to go beyond the inward-looking posture to communicate and network with the best minds all over the world and to collaborate much more aggressively. Otherwise, down the road, I can see that we'll have problems garnering funds.

What I have noticed over the last 5–6 years is that IRRI is not making headlines in the United States, when, 5, 10, or 15 years back, IRRI news was major news here in the *Washington Post* and the *New York Times*. I don't see any breakthroughs coming out, which are hitting the headlines. [At the time of the interview on 25 June 2006, this was perhaps true, but now, in 2009, IRRI is routinely making headlines in the U.S. and around the world; see irri.org/media/articles.all.asp.] We need to generate more relevant knowledge and technology and to communicate with the U.S. and other industrial nations so they feel excited about IRRI's research and support it on a sustained basis.

IRRI 50 1960-2010


De Datta


Herdt


Lampe


Toenniessen

IRRI must communicate its new knowledge and technology, which will help the next generation of food producers and consumers around the world. The primary beneficiaries are the developing regions, but let's not forget that the developed regions are our partners and we need to do a better job communicating with them as to why they need to support IRRI and other CGIAR centers. So, I consider that as a big, big challenge because resources are shrinking all over the world.

Robert Herdt, IRRI economist, 1973-83, head of the Economics Department, 1978-83; later director, agricultural sciences, and vice president, The Rockefeller Foundation; currently adjunct international professor of applied economics and management, Cornell University

I think IRRI's greatest challenge is how to turn over management and responsibility to the Asian countries that are the primary beneficiaries. There are many hundreds of millions of people in Asia who are still in need of the benefits of new technology and higher productivity, but there are also hundreds of millions in other countries in the world who are in a lot worse shape. Rice research is at a high level of development in Asia. This is something that Asian countries should take more responsibility for. If they don't feel like there is enough value to them having a regional research institute, then I personally don't believe the rest of the world should be supporting the whole thing. So, that's the biggest challenge.

Klaus Lampe, IRRI director general, 1988-95

I guessed that you might ask such a question. I recall the very first draft of a new strategic plan, developed in 1994, with the title IRRI towards 2050. It was rejected in the committee and by the board because the horizon was seen to be by far too long. Of course, nobody knew if IRRI would exist in 2050.

However, in my view, there are five functions, which I stressed at that time and still valid for IRRI in 2050: (1) to house the base collection of the world's rice germplasm and to perform the many evaluation, research, preservation, and service functions that this responsibility entails; (2) to collect, evaluate, select, and make accessible information on current rice research and development programs, rice and rice-related research, and global rice research resources—human, financial, and physical; (3) to retain a response capability, which can catalyze the use of those resources through internationally recruited teams working on topics of supra-national importance; (4) to organize and convene conferences, task forces, seminars, and meetings to facilitate the exchange of information and to focus the application of knowledge on the resolution of emerging problems; and (5) to define research needs that can be taken care of by existing research centers worldwide, promote funding, and harmonize the implementation.

Given its mandate, IRRI's future, its lifetime, will largely depend on its successful search for excellence in all aspects of its endeavors: excellence in research planning and implementation; excellence in human resource management, cooperation, and collaboration; excellence in efficiency and effectiveness at all levels; and excellence in its financial resource management and not to forget in public awareness, creating conducive donor-, partner-, client-, and target-group relationships.

Gary Toenniessen, managing director, The Rockefeller Foundation, and long-time IRRI collaborator

The biggest challenge for IRRI today is that many of the national programs that it is assisting are also becoming very strong. IRRI needs to really find its niche in Asian situations, in which the national programs are now quite capable as well. I think there really is a niche for IRRI. It's doing those kinds of things that can be shared across all of the rice research institutions in Asia or worldwide and that wouldn't likely be done by a national program or, if they were, that they wouldn't get shared. IRRI needs to be a coordinator, a source of knowledge or information, and continually a source of breeding lines, which have traits that have been generated through advanced science done throughout the world that no national program can probably access.

The new Sub1 lines that have submergence tolerance are a good example. The initial real work on that was done at the University of California, Davis. Not only was the technology transferred, but the person who did the work, David Mackill [IRRI senior scientist; see *Scuba rice: stemming the tide in flood-prone South Asia* on pages 26-31 of *Rice Today* Vol. 8, No. 2], was transferred as well from California to IRRI. And so, the next phase in that process was done at IRRI and all submergence-tolerant materials are now being shared with the national programs. I really do think there's an important role for IRRI to be the conduit by which and through which the best science in the world gets applied to rice research and then shared with the national programs in Asia.

To read further comments and additional background via hotlinks and video clips from these and at least 13 other pioneers, go to the *Rice Today* Web site at **irri.org/publications/today/challenges.asp.**

Overcoming the **toughest stress** in rice: DROUGHT

by **Lanie C. Reyes**

Efficient GM technologies and an innovative drought-screening facility at IRRI increase the chances of discovering new candidate genes for the development of drought-tolerant rice

Drought brings to mind negative images of wide expanses of dry and parched lands. It is often associated with abject poverty, distraught farmers, hungry children, sickness, and sometimes hopelessness (see *Dreams beyond drought*, pages 15-21 of *Rice Today* Vol. 4 No. 2).

According to the International Rice Research Institute (IRRI),[1] about 38% of the world area—home to 70% of the total population and source of 70% of global food production—suffers from drought. The effects of this problem are massive and devastating for the rice farmers who need to plant the crop that feeds half the world's people.

Drought is a formidable foe, which IRRI fights untiringly through rice research. Most scientists agree that it is one of the most complex and toughest stresses to overcome when compared with other constraints such as salinity, flooding, pests, and diseases.

Considering that rice is a water-adapted plant grown in flooded fields, helping it cope with water stress and enabling it to produce economically good yields under drought is a great challenge.

But, this does not stop IRRI scientists from finding answers and new solutions for breeding new varieties and from understanding the effects of drought on rice at the genetic and molecular level (see *Making rice less thirsty* on pages 12-14). For them, the challenge is clear—*increase rice yield despite drought.*

One potential solution for better understanding drought complexities is through genetic modification (GM, also called transgenics, uses modern biotechnology techniques to change the genes of an organism).


DR. RACHID Serraj


DR. INEZ Slamet-Loedin

WILLIAM STA. CLARA (4)

Coincidentally, scientists have been using genetic modification in some forms for years. In fact, all crops have been genetically improved (modified) for millennia by selection by farmers and by breeding in the past hundred years.[2] In addition, the Nuffield Council on Bioethics concluded in 1999 that genetic engineering could be considered as natural as conventional plant breeding.[3]

For farmers, GM crops are no longer a novelty. The International Service for the Acquisition of Agri-biotech Applications (ISAAA) reported in 2008 that 25 countries cultivated GM crops, including the developing countries Egypt and Burkina Faso. ISAAA reported that between 2007 and 2008, the area grown to GM crops rose by 9.4% or 10.7 million hectares, totaling more than 120 million hectares. An increasing number of people consider GM as a potential source for more benefits in agriculture, for example, for a rice variety tolerant to drought.

Research groups at IRRI, led by Drs. Rachid Serraj, crop physiologist, and Inez H. Slamet-Loedin, cell biologist, are currently working on drought-tolerant varieties using GM. (For a general idea about this process, see *Tool box for making GM rice.*). "Current GM technologies at IRRI are very efficient for both indica and japonica rice cultivars, and there is no major technical bottleneck in producing a large number of 'events' (independent plants generated from

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1 See *Economic costs of drought and rice farmers' coping mechanisms*, edited by S. Pandey, H. Bhandari, and B. Hardy, 2007.
2 See *Redesigning rice photosynthesis to increase yield*, edited by J.E. Sheehy, P.L. Mitchell, and B. Hardy, 2000.
3 www.nuffieldbioethics.org/fileLibrary/pdf/gmcrop.pdf

a GM cell) as long as there is space to plant and characterize them," said Dr. Slamet-Loedin.

A new drought-screening facility and a protocol that mimics drought conditions in the lowland rice ecosystem have been established at IRRI to support, enhance, and expand the scientists' work on developing a drought-tolerant crop. Unlike in the past, when GM drought-tolerant crops were mostly tested under artificial conditions using pots, the new facility allows scientists to better predict the crop's yield, which previously was difficult to estimate.

"The new drought-screening facility can assess a bigger population of plants to take into account the possible variation in the effects of a transgene on plant growth and yield performance," Dr. Serraj said.

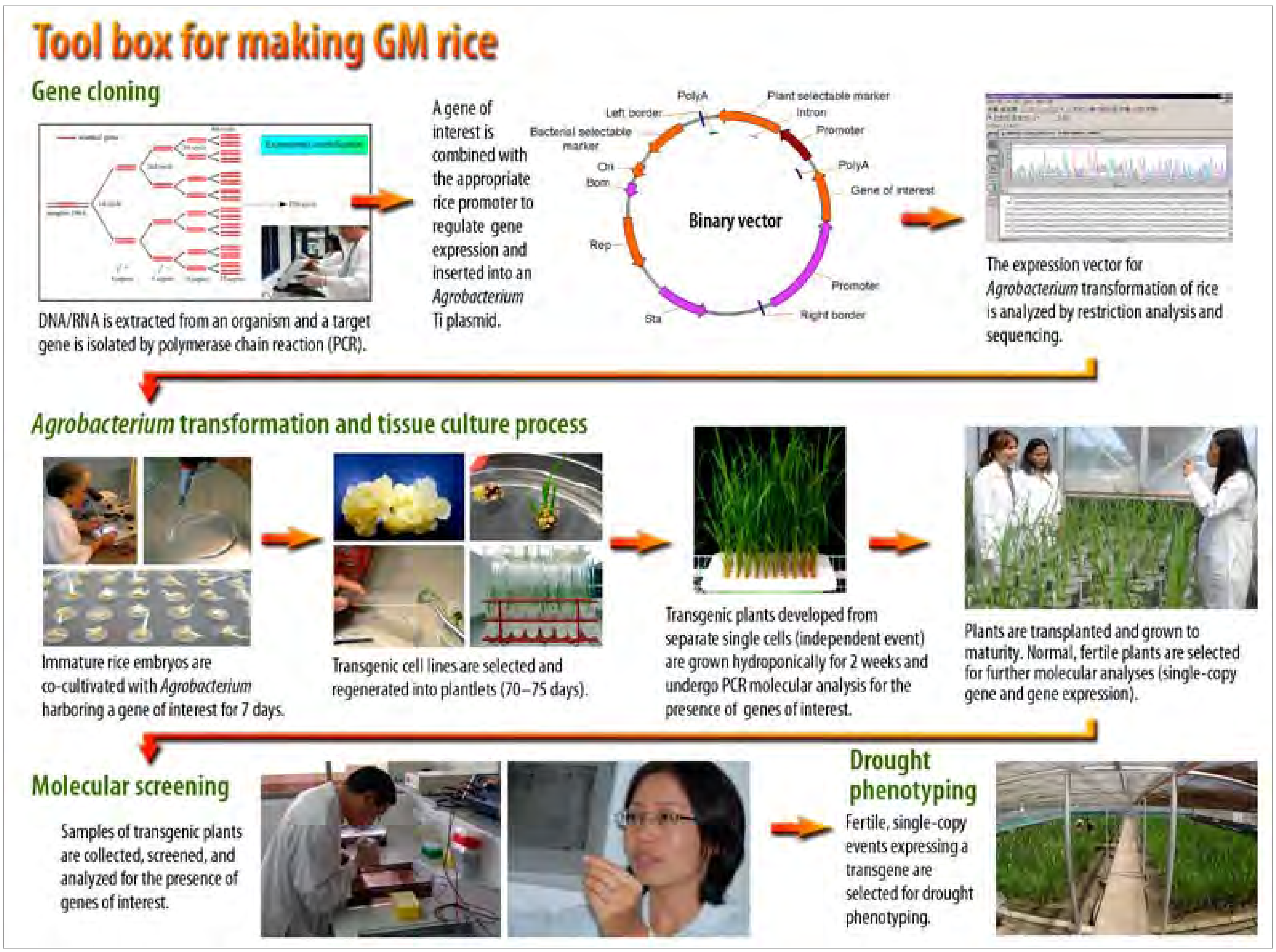
"Since IRRI is able to generate large numbers of transgenic events, it is more efficient to select and discard plants from the early steps, and keep only those showing promising responses," he added. The rice plants can be robustly and comprehensively selected based on their phenotypes (physical attributes) and yield characteristics.

Rice farmers, however, are often not interested in the significance of having a drought-tolerant crop *per se*, since they are more concerned about whether the crop will produce a good and sustainable yield. An improved crop could survive drought stress, yet not produce a harvestable yield. So, it is crucial for scientists to measure biomass accumulation (weight or total quantity of the plant) and yield performance that would result from modifying a gene.

"At an early step of the evaluation, we assess the impact of water deficit on plant growth and use nondestructive measurements to analyze crop performance," Dr. Serraj said. "Plant phenology (the plant's biological stage, that is, flowering, tillering, grain formation, etc.), growth, transpiration, canopy temperature, photosynthesis, leaf rolling, tillering ability, root biomass, and spikelet fertility are among the parameters to be measured for a large number of plants."[4]

Moreover, Dr. Dong Jin Kang,

[4] See *Drought frontiers in rice: crop improvement for increased rainfed production*, edited by R. Serraj, J. Bennett, and B. Hardy, 2008.



an IRRI postdoctoral fellow, explained (with reference to the samples in the drought-screening facility), "Plants that grow and produce well in this condition are selected as candidates for drought tolerance." The facility also contains a flooded control plot of GM rice. Scientists compare the performance of the tested varieties under different conditions, to make sure that any selected material would be able to perform well under a variety of environments.

NANCY SADIASA, Evelyn Liwanag, and Flor Montecillo, research technicians; Malen Estrada, assistant scientist (front row); Dr. Rachid Serraj, crop physiologist, and Dr. Dong Jin Kang, a postdoctoral fellow (at the back) at IRRI, inside the drought-screening facility.

Dr. Slamet-Loedin said that the performance of GM rice is tested under drought and irrigated conditions to identify transgenic events in both conditions since drought may not occur in each planting season.

Sometimes, the transgenic plant performs better than the wild-type counterpart in drought conditions, but may yield less in normal conditions. This is a crucial factor and the reason candidate genes tested at IRRI are designed to be activated by drought (making the expression of the drought tolerance gene inducible by drought) to avoid any yield penalty in normal conditions.

To further ensure that no uncontrolled water will enter and ruin these experiments, the scientists placed a 1-meter-deep physical barrier around the plots to prevent water seepage and percolation from adjacent flooded plots. The bed under the drought treatment, on the other hand, is equipped with a drainage system in which water gravitationally flows and gradually reduces the soil moisture of the topsoil.

Agrobacterium tumefaciens containing a binary vector is dispensed on immature embryos.

Moreover, to maintain the precision of soil drying, scientists constantly monitor the amount of moisture and water tension in the soil, as well as the air temperature, relative humidity, and vapor-pressure deficit.

"Periods of managed water deficits are imposed with precise parameters of stress timing, duration, and severity," Dr. Serraj explained. "Soil water is gradually reduced a few weeks after transplanting until the flowering and grain-setting stages, with soil moisture decreasing from fully saturated to minimal," he added.

The facility also has a double-layered mesh on the ceiling and the surrounding divider to satisfy biosafety requirements. "Without protection, flying insects could enter the facility," Dr. Kang explained.

The drought-screening facility has been successful in creating realistic drought conditions. During the dry season of 2007, the first drought-screening experiment using the facility was carried out to test the effects of a gene for drought tolerance provided by the Japan International Research Center for Agricultural Sciences. The scientists were pleased to observe that the data on yield under irrigated and drought conditions inside the drought-screening facility were similar to the ones obtained from non-transgenic field experiments at IRRI.

"We are making progress and we have already identified a few promising lines," Dr. Serraj confidently stated. "These, however, will need further testing and validation. The drought-screening facility greatly helped in our transgenic research, so we plan to establish a similar and bigger facility in the future. This will allow us to test more gene candidates."

Not leaving any stone unturned, IRRI scientists intend to find more ways to help farmers cope with drought. With advances in technology, things are definitely looking up for both scientists and farmers. Drought-tolerant varieties are developed and enhanced by the integration of GM approaches into breeding programs, as well as the by the use of this new facility that enhances precision and effectiveness in delivering new and improved genetic lines.

6th International Rice Genetics Symposium

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The symposium comes at a key time for the international rice industry, which is under unprecedented pressure caused by record high prices and major production challenges. It provides an important forum for reviewing the latest advances in rice research, how recent breakthroughs could affect global food security, and in-depth discussion and exchange of information on classical genetics and genomics. This major event will showcase the latest developments in the field, including research on breeding, mapping of genes and quantitative trait loci, identification and cloning of candidate genes for biotic and abiotic stresses, gene expression, and genomic databases and mutant induction for functional genomics.

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Jian-Kang Zhu	University of California-Riverside, USA
Ko Shimamoto	Nara Institute of Science and Technology, Japan
Makoto Matsuoka	Nagoya University, Japan
Masahiro Yano	National Institute of Agrobiological Sciences, Tsukuba, Japan
Monty Jones	FARA, Ghana
Naoko Nishizawa	The University of Tokyo, Japan
Olivier Panaud	University of Perpignan, France
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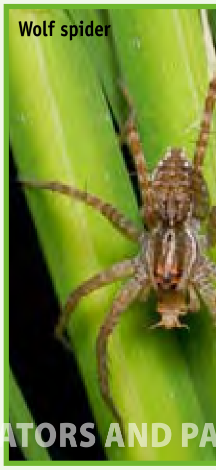
MAPS

Ecosystem services for biological control in tropical rice

by **K.L. Heong, R. Hijmans, J. Catindig,** and **S. Villareal**



At least 200 species of parasitoids and 150 species of predators live in tropical rice fields. Their diversity and abundance are the key indicators of the degree of biological control services present in an ecosystem, such as resisting pest invasion and regulating pests

Rice is produced in landscapes that range from extreme monocultures to highly diverse areas. Tropical rice fields often have a great diversity of naturally occurring arthropod groups that function as predators and parasitoids (*see photos above*). At least 200 species of parasitoids and 150 species of predators live in this environment. Their diversity and abundance are the key indicators of the degree of biological control services present in an ecosystem, such as resisting pest invasion and regulating pests.

Since rice is grown in seasons, and so does not provide a permanent habitat for pests, most of them come and infest fields when rice is planted. They multiply their population rather quickly. Their natural enemies, however, tend to prevent their exponential growth.

When rice is harvested, these natural enemies take refuge in other habitats surrounding the rice fields. But, as soon as a new crop is established, they too swarm the fields again. Generalist predators, however, such as spiders and crickets, are less mobile.

Based on this, factors such as landscape structure, habitat diversity, cropping patterns, and farmers' crop management practices can greatly affect these groups and the services they provide. These relationships are often scarcely studied and quantified.

Fig. 1

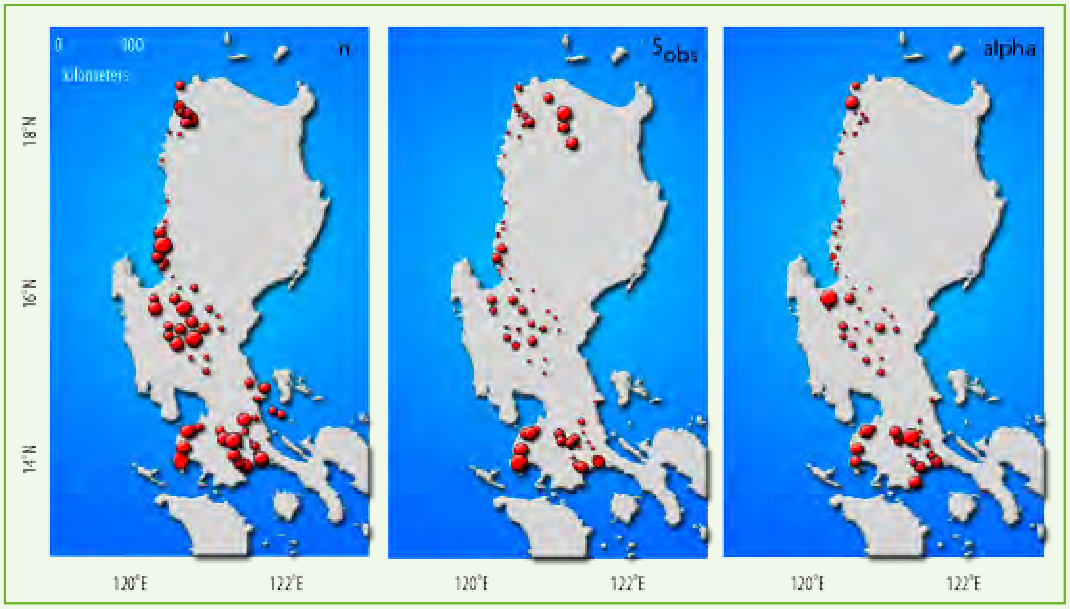


Fig. 3. Parasitoids.

IRRI (3)

Our maps show some of the preliminary results culled from an assessment of predators and parasitoids in rice fields of Luzon Island in the Philippines (Fig. 1). We obtained 3,050 net sweep samples from 61 sites. These sites were selected using remote sensing-derived land-cover data to ensure that the sampling covered a range of landscapes representative of the fraction of land used for agriculture (Fig. 2). We caught 11,041 predators that represent 109 species (81 genera), and 6,682 parasitoids that come from 156 species (87 genera). Note, however, that we could not determine the species level of all the insects found.

The number of insects caught at different sites was from 37 to 2,518, with a median of 209. The number of species, on the other hand, was from 11 to 79, with a median of 36. There was a spatial clustering of abundance (expressed as n), species richness (expressed as S_{obs}), and biodiversity (expressed as alpha) in parasitoids (Fig. 3) and predators (Fig. 4). Associations between species diversity and habitat and crop management were very weak and, in most cases, statistically insignificant. The relative strength of spatial autocorrelation between sites and the weakness of more association with local variables suggest that either larger scale processes shape ecosystem services for biological control or that our results are strongly influenced by sampling artifacts (sampling time, agronomic practices, and regions are confounded).

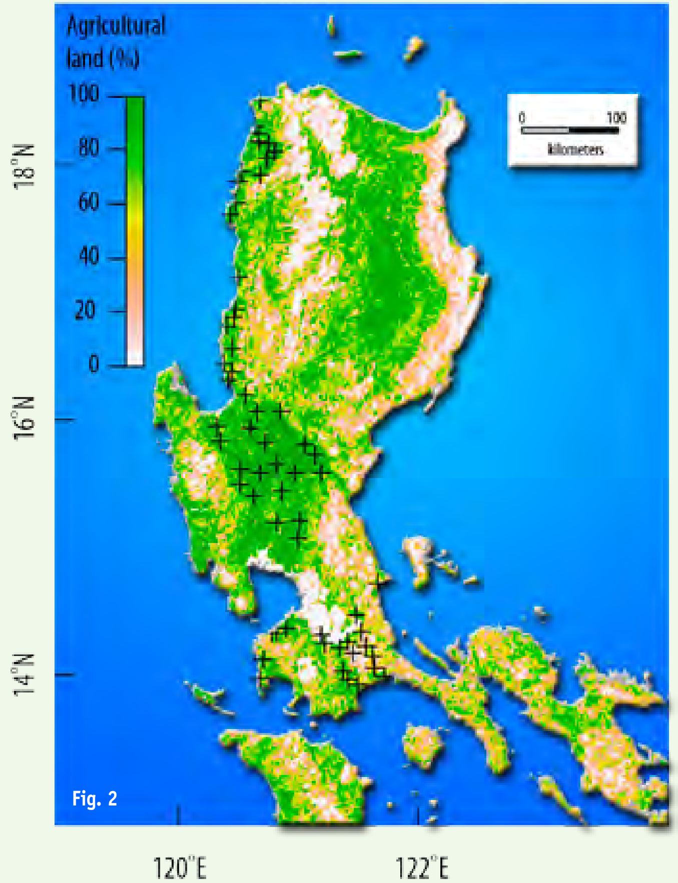


Fig. 2

Although parasitoid and predator biodiversity is clearly closely related to land-use patterns, there is still a need to establish direct linkages between diversity indicators and biological control services. Of particular interest is the effect of agronomic practices such as pesticide use on biological control; the influence of selected vegetation that provides food resources to parasitoids, such as nectar-producing flowers; and the use of ecological engineering methods to design more effective habitat mixes. Further research should answer these questions.

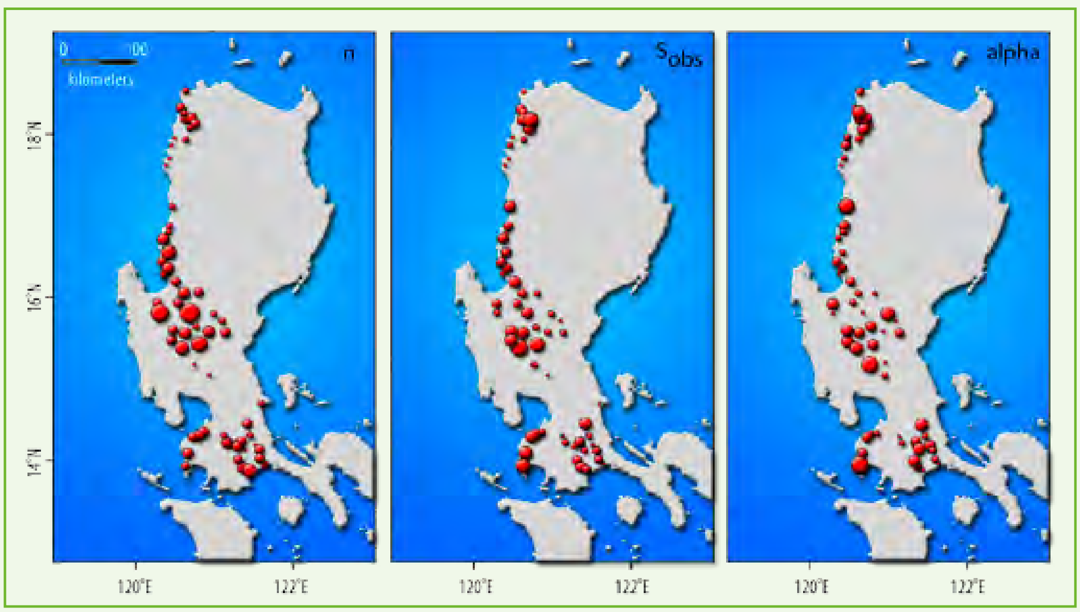


Fig. 4. Predators.

Dr. Heong is a senior scientist in entomology and a specialist on integrated pest management, while Dr. Hijmans is a GIS specialist at IRRI. Ms. Catindig, an assistant scientist, and Ms. Villareal, a researcher, work in IRRI's Crop and Environmental Sciences Division.

IRRI

Banking our **rice** knowledge

by **Sophie Clayton**

A repository of "best practice" information about rice farming, the Rice Knowledge Bank delivers research solutions to extension workers and farmers worldwide, effectively and efficiently

Generating relevant and useful research solutions to agricultural problems is only half way to improving farm productivity and sustainability, and helping raise farmers out of poverty. These solutions need to get to farmers, who, in turn, learn and adopt them to realize their full potential benefit.

Extending rice research

In 2002, the International Rice Research Institute (IRRI) discovered that, while it had vast amounts of valuable rice-farming knowledge, the information was not really accessible to the wider extension community of government and nongovernment organizations, universities, and the private sector. To bridge this gap, the Institute formed the Rice Knowledge Bank (RKB; www.knowledgebank.irri.org/Rice/Ricedefault.htm), which brought together all of IRRI's current validated rice-farming knowledge relevant to the extension community, and made it available in a one-stop shop on the Internet and on CD.

The RKB covers the whole seed-to-market cycle of rice production that includes seeds, land preparation and crop establishment, water management, integrated nutrient management, integrated pest management, harvesting and threshing, drying, storage, milling, processing, and economics and marketing.

Moreover, the RKB presents information in the form of fact sheets, which can easily be printed out. It also prepares online training courses designed with nonscientists in mind, to ensure effective communication with users.

Aside from providing practical information on rice, the RKB also offers information that aims to build the skills of extension workers and help them improve their capacity to teach farmers.

Noel Magor, head of the Training Center at IRRI and one of the leaders in developing the RKB, explains that the RKB complements the suite of face-to-face and online/CD training programs that IRRI runs for extension officers.

"We train extension officers and others worldwide to teach them the latest best practices in a range of rice-related topics," Dr. Magor said. "When these people head back to their home countries and start providing training and information to rice farmers, they can draw upon the resources of the Rice Knowledge Bank to support them.

"This is the real power of the Rice Knowledge Bank—helping provide information to rice farmers through established local extension mechanisms and information delivery routes," he added.

Getting local

Stage one of the RKB focuses on providing information exclusively generated from IRRI research. Although considered high-quality, current, and scientifically credible, IRRI's research is recognized as only part of a bigger picture, because two important ingredients are included: national research results and indigenous knowledge.

In 2005, IRRI started to work with its partners in the national agricultural research and extension systems (NARES) and planned country-based versions of the RKB to complement the overarching IRRI research component.

This effort has since culminated in the launching of the country-based RKBs for all the major rice-growing countries such as Nepal, Sri Lanka, Bangladesh, Myanmar, Thailand, Lao PDR, Cambodia, Vietnam, China, the Philippines, and Indonesia. The team has also started to apply the RKB concept in India. Each national RKB is translated into the country's respective language, and is developed and managed by the pertinent local authority to include validated information that is locally relevant and owned.

For example, the Bangladesh Rice Knowledge Bank (BRKB) was established in 2004. Since then, 76 government and nongovernment extension providers have been trained how to use it, 3,860 participants in 95 rice production training courses have been informed about it, 900 CDs have been distributed, and more than 20,000 people have visited the BRKB Web site (www.knowledgebank-brri.org).

"The Bangladesh Rice Knowledge Bank is a one-stop repository of rice information including a training module, rice production handbook, and flip charts," said Dr. Jahirul Islam, chief scientific officer and head of the Training Division at the Bangladesh Rice Research Institute.

"It is well accepted and used by the rice community as it is reader-friendly," he added. "The government is also planning to use it through telecenters at the farm level, to improve the country's rice production. The Bangladesh Rice Knowledge Bank is a cost-effective new route toward food security."

After Asia, the next frontier for the RKB is Africa. Rice is becoming a major crop for eastern and southern Africa, with regional demand growing at 6% every year. In 2009, in collaboration with the Africa Rice Center (WARDA), the RKB concept is being introduced to six rice-growing African countries. More countries are expected to follow shortly. This will form part of WARDA's grand plan to develop a Rice Information Gateway for Africa.

COURTESY OF CRKB

DR. NOEL Magor, head of the International Rice Research Institute's (IRRI) Training Center, distributes CDs of the Cambodia Rice Knowledge Bank to IRRI's project partner in Pursat Province.

The impact

More than just a Web site or CD, the RKB is a gateway to information and resources to help improve the knowledge and capacity of extension officers, who, in turn, can tailor the delivery of information to their local farming communities. National RKBs have also greatly improved the use of national research, making the best knowledge readily available to the extension community.

In Thailand, an evaluation of the RKB has shown that extension officers saved, on average, about US$2,500 a year each when they used the RKB. This is based on the time they saved searching for information and revisiting farmers, and on the costs they saved on photocopying. More importantly, Thai farmers who used the RKB had fewer costs and higher revenue. They had a total net income of $60 per hectare more than non-RKB users.

The evaluation also gave suggestions on how to increase the use of RKB information, including encouraging farmers to participate in RKB meetings and improving the general knowledge of farmers about computers. This feedback will be used to further improve the extension of the RKB program.

In Vietnam, farmers, extension practitioners, and other users appreciate the Vietnam RKB because, for the first time, they have a bank of comprehensive, up-to-date, and easily understood rice knowledge, which was previously scattered across various sources. With the Vietnam RKB available online, extension staff can access and select the updated information from their RKB to develop training materials and handouts for their work. More than 500,000 people accessed the Vietnam RKB online in its first 4 months of operation. Where the Internet is unavailable, users can access the Vietnam RKB by using CDs that are reproduced for distribution.

Furthermore, the Cambodian RKB was officially launched by the Ministry of Agriculture, Forestry, and Fisheries. The event was followed by training activities in 15 target provinces. According to Mr. Ty Channa, head of the Training and Information Center at the Cambodian Agricultural Research and Development Institute (CARDI), the Cambodian RKB has provided effective support for field-level demonstrations for farmers. CARDI's efforts in the development of new rice varieties have been strengthened by the Cambodian RKB. Cambodian farmers are now using new rice varieties on 48% and 87% of the total cultivated areas in the wet and dry season, respectively.

With such demonstrated successes, the RKB concept is now also being used as a model for other crops and livestock. Particularly, the International Maize and Wheat Improvement Center (CIMMYT), based in Mexico, is partnering with IRRI to build upon the successes of the RKB with other cereals, and to jointly launch the Cereal Knowledge Bank.

THE PROMISE OF LATIN

The Rice Americas 2009 unveils Latin America as an emerging major rice exporter in the world

by **V. Subramanian**

The Rice Trader Rice Americas 2009 Conference held last 12-14 May in Miami, Florida (USA), revealed key concerns of the rice industry and some valuable updates on progress made in food security. About 300 industry members from North, South, and Central America, the Caribbean, and even Asia attended the event, as these regions scrambled to plant more rice and to take a closer look at farm management and varietal needs to keep rice affordable and available to meet the world's growing demand.

Traders fretted over the recent fall in rice prices. This concern was compounded by a tough business environment, which saw credit lines cut and high-priced inventory create anguish among many unprepared businesses. Moreover, as the threat of an Indian return to the export market was felt as far away as Latin America, the conference identified research, investments in research, and farm management as the key building blocks of future rice production.

Representatives from research and academic fields as well as experts from the public and private sector agreed that efforts aimed at alleviating poverty, feeding the world, and sustainably producing food are the elements crucial to the global rice market. The rice industry has found itself vulnerable to volatility from supply shocks, after more than 10 years of yield growth being unable to keep up with population growth and demand.

Former U.S. Secretary of Agriculture Ed Schafer received The Rice Trader Market Achievement Award for his contributions to food security by being a faithful steward of relevant policies related to food in the U.S. and key regional markets that depend on food from the country.

The three authors of the following features on Latin America were speakers at the conference. Their articles examine topics that were not only highlighted at the event, but that were also subjects representing their lifetime passion and work in the rice industry.

Interestingly, the conference revealed South America's own export ambitions. Argentina, Brazil, and Uruguay reported on their exports to key African markets that used to be the domain of Asian and U.S. exporters. The three Latin American speakers discussed the region's potential as a major rice exporter—supporting the points raised by the International Rice Research Institute's Social Sciences Division Head, Samarendu Mohanty, in his previous Rice Facts article (see *Global rice trade: What does it mean for future food security?* on pages 44-45 of *Rice Today* Vol. 8, No. 2). He had called for more production initiatives to develop new international rice suppliers or new sources for rice.

Rice Today's publisher, Jeremy Zwinger, and its associate publisher, Duncan Macintosh, were also presenters at the event. Both emphasized the short-term business and longer term humanitarian ambitions of the global rice industry.

MR. ZWINGER (7th *from left*) with some of the Rice Americas 2009 Conference participants.

V. SUBRAMANIAN

AMERICA

Marketing for a cause

by **Dwight Roberts**

Rice farmers throughout the Western Hemisphere learned long ago that their climates and soils would produce profitable yields, and that, over time, thanks to the efforts of research, improved seed, and technology, their crop would prove to be an essential part of the daily diet. In Brazil, Peru, Cuba, Haiti, Venezuela, Colombia, Costa Rica, and a few other countries, rice has its spot on the dinner table. The phrase "if we do not eat rice, then we do not eat" is common in these cultures. But, although rice is grown from as far north as the U.S. state of Missouri to as far south as Argentina, some countries lag behind others in consumption, even though rice is affordable to all social classes.

In Mexico, a country with an estimated total population of 108 million, beans and maize are the basic commodities of people's diet. Yet, in 2008, the country imported more than 800,000 tons of rough rice to fill in the gap of local production and meet domestic needs. However, per capita consumption is still well under 13 kilos per person. This is in a country where more than 80% of the population is considered low-income consumers. They can afford to purchase rice, but many still do not know how to cook it and are unaware of its diverse benefits.

Moreover, in the extreme southern part of the Western Hemisphere, Argentina and Uruguay are two large rice-exporting countries. Both have considerable Italian influence, so it is more common to find pasta on the table than rice.

In between these two geographic extremes, there is a world of opportunity for the rice industry to educate consumers on the benefits and advantages of consuming rice on a daily basis.

PROMOTIONAL VEHICLES are used in Mexico and Central America to bring awareness about the nutrition programs.

USRPA

With the vast majority of the population living on a low income, it did not take long for the rice industry to realize that it had missed the most important consumer group in the region. The industry forgot that the poor must eat. Further analysis led to the development of cause marketing in Mexico and Central America. It is also gaining popularity in other countries throughout South America.

Cause marketing or *cause-related marketing* is a strategy that involves cooperative efforts for mutual benefit. This term is sometimes used more broadly and generally to refer to a marketing tactic that aids social and other charitable causes. The Famous Amos Cookie in the United States is one of the first examples of a cause-related marketing campaign done in the late 1970s. Wally Amos became the spokesperson for the Literacy Volunteers of America and he was credited with alerting more people about the problem of illiteracy than any person in history. Soon after, this approach gained tremendous popularity in the markets of Costa Rica, El Salvador, Guatemala, Honduras, Mexico, and Nicaragua through the teamwork of local governments, nonprofit organizations, the local rice industry, and trade organizations. It resulted in not just an increase in the volume of rice sold in a particular area of the market, but it also served as a great humanitarian gesture, as it built and strengthened positive relations between countries and communities, and between cultures and customs.

In Central and South America, cause marketing targeted the school nutrition programs and community development activities in poor rural and urban areas. As a result, it boosted rice consumption of consumers as they learned more economical and nutritious ways to feed their families without raising the cost of their meal budgets. The versatile use of rice and the cereal's health benefits are the key components of this educational process. In Central America particularly, the school nutrition program not only increased rice use between 20% and 66% in the areas where the promotion was conducted but also provided nutritious meals to school children and helped improve their school attendance.

With creative educational efforts, the benefits are shared by rice farmers, rice millers, and rice consumers. Viva el arroz!

Mr. Roberts is the president/CEO of US Rice Producers Association.

FLAR synergy

by **Gonzalo Zorilla**

Latin America and the Caribbean (LAC) represent only 4% of world rice production. Despite its small share on a global scale, however, rice is the most important crop in the region as it is the staple food of a majority of LAC's population.

Moreover, diverse agroecosystems characterize this region, and irrigated rice accounts for 70% of its total crop production. Rice farmers are mostly commercial producers and, even if the region, as a whole, is a net importer, several countries are active players in the international market.

Country	Partner institutions	Kind of institution			
		Producer [1]	Miller [2]	Seed [3]	Public [4]
Argentina	INTA-COPRA-ADECOAGRO	✓	✓	✓	✓
Bolivia	CONARROZ	✓	✓	✓	✓
Brazil	IRGA	✓			✓
Colombia	FEDEARROZ	✓		✓	
Costa Rica	SENUMISA	✓	✓	✓	
Dominican Republic	GENARROZ	✓	✓	✓	
Ecuador	INIAP				✓
Guatemala	ARROZGUA	✓	✓	✓	
Guyana	GRDB				✓
Honduras	DICTA-AHPRA-ANAMH	✓	✓	✓	✓
Mexico	Consejo Mexicano del Arroz	✓	✓		✓
Nicaragua	ANAR	✓			
Panama	FEDAGPA	✓		✓	✓
Uruguay	INIA-ACA	✓		✓	✓
Venezuela	FUNDARROZ	✓	✓	✓	✓
	CIAT				✓

[1] Rice farmers' association
[2] Rice industry groups
[3] Rice seed companies
[4] Public institutes for rice research and/or extension

FLAR at a glance

During the past 20 years, international cooperation has been changing its strategies, and one of the clear trends is the focus on Africa and some parts of Asia. Consequently, efforts in other places in the world have decreased, especially in Latin America. This shift prompted the establishment of the Latin American Fund for Irrigated Rice (FLAR).

In January 1995, the International Center for Tropical Agriculture's (CIAT) irrigated rice program experienced a lack of funding. A few local institutions allied with CIAT tried to save the program from closing by establishing FLAR. This initial impulse has subsequently evolved over the years into a new form of regional cooperation, which has taken up the challenge of creating a South-South alliance for rice research and development.

FLAR is an association of public and private institutions from 15 LAC countries (see figure) that are directly linked to the rice sector and that invest part of their resources in this joint regional effort. Producers, national research institutions, seed companies, and rice industry players serve as members of FLAR. They participate in the management of the Fund (see table) and ensure that the objectives of the association are defined by demand.

Furthermore, with its roots tied to CIAT, FLAR takes full advantage of CIAT's scientific capacity, infrastructure, legal representation, and its direct link with the International Rice Research Institute (IRRI) and the entire Consultative Group on International Agricultural Research system.

FLAR in action

Since the beginning, FLAR's priority has been its breeding program. In 1995, it inherited CIAT's genetic improvement program on irrigated rice—the one that IRRI supported and that later on sparked the region's own Green Revolution. This project introduced semidwarf varieties to LAC, and then soon after released hundreds of new varieties that have become essential to rice production.

FLAR soon developed an entirely new breeding program with one subprogram focused on the tropics and another on the temperate southern region. This is an integrated program in which the Fund is responsible for the initial steps of crossing and selection, and in which local institutions are responsible for the evaluation, final selection, and the release of new varieties. Thirteen commercial varieties have already been distributed to farmers and many of them are now the most planted ones in the farmers' respective countries. Several new varieties are in the pipeline, indicating the program's successful development.

Improving rice productivity, however, is not only a matter of breeding new varieties. In fact, very few places in the region have shown the need for new cultivars to increase yields. There is still a huge gap between the varieties' yield potential and farmers' actual production results. To help bridge this gap, FLAR developed a strong program on the transfer and extension of good management practices. It began with a project funded by the Common Fund for Commodities (CFC) from 2003 to 2006. This has continued and has expanded since then. Currently, the project is being established in 10 countries. On average, it has increased farmers' yields by 1–3 tons per hectare and has reduced costs by 10–30%. It definitely made a huge improvement in farmers' income and competitiveness.

FLAR intensively seeks new sources of funds to further advance its programs' actions. Recently, CFC approved a new project that incorporated the concept of "water harvesting" with small upland rice farmers in Central America. The strategy aimed to build small dams in farmers' fields to collect rainwater, allowing them to shift from low-yielding upland rice planted in the rainy season to high-yielding irrigated rice planted during the dry season. The project also encouraged farmers to use other irrigated crops and engage in fish production, as these are good means to diversify their livelihood sources and augment their income.

Network synergy

FLAR's mission is to create a regional independent organization for rice technology and development, focused on improving the rice sector's competitiveness, ensuring food supply, and reducing unitary costs.

Complementarity and synergy serve as the foundation of the system, with FLAR targeting those technological issues for which combining efforts lead to better results than having each member working alone.

The competitiveness of LAC's rice sector continues to improve through the joined efforts of everyone in the network—with CIAT being the top-level research center opening new frontiers, FLAR incorporating the new technologies in its applied research projects and funneling them to its members, and, finally, with the private and public institutions of each country adopting and adapting these technologies in farmers' fields to produce better outputs.

Mr. Zorilla is the executive director of FLAR.

Brazil steps up

by **Tiago Sarmento Barata, Renata Pereira da Cruz,** and **Valmir G. Menezes**

Apart from being a traditional soybean, maize, coffee, sugarcane, meat, and fruit producer, Brazil is a major producer and consumer of long-grain rice outside of Asia. It produces a total of 12.8 million tons of paddy rice on approximately 3 million hectares. This production, however, is still insufficient to meet domestic demand (approximately 13 million tons).

So, Brazil fills the gap by importing rice from its neighbors, particularly Argentina, Uruguay, and Paraguay. In spite of this gap, Brazil's rice has increasingly become a presence in the international market. In 2008, the country exported 790,000 tons and imported 590,000 tons of rice (on a paddy rice basis).

The country uses both upland and irrigated rice production systems but the geographic distribution of production has gone through significant cultural migration from the west-central region to the south during the past few years. By the end of the 1990s, the need for better markets and technology imposed unfavorable competition in the upland rice-producing regions, which favored cattle and other crops, mainly soybean and, more recently, sugarcane. The irrigated rice-producing regions (the southern part of the country), on the other hand, began an intense technological advancement process that considerably raised yields and increased the competitiveness of the irrigated crop.

To illustrate, during the 1976-77 growing season, irrigated rice production in Santa Catarina (SC) and Rio Grande do Sul (RS) accounted for 21% of the cultivated rice area and 37% of national production. Today, however, its share has increased to 44.5% of the cultivated area and more than 71% of total cereal production. Hence, rice production has been greatly strengthened and improved in southern Brazil.

COURTESY OF IRGA

RICE HARVEST in Rio Grande do Sul, Brazil.

Programs developed by research institutes such as the Rio Grande do Sul Rice Institute (IRGA) have been fundamental in increasing the average yield of the irrigated rice crop at the farm level in RS. Initiatives to reduce production costs and use natural resources more efficiently also helped guarantee a profit increase and sustainability among rice growers.

Over the past 6 years, average yield in RS showed an increment of 37%, from 5.33 to 7.3 tons per hectare in an area occupying more than 1 million hectares. The main factors that contributed to this progress were the release in 2002 of a herbicide-tolerant cultivar that allowed efficient red rice control and rice production in areas highly infested by insects (hybrid cultivars with herbicide tolerance were released in past years and the Clearfield system[1] was expanded in RS); more efficient cultivation systems (a minimum-tillage system in RS and a pregerminated seed[2] system in SC); anticipation of sowing time; adoption of an integrated cultivation system in the rice crop; anticipation of irrigation and nitrogen-fertilizer topdressing; change in crop fertilization schemes, with intensive use of higher amounts of basal and topdressing fertilization aimed at high yield; and intensification of the technology transfer process by public institutes such as IRGA, Emater, and Embrapa, and private companies.

Considering all of this, Brazil, led by RS, has played an important role in helping ensure food security in the world today.

Mr. Barata, a market analyst; Mr. Pereira da Cruz, a reseacher; and Mr. Menezes, technical director; all work at IRGA.

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[1] Clearfield is a production system developed by the BASF chemical company to control red rice.

[2] Seeds are normally pregerminated when directly sown into the puddled seedbeds. Pregerminating the seed increases the rate and percentage of seedlings established. It also reduces the time required for seeds to obtain enough moisture to initiate germination.

A look at INDIA

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

"Rice is life" truly lives up to its meaning in India, where its origin dates back to as long ago as 2500 B.C. In this vast country, rice is a staple food for more than half of its billion-plus population, and a source of livelihood for more than 50 million households. Apart from its economic and strategic importance, rice is also deeply engraved in the rich Indian tradition and culture. Rice offerings are common on many auspicious occasions to bring good health and prosperity to family members. Families bless newlywed couples by showering rice on their heads for prosperity and good luck (*photo above*). The significance of rice extends beyond life for many Indian communities. Rice is used in many rituals, including offerings of it to the departed soul.

While growing up in a small town in eastern India, we were frequently reminded by our parents not to waste rice as it would alienate *Lakshmi*, the Hindu goddess of wealth, fortune, and abundance. Numerous such instances can be cited to bolster the cultural and social significance of rice in India.

On the global front, India has the largest area under rice cultivation, but falls behind China in terms of volume of production. In the past 50 years, Indian rice production has nearly tripled with the introduction of semidwarf modern varieties as part of the Green Revolution technology package. During this period, production has been able to keep up with population growth, with a steady increase in per capita production throughout the Green Revolution era in the 70s and 80s, before flattening out in the 90s and finally declining in the 21st century (Fig. 1). An overlay of per capita consumption on per capita production clearly reveals that consumption was a shadow of production until the early 90s. But, since then, per capita consumption has been declining at a faster rate than per capita production—making India a rice-surplus country. The decrease in rice consumption, which started in the early 90s, coincided with economic reforms and trade liberalization that resulted in higher economic growth and diversification from rice to more high-value products.

The decline in average per capita rice consumption enabled India to become the second-/third-largest rice exporter in the world, accounting for as much as 20% of the market share in some years. It is also interesting to note that strong economic growth in the past decade resulted in the diversification of the food basket away from rice for all income groups (Figs. 2 and 3). Furthermore, per capita rice consumption among the lower income groups of both the urban and rural population also dropped over this period.

Despite the decline in per capita rice consumption, however, total consumption continued to climb because of growing population. The drastic drop in production in

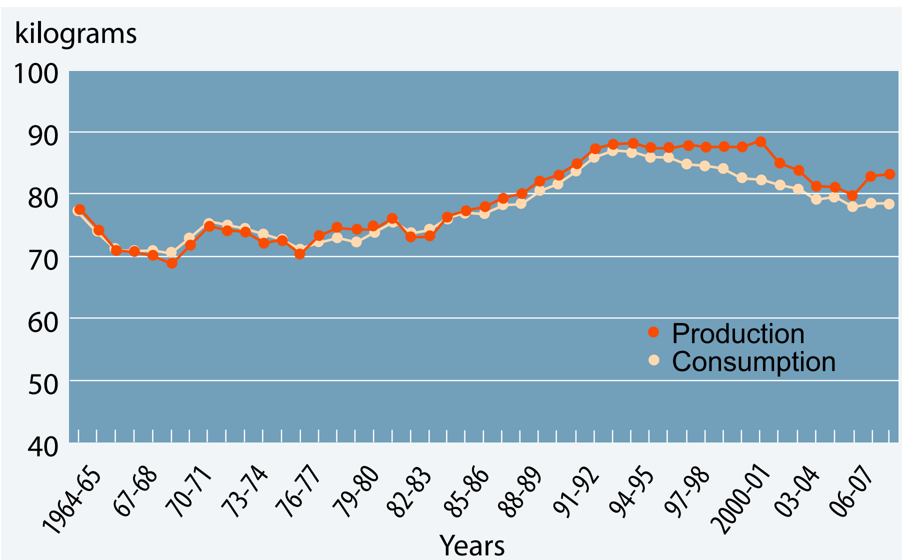

Fig. 1. Indian rice production vs. consumption on a per capita basis.*

*5-year moving average
Data sources: USDA and FAO

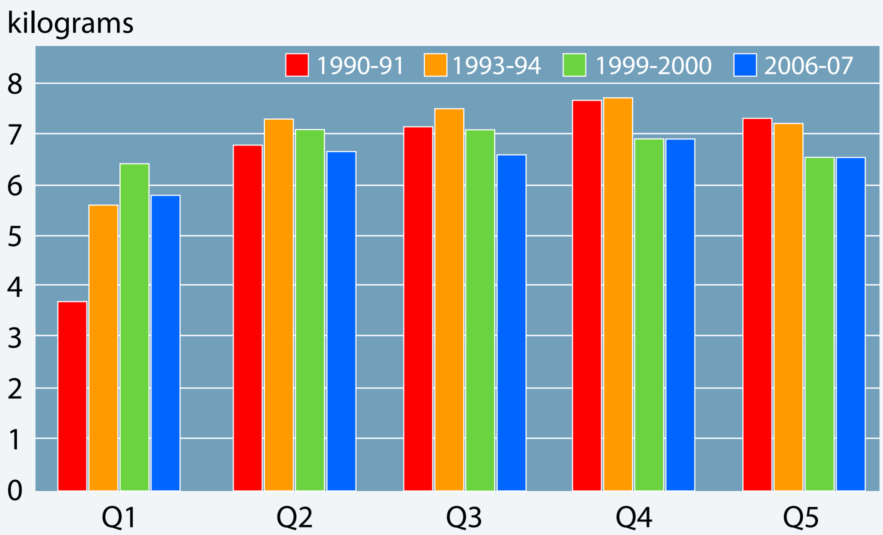

Fig. 2. Monthly rural per capita rice consumption by income groups.

Q1 = poorest 20% of the population and Q5 = richest 20% of the population.
Data source: various issues of household consumption expenditures by the National Sample Survey Organization.

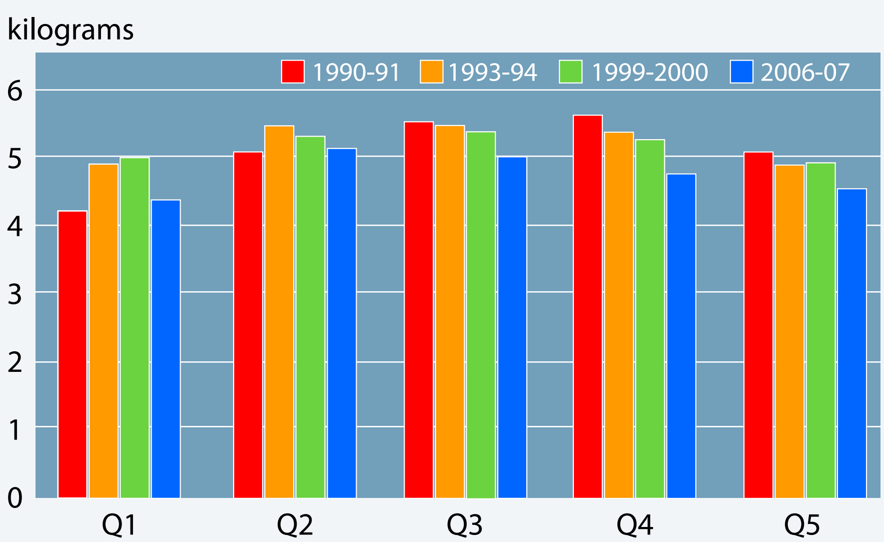

Fig. 3. Monthly urban per capita rice consumption by income groups.

Q1 = poorest 20% of the population and Q5 = richest 20% of the population.
Data source: various issues of household consumption expenditures by the National Sample Survey Organization.

2002 and 2003 because of drought made buffer stocks fall to a level not witnessed in decades. During this precarious food situation, the onset of a global food crisis prompted the government to protect the domestic supply by imposing a ban on nonbasmati rice exports in late 2007. Although the export ban was later replaced by a minimum export price for a few months, the government eventually re-imposed the ban in early 2008.

Current situation

According to USDA estimates, India is expected to harvest another record crop in 2008-09 after harvesting around 97 million tons in 2007-08. Domestic consumption is also projected to rise by around 2% this year. The continuing ban on nonbasmati rice has lowered rice exports for the second year in a row, from 5.5 million tons in 2006-07 to a projected 2.5 million tons in 2008-09. Lower exports and record production have contributed to rebuilding the stock from 8.5 million tons in 2004-05 to 17 million tons in 2008-09.

Although the situation has improved—consecutive record crops were produced and buffer stocks were gradually rebuilt—India continues to play it safe by keeping the export ban on nonbasmati rice. Continuing uncertainties in the global food and financial markets have also forced the government to be absolutely risk averse before the April-May 2009 general election. However, it is widely believed in the trading circle that the export ban will be lifted in the second half of 2009 to free up storage space for the upcoming *kharif* crop.

A simple comparison of rice retail prices in two major Indian markets (Hyderabad and Coimbatore) with that of the Philippines, the largest importer of rice in the world, revealed some interesting findings. Between October 2007 and January 2009, rice prices in Coimbatore and Hyderabad increased by 33% and 55%, respectively, compared with a 26% increase in the Philippines (Fig. 4). In some Indian markets, rice prices nearly doubled during this period. This may imply that the export ban has not been very effective in keeping rice prices low in the Indian domestic market. Even then, the government decision to restrict rice exports is logical based on the simple fact that rice is more than just a staple food in India, where political bigwigs hotly debate its affordability and availability.

Future challenges

As India moves into the future, it is almost certain to assume that higher income will bring about diversification of the food basket from cereal staples to more high-value products with a continuing downward slide of per capita rice consumption for people from all economic spectra. At the same time, it is also safe to assume that the rate of diversification will be much slower than what we have witnessed in China and in other East Asian countries during their development process. The ongoing financial

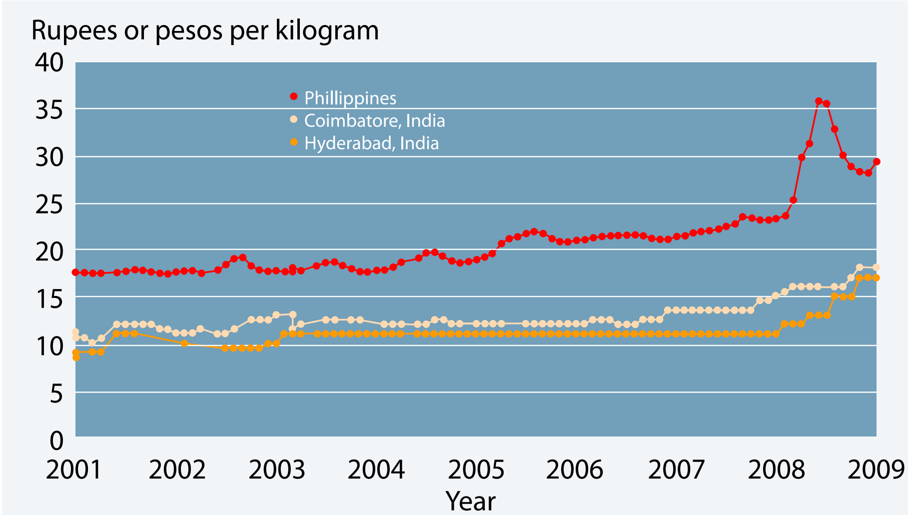

Fig. 4. Rice retail prices: India vs. Philippines.

Data sources: Indian Ministry of Agriculture and the Bureau of Agricultural Statistics, Philippines.

crisis may also slow down the rate of diversification even further.

Thus, total domestic rice consumption may still rise in the next decade with the United Nations (UN) projecting another 160 million people by 2020 added to India's current population base of 1.2 billion. Using the population projections from the UN and GDP projections from the International Food Policy Research Institute, our own estimate indicates that Indian domestic rice consumption will increase by 13 million tons of milled rice by 2020. The real question is, can Indian rice production increase by at least 13 million tons or more in the next decade to meet the domestic demand and maintain the status of an exporter in the global rice market? If current yield growth continues, and rice area remains at the 2008-09 level, India is likely to produce an additional 15 million tons of milled rice by 2020, which will be good enough to meet domestic demand.

Among the various and most glaring emerging uncertainties that can derail this outcome, however, are growing water shortages, imbalanced fertilization, competition for rice land from nonagricultural uses and biofuel crops, increasing frequency of extreme weather, and emerging pest outbreaks. Depending on the extent of these problems, production growth in the future may fall well below the baseline projections. Currently, imbalanced fertilizer applications in favor of nitrogen because of a subsidy are widespread in India, which adversely affects productivity and causes higher incidence of pests and diseases. The problem is much more severe in Punjab and Haryana, which have the highest marketable surplus and which contribute the most to the government procurement stocks. Subsidization of selected fertilizers has also led to fertilizer rations in many states, resulting in excess application in northern states and suboptimum application in many eastern and northeastern states (200 kg/ha in Haryana and Punjab versus 10 kg/ha in Arunachal Pradesh). A rapidly depleting water table in many northern states is also a matter of concern for future productivity growth.

On the positive side, the recent introduction of Sub1 or flood-tolerant modern varieties in India, where around 5 million hectares of rice land are prone to flash flooding, allows the rice plant to survive up to 2 weeks under water (see *Scuba rice* on pages 26-31 of *Rice Today* Vol. 8, No. 2). This period is long enough to completely destroy the traditional non-submergence-tolerant modern varieties. According to IRRI estimates, these Sub1 varieties have the potential to increase production by up to 4 million tons in India and Bangladesh. Similarly, IRRI's first drought-tolerant variety, IR74371-70-1-1, which was recently recommended for release in India, and a few more drought-tolerant varieties in the pipeline, if successful, could have an even bigger impact on production than submergence-tolerant varieties. The rice varieties developed for salt tolerance through collaborative research at IRRI and Indian research centers are also making an impact on the 6.7 million hectares of salt-affected area.

Another yield booster, hybrid rice, appears to have picked up its pace after an extremely slow start for more than a decade since its introduction in the mid-1990s. USDA estimated that hybrid rice area in India increased from 10,000 hectares in 1995 to 1.3 million hectares today. It is expected that the area under hybrid rice will likely continue to grow at a faster pace in the near term because of several promising hybrid seeds being developed by private companies, and also because of the government's efforts to expand hybrid rice area to 3 million hectares by 2011.

A combination of appropriate policy reforms and new technologies, particularly the development and diffusion of stress-tolerant varieties, can put Indian rice production back on track to ensure food security for the vulnerable in the future. A recent policy reform to lower the price disparity between straight and complex fertilizers is a move in the right direction to promote balanced fertilizer application. The introduction of a uniform freight subsidy scheme for all subsidized fertilizers will also likely help improve availability in all parts of the country. Eventually, the government will have to deal with the sustainability of the fertilizer self-sufficiency program in the face of a rising subsidy bill, which jumped from US$5.8 billion in 2006-07 to a whopping $22 billion in 2008-09. Similarly, free water and electricity for farmers in many states need a careful examination to make sure that enough incentives are built into the system to minimize wastage of groundwater.

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Doubled haploids: from laboratory to field

BY DEEPINDER GREWAL

Plant breeders are always in search of new breeding tools to produce high-yielding crop varieties with superior grain and nutritional quality, which are also resistant to diseases and insects, and tolerant of environmental stresses (drought, flooding, salinity, cold, etc.). Of the many tools available, anther culture-derived doubled haploids (haploid cells having two copies of the set of chromosomes) have been considered the most desirable method to shorten the breeding cycle in the varietal development process and to map genes/quantitative trait loci (QTLs) for agronomic traits.

The anther culture technique is a friendly tool for plant breeders. It provides a link between conventional plant breeding and genomics. Haploids were first produced from anther culture of the ornamental herb *Datura innoxia* by scientists at Delhi University, India, in 1964. Since then, haploids have been produced in several plant species, including cereals. In fact, several rice varieties have been developed and released, particularly in Korea and China, using this technique. These varieties are japonica type, which are very responsive to anther culture. The potential of this technique in indica rice breeding, however, has not been realized because of the recalcitrant anther culture response of indica varieties, and also because it often produces albino plants that eventually die.

In addition to increasing rice yield potential, plant breeders are aiming to improve the grain's nutritional quality. Breeders are trying to enhance micronutrient content, particularly iron and zinc, through biofortification to overcome the problem of malnutrition. Iron deficiency alone affects more than 3 billion people in the developing world. Lack of this nutrient during childhood and adolescence impairs physical growth, mental development, and learning capacity. In adults, it reduces the capacity to perform physical tasks. Moreover, according to the World Health Organization, zinc deficiency ranks fifth among the most important health risks in developing countries, and eleventh worldwide. In children, zinc deficiency is commonly associated with diarrhea, pneumonia, and stunted growth, and it can cause death.

To overcome zinc and iron deficiency among people where rice is a staple, the International Rice Research Institute (IRRI) has embarked on an ambitious project supported by the HarvestPlus Challenge Program to produce nutritious rice. This requires increasing the grain micronutrient content of existing and future high-yielding indica varieties using high-zinc, high-iron japonica donors, which

The anther culture technique is a friendly tool for plant breeders. It provides a link between conventional plant breeding and genomics.

are known to be highly responsive to anther culture. We used anther culture to produce doubled-haploid (DH) lines from crosses between indica and japonica lines. Mega-varieties such as IR64, IR36, PSBRc82, and BR29 were selected as one of the parents in diverse crosses with japonica donors. IR64 and IR36 are internationally popular varieties, while PSBRc82 is a popular Philippine variety and BR29 is a mega-variety in Bangladesh. These two countries are the target areas where zinc and iron deficiencies are most prevalent.

Fortunately, we have been successful in producing more than 1,500 DH lines through anther culture. These lines are being evaluated for their agronomic potential and for high iron and zinc contents. Some of the lines may perform better than the parents. This technique has opened more opportunities to map genes/QTLs governing high iron and high zinc since little is known about the genetics of these traits, and to search for elite DH lines possessing high-yield traits, along with high iron and zinc. This information will be useful to design efficient breeding strategies for improving the nutritional quality of rice.

This technique is important in developing true breeding lines in the next generation from any segregating population; hence, the DH plants can be multiplied and analyzed just like pure breeding lines. This shortens the breeding cycle, as traits get fixed in the homozygous state. The other advantage is that DH populations can be used as permanent mapping populations because they are stable and constant. The DH lines offer a unique opportunity to improve selection efficiency for various traits because the haploid method is based on gametophytic instead of sporophytic selection. One such example is IRRI's use of a DH mapping population derived from a cross between IR64 and Azucena. This population was shared worldwide, and rice researchers have used it to map QTLs for several agronomic traits.

This technology is expected to support conventional breeding, especially for value-added traits.

As mentioned earlier, it has been challenging to use the DH technique in indica rice breeding. Consequently, this technique has not been deployed on a large scale to become an integral component of breeding programs for indica rice.

Nevertheless, IRRI has developed an indica-type variety through anther culture and it has been released for salt-affected areas in the Philippines. The difficulty will soon change, however, as we continue to explore and search for genes for high anther culturability, and eventually transfer these genes into recalcitrant indica varieties. Once such genes become available, this would make this technology more effective in adding new genetic properties into the breeding programs of indica rice, for which they are highly needed.

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